Structural and Institutional Challenges Facing the Agricultural Sector in the Context of Contemporary Economic Transformations -A Case Study of the City of Ain Bessam, Bouira Province-

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Abstract :
his study aimed to analyze the impact of structural and institutional challenges on the performance of local agriculture in the context of contemporary economic transformations, through a case study of the city of Ain Bessam in the province of Bouira and an assessment of the agricultural sector's infrastructure and production capacity. The study adopted a case study approach by analyzing local data and documents relevant to this sector, as well as productivity indicators and the institutional support and regulatory mechanisms governing it. The study concluded that improving local agricultural performance depends primarily on enhancing resource efficiency, developing institutional regulatory mechanisms, and adopting modern agricultural techniques capable of adapting to current water and economic constraints.

Mots clés:
Mot clé.1: secteur agricole
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Abstract : Cette étude visait à analyser l'impact des défis structurels et institutionnels sur les performances de l'agriculture locale dans le contexte des transformations économiques actuelles, à travers une étude de cas portant sur la ville d'Ain Bessam, dans la province de Bouira, ainsi qu'une évaluation des infrastructures et des capacités de production du secteur agricole. L'étude a adopté une approche par étude de cas en analysant les données et documents locaux relatifs à ce secteur, ainsi que les indicateurs de productivité et les mécanismes institutionnels de soutien et de régulation qui le régissent. L'étude a conclu que l'amélioration des performances de l'agriculture locale dépend principalement d'une meilleure utilisation des ressources, du développement de mécanismes réglementaires institutionnels et de l'adoption de techniques agricoles modernes capables de s'adapter aux contraintes actuelles en matière d'eau et d'économie.

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I. The introduction:

Agriculture is considered one of the strategic sectors for supporting food security and meeting the requirements of sustainable development; however, at the international level, its performance has become subject to a series of economic shifts and increasing structural pressures. The most significant of these pressures are the scarcity of natural resources, particularly water resources, as well as rising production costs and the complexity of the regulatory and institutional frameworks governing agricultural activity. Comparative studies have shown that improving agricultural performance is no longer dependent solely on expanding cultivated areas or increasing production volumes, but is now more closely linked to the efficiency of resource management, the effectiveness of regulation, and the ability of agricultural systems to adapt and persist within volatile economic and environmental contexts.

In Algeria, this issue takes on even more acute dimensions, given the country's semi-arid climate and increasing pressures on water resources, as well as the competing priorities between drinking water supply and agricultural irrigation needs. Added to this are persistent structural and institutional imbalances that affect the agricultural sector's productivity and stability. Despite efforts under public policies aimed at developing agriculture—through support programs and the expansion of irrigated areas— performance disparities persist across regions, raising questions about the effectiveness of these policies and the extent to which they translate into on-the-ground results.

In this context, this study focuses on the case of the city of Ain Bessam in the province of Bouira, as an irrigated agricultural area that relies on a regulated water resource system, while simultaneously facing clear water and regulatory constraints. The study aims to analyze the impact of these structural and institutional constraints on the performance of local agricultural activity through an applied approach that combines theoretical analysis with the examination of quantitative and qualitative performance indicators, and then applying the results to concrete realities. Through this, the research seeks to provide a realistic interpretation of local agricultural performance and highlight opportunities for its improvement within the framework of a more sustainable development vision.

Research Question

How do the structural and institutional challenges facing the agricultural sector interact with contemporary economic transformations to influence

local agricultural performance, as examined through a case study of the city of Ain Bessam in the province of Bouira?

Sub-questions

- ✓ What are the structural and institutional challenges that characterize the local agricultural sector in the city of Ain Bessam?
- ✓ To what extent do fluctuations in water resources and the associated institutional framework affect indicators of local agricultural performance?
- ✓ How does the regulatory and institutional framework help explain the disparities observed in local agricultural performance within the same region?
- ✓ What are the limitations of current policies and practices in improving local agricultural performance in Ain Bessam, and what are the realistic prospects for overcoming structural and institutional imbalances in light of current economic transformations?

Research Hypotheses

- ✓ Structural and institutional challenges, particularly those related to water resource management, weaken the effective utilization of local agricultural potential in the city of Ain Bessam, thereby limiting the regularity and stability of agricultural activity.
- ✓ Fluctuations in water supply, given existing regulatory constraints, contribute to a decline in local agricultural performance indicators, particularly in terms of productivity, production stability, and the sustainability of agricultural operations.
- ✓ Variations in local agricultural performance within the city of Ain Bessam are linked to the degree of institutional effectiveness, including the management of irrigated areas, cooperative organization, and access to support and financing.
- ✓ The limitations of current policies and practices hinder improvements in local agricultural performance, whereas adopting an integrated approach to resource management and strengthening institutional governance would reduce structural imbalances and improve outcomes in the medium term.

Significance of the Study: This study aims to:

- ✓ Identify the structural and institutional challenges facing the local agricultural sector in the city of Ain Bessam, with a focus on how these challenges manifest in the field in terms of water resource management and agricultural organization.

- ✓ To evaluate the performance of local agriculture by analyzing indicators of productivity, production stability, and the sustainability of land use, in the context of fluctuating water resources.
- ✓ Analyze the role of institutional organization and the cooperative framework in explaining the observed disparities in local agricultural performance within the city of Ain Bessam, given the differences in management styles and support mechanisms.
- ✓ Identifying the limitations of current policies and practices aimed at improving local agricultural performance, and proposing practical and realistic solutions to overcome structural and institutional imbalances.

Research Methodology

This research adopted an integrative methodological approach combining descriptive-analytical and case study methods, with the aim of analyzing the impact of structural and institutional challenges on local agricultural performance through a case study of the city of Ain Bessam in the province of Bouira.

The research relied on official sectoral data (National Statistics Office, Directorate of Agricultural Services, ONID), supported by an analytical questionnaire to measure quantitative and qualitative indicators of agricultural performance, in addition to semi-structured interviews used as a qualitative interpretive tool.

Scope of the Study

Geographical Scope: The study is limited to the city of Ain Bessam in the province of Bouira, drawing on provincial-level reference data when analytically necessary.

Subject Scope: The research focuses on analyzing structural and institutional challenges and their direct impact on local agricultural performance, without delving into aspects unrelated to the issue under study.

Temporal Scope: The study covers the period from 2016 to 2025, as this is a pivotal phase that witnessed significant hydrological and regulatory changes, particularly regarding the decline in water storage capacity, the reorganization of irrigated areas, and increasing pressure on water resources, reflecting the current reality of local agricultural activity.

II. Structural and Institutional Challenges Facing the Agricultural Sector

1. Structural Challenges Facing the Agricultural Sector

1.1. Structural Imbalance in the Mobilization and Allocation of Agricultural Water Resources

The imbalance in the system for mobilizing and allocating water resources among various uses represents one of the most significant structural challenges facing agricultural activity in Algeria, as priority is

often given to supplying the population with drinking water—particularly during periods of scarcity and drought— at the expense of allocations for agricultural irrigation. This situation results in an irregular reduction in the quantities of water available for agriculture, which undermines the stability of the production cycle and makes agricultural planning subject to external factors that are difficult to control.

This imbalance directly affects the profitability of agricultural investments and producers' ability to adhere to established agricultural programs, especially in inland areas that rely primarily on irrigated areas. It also negatively impacts the sustainability of agricultural activity by increasing production risks and reducing productivity, highlighting the structural nature of this issue as a result of allocation and structural choices that go beyond current climatic conditions. (Guessas, Boudrama, & Guettaf, 2024, pp. 361-378)

1.2. Fragmented Farm Holdings and Weak Economies of Scale

The land tenure structure, characterized by small and fragmented farm holdings, is considered one of the fundamental structural obstacles limiting the ability of agriculture to develop and modernize. This fragmentation hinders the achievement of the economies of scale necessary to reduce production costs, adopt mechanization, and utilize modern technology in agricultural operations. Studies on Algeria's agricultural structure show that the fragmentation of holdings weakens farmers' investment capacity and makes production more vulnerable to climate shocks and price fluctuations, and hinders the integration of farms into organized value chains, which directly affects the effectiveness of agricultural policies and the sector's productivity. (Mostefa, 2025, pp. 278-291)

1.3. The Fragility of Agricultural Infrastructure and Post-Harvest Chains

Structural challenges are not limited to the agricultural production stage alone, but extend to include weaknesses in the infrastructure associated with post-harvest operations—from storage and refrigeration to transportation and marketing. This weakness leads to the loss of a significant portion of crops after harvest, thereby reducing the value added of agricultural activity. Studies on food security in Algeria indicate that these imbalances limit the effectiveness of policies aimed at increasing production, as the sector's overall performance remains dependent on the efficiency of these chains in preserving the product and ensuring its effective marketing. Consequently, the development of agricultural infrastructure is a key factor in sustaining production and enhancing the impact of agricultural policies. (Bencharif & Rastoin, 2007)

2. Institutional Challenges Facing the Agricultural Sector

1.2. Limited Effectiveness of Public Support Policies in Boosting Productivity

Although public support programs for the agricultural sector in Algeria have expanded, the mere existence of such support does not necessarily guarantee an improvement in farmers' technical efficiency. The effectiveness of support depends directly on its design, its alignment with productivity incentives, and its promotion of innovation, and the clarity of measurable and monitorable objectives and frameworks. A recent benchmark study indicates that the volume of subsidies may sometimes be associated with a significant decline in technical efficiency, while support mechanisms not directly linked to production may have less of a negative impact on farm performance. This reflects that the challenge lies not in the existence of support itself, but in the nature of this support, its conditions, its targeting mechanisms, and how it is monitored to ensure a sustainable positive impact on production efficiency. (Ali, H, Mokhtar, & Tsabet, 2024)

2.2. Constraints on Agricultural Financing and Risk Management (Credit and Insurance)

Agricultural financing is one of the institutional bottlenecks in the agricultural sector, as agricultural enterprises face multiple constraints, most notably difficulty in accessing credit, high financing costs, and limited collateral and risk management tools. The impact of these constraints is exacerbated by rising levels of climate uncertainty and price volatility, and the relationship between financial support or bank financing and production performance is not direct; but rather requires an integrated institutional environment that includes effective channeling of financing, improved lending conditions, and expanded insurance and hedging tools. This aims to ensure the sustainability of agricultural investments and prevent them from being confined to short, high-risk production cycles, thereby contributing to enhanced productivity and the overall efficiency of agricultural activity. (Guemmaz, 2025, pp. 58-70)

2.3. Weaknesses in the Agricultural Extension and Advisory System and Their Impact on Innovation Adoption

Agricultural extension and advisory services are a fundamental institutional component in enhancing the performance of the agricultural sector, particularly in areas dominated by small-scale producers, as they contribute to the transfer of technical knowledge, the improvement of agricultural practices, and the enhancement of the capacity for informed agricultural decision-making. Studies indicate that the impact of extension services in Algeria remains uneven, as limited access to effective advisory

services causes many farmers to rely on personal experience, which slows the adoption of innovation and limits the sector's ability to adapt to climate change and market fluctuations. Improving the institutional performance of extension services is a necessary condition for achieving a tangible impact on agricultural productivity. (Tlemsani, Brahim, M, Ramdane, & Aoues, 2024, pp. 1446–1452.)

III. Local Agricultural Performance and Its Measurement Indicators

1. Local Agricultural Performance as an Assessable Productive and Economic Capacity

1.1. Agricultural performance as the efficiency of converting resources into agricultural outputs

Agricultural performance at the local level is measured by the extent to which agricultural enterprises efficiently convert available resources—such as land, water, labor, and capital—into tangible actual production. From this perspective, the concept of performance is directly linked to productivity and technical efficiency, not merely to the volume of production; and that variations in performance between regions reflect not only the availability of resources but also depend to a large extent on how these resources are managed and organized within the local context, as well as on the efficiency of agricultural planning and the institutional framework governing production processes. (Coelli, Rao, & O'Donnel, 2025)

1.2. Agricultural Performance as the Capacity to Generate Local Economic Value

The assessment of agricultural performance is not limited to agricultural productivity alone, but also encompasses the capacity to generate local economic value through income generation, job creation, and contributing to the regional economy. High-performing agricultural enterprises are those capable of transforming agricultural production into a sustainable source of income and employment, thereby promoting local development and reducing the vulnerability of rural communities. This performance is linked to the ability to effectively organize and manage available resources. (Hayami & Ruttan, 1985)

1.3. Agricultural resilience as the capacity to sustain operations and adapt to shocks

Local agricultural performance is viewed as the ability of agricultural holdings to maintain acceptable levels of production and income despite climatic, economic, and institutional shocks. Sustainability and resilience are key elements in assessing agricultural performance, particularly in regions that depend on volatile natural resources. From this perspective,

performance can only be considered high if agricultural holdings are able to maintain productivity and sustainable income over the medium term, while being able to adapt to sudden changes and fluctuations in the internal and external environment of the agricultural sector. (Pret, Falconnier, & All, 2025)

2. Indicators for Measuring Local Agricultural Performance

1.2. Quantitative Indicators for Measuring Local Agricultural Performance

Quantitative indicators are based on objectively measurable statistical data and are used to assess the level of production, efficiency, and stability in local agricultural activity. These indicators are considered an essential tool for conducting comparative analyses across different regions and time periods, which helps identify strengths and weaknesses in agricultural performance. (Fuglie, 2012, pp. 335-368)

2.2. Key quantitative indicators:

- ✓ Cultivated area by agricultural sector (hectares).
- ✓ Actually irrigated area within agricultural sectors (hectares).
- ✓ Agricultural production volume by agricultural sector (quintals/tons).
- ✓ Agricultural yield (quintals/hectare).
- ✓ Productivity of production factors, such as land and labor.
- ✓ Seasonal production variability (stability index).
- ✓ Number of active agricultural holdings.
- ✓ Size of the direct agricultural workforce.

These indicators provide an accurate diagnosis of disparities in agricultural performance, but they remain insufficient to explain the underlying causes of these disparities without linking them to the regulatory and institutional dimensions that influence resource management and production efficiency.

2.3. Qualitative Indicators for Measuring Local Agricultural Performance

Qualitative indicators complement quantitative analysis by assessing aspects that cannot be directly measured but have a decisive impact on agricultural performance and sustainability. These indicators are essential for understanding performance differences between regions with similar natural resources, as high quantitative results may not reflect the sustainability of agricultural activity. Among the most important qualitative indicators adopted are: (Girma & Petros, 2024, pp. 68-74)

Regular water supply and consistent irrigation.

- ✓ Stable farmer income.
- ✓ Quality of storage, cooling, and marketing services.

- ✓ Level of integration of agricultural technology, such as drip irrigation, mechanization, and the use of improved fertilizers.
- ✓ Access to agricultural extension and advisory services.
- ✓ Farms' ability to adapt to climate shocks.
- ✓ Degree of farmers' professional organization.

Neglecting these qualitative indicators leads to an incomplete assessment of agricultural performance, as some regions may achieve high production in the short term without this reflecting the sustainability or efficiency of agricultural activity in the medium and long term.

2.4. Comprehensive Indicators for Assessing Agricultural Performance: Between Quantity, Quality, and Pathways to Sustainability

While quantitative indicators provide a material basis for measuring agricultural performance, recent research shows that understanding the true performance of agricultural activity requires broader and more comprehensive indicators that take into account environmental, social, and economic dimensions alike. An effective assessment of agriculture is not limited to production and quantity alone, but also includes indicators related to biodiversity, crop diversity, agricultural income, and agricultural training and education, as well as other social indicators linked to farmers' ability to adopt sustainable practices and adapt to environmental and social changes. These multidimensional indicators help provide a more accurate assessment of local agricultural performance and enable the development of support policies aimed at improving the overall sustainability of the agricultural system, rather than focusing on one-dimensional indicators. (Ali & Perna, 2021, pp. 5-21)

IIV. Case Study of the City of Ain Bessam (Bouira Province)

1. Technical and Agricultural Profile of the Region

1.1. Spatial and Demographic Characteristics of the City of Ain Bessem

The city of Ain Bessem is a municipality and the seat of an administrative district within the province of Bouira. It is situated in a clearly agricultural plain in the center of the province. According to data from the 2008 General Population and Housing Census, the municipality's population stood at 42,635, while its total area is estimated at approximately 127 square kilometers, resulting in a population density of nearly 336 people per square kilometer.

These spatial and demographic indicators highlight a notable overlap between the expanding urban area and the surrounding agricultural zone, making agricultural activity a structural component of the local economy and an active factor in supporting population stability and promoting the dynamics of economic and social development in the region. (source2020)

1.2. The Water Base for Agricultural Activity: The Water Resources System and the Lekhal Dam

Agricultural activity in the city of Ain Bessam relies primarily on the organized irrigation system of the province of Bouira, which encompasses an irrigated agricultural area that has undergone expansion and rehabilitation covering an estimated 2,200 hectares. This area is managed by the National Office for Irrigation and Drainage, within an institutional framework aimed at regulating the use of water resources and ensuring the continuity of irrigation for irrigated crops.

However, the water supply on which this activity relies faces significant structural constraints, primarily linked to the decline in storage capacity of the Lekhal Dam, which is the main water source supplying the irrigated area. Available technical data indicates that its storage capacity has shrunk to approximately 25 million cubic meters due to siltation. Furthermore, a significant portion of the currently stored water resources is being diverted to meet drinking water supply needs, which negatively impacts the regularity of irrigation operations within nearby agricultural basins, including the Ain Bassam basin.)Algérie(2020 ،

1.3. Characteristics of Local Agricultural Activity and the Existing Production Base

Agricultural activity in the municipality of Ain Bessam is characterized by a primary reliance on irrigated farming within an agricultural sector subject to public management, with a clear emphasis on vegetable cultivation, particularly potato cultivation. Field data published in the press indicate that the agricultural sector comprises approximately 120 agricultural cooperatives and encompasses nearly 900 producers, reflecting a high level of institutional organization within the local production structure.

In terms of benchmark production performance, data from the Directorate of Agricultural Services (DSA) indicate that potato yields in the province of Bouira reach approximately 350 quintals per hectare, a rate that allows for an assessment of the region’s production potential when irrigation conditions and stable management are available. At the same time, this rate highlights the vulnerability of agricultural activity to any disruption in water resources or the local institutional framework, which puts production efficiency at risk in cases of shortcomings or organizational breakdowns. (Kabylie, 2013)

1.4. Technical Summary:

The data presented in this fact sheet show that the city of Ain Bessam represents a local model of agricultural activity based on a substantial irrigated production area, estimated at approximately 2,200 hectares.

However, the sustainability of this activity remains subject to structural water constraints, primarily linked to the declining storage capacity of the Lakhal Dam and the increasing diversion of water resources to meet drinking water supply needs. This occurs within a demographic context characterized by significant mobility, and a relatively organized producer base, which provides a realistic framework for analyzing the performance of local agricultural activity based on field data that is monitorable and verifiable.

2. Water Resources and Agricultural Activity in Ain Bessam

2.1. The Agricultural Water Supply System and the Limits of Irrigation Regularity

Agricultural activity in the city of Ain Bessam relies on an organized irrigation system linked to the region's surface water resources; however, the regularity of water supply remains subject to a set of structural constraints, as technical documents regarding the Lekhal Dam reveal a significant decline in its actual storage capacity, which has shrunk to approximately 25 million cubic meters due to siltation, compared to its original capacity when it first entered service. It is also noted that the majority of currently available water resources are directed toward meeting drinking water supply needs.

This situation results in an actual reduction in irrigation quotas during certain periods of the agricultural season, which directly affects the regularity and temporal stability of irrigation operations. Consequently, local agricultural activity, particularly irrigated farming, becomes more vulnerable to fluctuations in water supply, making water resources a decisive factor in determining production levels and the sustainability of agricultural operations in the region. (Mammer, 2023)

2.2. Actually Irrigated Areas and Their Relationship to Local Production Capacity

The area technically suitable for irrigation in the Ain Bassam agricultural region is estimated at approximately 2,200 hectares; however, this figure reflects the theoretical capacity of the irrigation system and does not necessarily correspond to the area that is actually irrigated throughout the growing season. Available sectoral data reveal a significant discrepancy between equipped areas and those actually utilized, a discrepancy primarily linked to water and regulatory constraints that affect the regularity of supply, particularly during periods of water stress.

This discrepancy serves as a practical indicator of the extent to which water availability influences local agricultural performance, as the reduction in irrigated areas directly impacts yield levels, particularly in crops that require

precise timing of irrigation, primarily vegetable crops. Consequently, the close relationship between the effectiveness of the irrigation system and the stability of the region's productive capacity becomes evident. (d'Oran, 2016)

2.3. The Impact of Water Resources on Reference Yields: The Case of Potato Cultivation

Potato cultivation is among the most important irrigated crops in local agricultural activity in the city of Ain Bessam, making it a model case for analyzing the relationship between the regularity of water supply and production performance levels in the province of Bouira. Data from the Directorate of Agricultural Services indicate a reference yield of approximately 350 quintals per hectare during periods of stable irrigation water supply.

It follows that any disruption in irrigation regularity within the agricultural sector of Ain Bessam leads to an actual decline in achieved results compared to available production potential, thereby widening the gap between theoretical and field performance. This reality highlights the critical role of water resources in determining the level of local agricultural production, particularly in crops that are highly sensitive to irrigation regularity, such as potato cultivation. (Watan, 2022)

Transition to a sustainable smart irrigation system to boost agricultural production in Ain Bessam

3.1. Adopting smart drip irrigation for all irrigated land (2,200 hectares)

Converting all irrigated land (2,200 hectares) to smart drip irrigation connected to soil moisture sensors, ensuring that each crop receives exactly the amount of water it actually needs. (Adak, 2025, pp. 502-507)

Expected Results: (Aisyah, Early, & Aldi, 2025)

-Reduce water waste by 30–50% compared to current flood irrigation.

-Increase potato and vegetable yields to a level close to the benchmark production potential of 350 quintals/hectare.

-Implementation model: The Smart Irrigation Project in Morocco and North Africa, which implemented drip irrigation systems + moisture sensors to conserve water and increase productivity

Direct implementation:

-Install drip irrigation pipes in each agricultural plot.

-Place moisture sensors at a depth of 15–30 cm in the soil.

-Connecting the sensors to a central control unit to automatically direct water when needed.

3.2. Integrating traditional water resources with supplementary sources to address structural constraints (Alsammak & Saeed, 2022, pp. 49–65)

Use the Lakhal Dam as the primary source of irrigation water, while constructing rainwater harvesting tanks with a capacity of 50,000–100,000 liters per unit to cover periods of drought.

-Automatically direct water to the smart irrigation system according to priorities:

- Sensitive crops (potatoes, vegetables) High priority.
- Less sensitive crops Gradual distribution.

To bridge the gap caused by the dam's limited storage capacity and the diversion of part of the water for drinking, thereby ensuring continuous irrigation throughout the growing season.

Applicable models:

Experimenting with rainwater harvesting in arid regions and integrating it with modern irrigation systems to improve production sustainability.

Direct implementation:

- Installing tanks around the fields.
- Connecting them to smart drip lines.
- Using pumps to control water flow according to actual needs.

3.3. Smart Irrigation Control and Field Performance Analysis (Chaudhari et al., 2025, pp. 256–261)

A central PLC controller was installed to control all valves in the network, based on:

- ✓ Sensor data.
- ✓ The actual needs of each crop.
- ✓ Forecast weather conditions (integration of local weather data).
- ✓ Tangible results:
- ✓ Achieving complete stability in irrigation and cultivation despite current water constraints.
- ✓ Ensuring maximum possible productivity without increasing pressure on resources.

✓ Closing the gap between theoretical production potential (350 quintals/hectare) and current actual field performance.

Globally Applied Models:

Smart irrigation systems implemented in North Africa and Asia for sensor-based water distribution, which have proven capable of increasing productivity by 20–30% and reducing water waste by 40–50%.

Direct Application:

- System operation via a central control unit at the agricultural administration headquarters.
- Monitoring of irrigation performance via a digital dashboard, with the ability to adjust water priorities immediately.

While the region's agricultural production potential remains significant, the actual performance of agricultural activity continues to be affected by a range of structural and institutional constraints, particularly those related to water resource management and the regulation of agricultural activity. The study also demonstrated that improving local agricultural performance primarily involves enhancing resource use efficiency, developing institutional regulatory mechanisms, and adopting modern agricultural techniques capable of adapting to current water and economic constraints. From this perspective, this study contributes to providing a practical analysis of the relationship between structural and institutional challenges and the level of local agricultural performance, while highlighting the importance of adopting an integrated approach that combines technical innovation and institutional development to achieve sustainable agricultural activity.

Discussion:

The study reached a number of key findings, which can be summarized as follows:

- ✓ The city of Ain Bessam has a significant irrigated agricultural base estimated at approximately 2,200 hectares, reflecting significant production potential for local agricultural activity.
- ✓ The local agricultural sector comprises approximately 900 farmers organized into nearly 120 agricultural cooperatives, representing an organizational framework that can support the development of agricultural production.
- ✓ The decline in the storage capacity of the Lekhal Dam to approximately 25 million cubic meters represents one of the most significant structural constraints affecting the regularity of water supply within agricultural areas.
- ✓ Fluctuations in water supply lead to a reduction in the area actually irrigated compared to the technically available area, which directly affects agricultural productivity.
- ✓ The reference yield for potato cultivation in the province of Bouira is approximately 350 quintals per hectare under stable irrigation conditions; however, water imbalances lead to lower actual field yields.
- ✓ The study reveals a clear gap between theoretical production potential and actual agricultural performance due to structural and institutional constraints.
- ✓ The adoption of smart drip irrigation systems could reduce water waste by 30% to 50% and increase agricultural productivity by approximately 20% to 30%.
- ✓ Improving water resource management and developing institutional frameworks are among the most important prerequisites for enhancing the sustainability of local agricultural activity.

Recommendations

In light of the findings, this study proposes a set of practical recommendations that could contribute to improving the performance of local agriculture and enhancing its sustainability:

- ✓ Accelerate programs to remove silt from dams and restore the storage capacity of water resources to ensure a regular supply of irrigation water.
- ✓ Widespread adoption of smart drip irrigation systems within irrigated agricultural areas to improve water use efficiency and reduce water waste.
- ✓ Encourage the construction of rainwater harvesting facilities and supplementary agricultural reservoirs to secure additional water sources during periods of drought.
- ✓ Strengthen the role of agricultural cooperatives and professional organizations in organizing production and facilitating access to technical services and agricultural financing.
- ✓ Develop agricultural extension and advisory services by integrating digital technologies and modern agricultural guidance platforms.
- ✓ Invest in post-harvest infrastructure, particularly storage, refrigeration, and agricultural transport, to reduce losses and enhance the economic value of production.

Support the integration of local agriculture into organized agricultural value chains to enhance farmers' economic stability.

References:

1. Adak, S. (2025). Use of Soil Moisture Sensor for Efficient Irrigation in Smart Agriculture. Journal of Experimental Agriculture International, 47(6), 502–507.

2. Aisyah, N., Early , D. U., & Aldi, D. (2025). Design of an IoT-Based Smart Irrigation System Using Soil Moisture Sensors for Water Efficiency. *JOP (Journal Online of Physics), 11(1).*

3. Algérie, R. (2020). *La gestion des grands périmètres agricoles confiée à l'ONID.* extension du périmètre irrigué des Aribs à Aïn Bessem (2200 ha).

4. Ali, A. M., & Perna, S. (2021). Sustainability indicators in agriculture: A review and bibliometric analysis using Scopus database. *Journal of Agriculture and Environment for International Development (JAEID), 115(2),* 5-21.

5. Ali, M., H, G. M., Mokhtar, F., & Tsabet, A. (2024). The effect of subsidies on technical efficiency of Algerian agricultural sector: Using stochastic frontier model (SFA). *Discover Sustainability, 5(1).*

6. Alsammak, H., & Saeed, Z. (2022). Internet of things (IoT) work and communication technologies in smart farm irrigation management: a survey. *NTU Journal of Engineering and Technology, 1(3),* 49-65.

7. Bencharif, A., & Rastoin, J. L. (2007). Concepts et méthodes de l'analyse de filières agroalimentaires : application par la chaîne globale de valeur au cas des blés en Algérie. *New Medit, 6(3), 2–8.*

8. Chaudhari, R. J., & ALL. (2025). Smart irrigation system for leafy vegetable crops. *Journal of Eco-Friendly Agriculture, 20(1),* 256-261.

9. Coelli, T. J., Rao, D. S. P., O'Donnell, C. J., & Battese, G. E. (2005). An Introduction to Efficiency and Productivity Analysis (2nd ed.). Springer.

10. d'Oran, L. Q. (2016). *l'irrigation des terres agricoles fait mieux – périmètre des Aribs (Aïn Bessem).* Bouira .

11. Fuglie, K. O. (2012). Productivity growth and technology capital in the global agricultural economy. *In Productivity growth in agriculture: An international perspective CABI*, 335-368.

12. Girma, G. T., & Petros, W. W. (2024). Indicators, theory of change and impact pathways in climate smart agriculture for sustainable development: A systematic review. *Agricultural Reviews, 45(1)*, 68-74.

13. Guemmaz, S. (2025). Investment agricultural bank credit: An analysis of differentiation on the Algerian market. *Namah Journal of Economics and Commerce, 9(1)*, 58-70.

14. Guessas, T., Boudrama, M., & Guettaf, L. (2024). The problem of water resources in Algeria: Assessment of the current situation and proposal of suitable solutions. *Journal of Contemporary Economic Studies, 9(2)*, 361-378.

15. Hayami, Y., & Ruttan, V. W. (1985). *Agricultural Development: An International Perspective (Rev. And expanded ed.).* Johns Hopkins University Press.

16. Kabylie, D. d. (2013). *La production d'arrière-saison menacée dans le périmètre des Aribs.*

17. Mammer, U. M. (2023). *Compte rendu de sortie.* Tizi Ouzou: Compte rendu de sortie : Barrage Lekhel.

18. Mostefa, S. M. (2025). Rural and agricultural development in Algeria: What policies for what results? *Al Riyada for Business Economics Journal, 11(2)*, 278-291.

19. Pret, V., Falconnier, G. N., & All. (2025). *Farm resilience to climatic risk: A review.* Agronomy for Sustainable Development, 45, Article 10.

20. source, P. s. (2020). *City Population .de. (N.d.). Aïn Bessem (Bouira, Algeria)* . Office National des Statistiques (ONS), Algeria.

21. Tlemsani, A., Brahim, M, M., Ramdane, S., & Aoues, K. (2024). Understanding the impact of agricultural extension services in Algeria: A comparative study of Ouargla, Béjaia, and Relizane. *European Economic Letters, 14(4),*, 1446–1452.

22. Arbane, O. (2023, August 7). Filière pomme de terre à Bouira : la problématique du stockage enfin résolue. El Watan.