

# Food Security Challenges in Light of Biological Threats: A Case Study of Algeria

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## Abstract:

This paper focuses on the case of Algeria and analyzes the biological challenges affecting its food security. It reviews a wide range of potential biological threats, such as plant diseases, harmful insects, and animal epidemics. The impact of these threats on agricultural production and livestock in Algeria, as well as on the availability and quality of food, is highlighted. In addition to reviewing these threats and their impact on agricultural and food production in Algeria, this paper presents a number of findings and recommendations that can contribute to improving policies to achieve food security and combat biological threats. The discussion also includes the difficulties and challenges faced in implementing these policies and suggestions for enhancing and improving them.

**Keywords:** Food security, Biological threats, Biosecurity, Algeria.

## Introduction:

Food security is a critical global issue that encompasses the availability, access, utilization, and stability of food for all individuals. However, this fundamental aspect of human well-being is increasingly threatened by various factors, including biological threats. These new threats affect all countries, and Algeria is among those facing unique challenges in this new environment in terms of food security.

Algeria faces inherent challenges in achieving food security, primarily due to its heavy reliance on food imports and a range of internal issues in the agricultural sector. Limited arable land, water scarcity, outdated agricultural techniques, and inadequate infrastructure pose significant obstacles to local food production. These pre-existing challenges are exacerbated by the emergence and spread of biological threats, such as crop diseases, pests, and zoonotic diseases, which have the potential to disrupt the food system.

Crop diseases, such as wheat rust, potato blight, and date palm diseases, pose a significant risk to Algerian agricultural production. The outbreak of these diseases can

lead to significant losses and reduce the availability of essential food crops. Additionally, Algeria is prone to pest outbreaks, including locusts and beetles, which can destroy crops and further endanger food security.

Zoonotic diseases that can transmit from animals to humans also pose a dual threat to both public health and animal production systems in Algeria. Diseases like avian influenza, brucellosis, and foot-and-mouth disease can have severe consequences on livestock and poultry, affecting the availability and safety of animal food products.

The interaction of these biological threats with existing food security challenges in Algeria has opened the field for research and comprehensive interventions to explore the implications of biological threats on the country's food systems.

In this context, the following problem can be posed:

- What are the main biological threats that pose significant challenges to food security in Algeria, and how do they affect the country's food production?

Sub-questions include:

- What is the status of food security in Algeria?
- What factors contribute to the dynamics of pest spread in various regions of Algeria?
- How do zoonotic diseases affect animal production systems and the availability of animal food products?
- What are the current resilient practices and adaptive strategies used in Algerian agriculture to mitigate the impact of biological threats?

To address the problem, the following hypotheses were adopted:

- **Crop disease impact hypothesis:** The spread of crop diseases significantly affects agricultural production in Algeria, leading to decreased crop yields and threatening food security, and consequently human health.
- **Pest outbreak hypothesis:** The dynamics of agricultural pest outbreaks have a significant negative impact on crop production in Algeria, leading to decreased food availability and increased food security risks.
- **The spread of zoonotic diseases:** Including avian influenza, brucellosis, and foot-and-mouth disease, negatively impacts Algeria's

animal production systems, leading to decreased livestock yields, endangering food safety, and posing potential public health threats.

- **The implementation of resilient and adaptable practices:** such as crop diversification, introduction of disease-resistant varieties, integrated pest management, and enhanced monitoring systems, positively contributes to enhancing food security in Algeria by mitigating the impact of biological threats.

To answer the problem and test the hypotheses, the following points were followed:

### **Firstly: The Evolution of the Concept of Food Security: From Traditional Threats to Biological Threats**

The concept of food security has garnered significant attention since the Food and Agriculture Conference in 1943. Since then, the concept has been redefined as "ensuring a sufficient and stable supply of food for every person." The next step in the 1950s involved the establishment of bilateral agencies by donor countries like the United States and Canada to ship their agricultural surpluses to needy countries. By the 1960s, there was a growing realization that food aid could actually hinder the progress of countries in achieving self-sufficiency, leading to the birth of the "Food for Development" concept in 1963.

However, the 1970s saw a food crisis, prompting many countries to develop insurance plans to ensure access to food supplies, thereby enhancing coordination between donor organizations and improving ways to monitor the situation on the ground in recipient countries. Consequently, the concept of food security was redefined at the World Food Conference in Rome in 1974 as "ensuring that sufficient supplies of basic foodstuffs are available globally at all times to maintain a steady expansion in food consumption and to offset fluctuations in production."<sup>1</sup>

In 1986, the World Bank published its report titled "Poverty and Hunger," defining food security as "access by all people at all times to enough food for an active and healthy life." This definition focused on the temporal dynamics of food insecurity, distinguishing between chronic food insecurity associated with ongoing or structural poverty and low income, and insecurity resulting from natural disasters, economic collapse, or conflicts.<sup>2</sup>

<sup>1</sup> Marion Napoli, "Towards a Food Insecurity Multidimensional Index (FIMI)", (Master in Human Development and Food Security, università degli studi di roma. 2011), P. 7

<sup>2</sup> World Bank, "Poverty and Hunger: Issues and Options for Food Security in Developing Countries" (Washington DC. 1986). p1

According to the Food and Agriculture Organization (FAO) definition in 1996, food security means "providing all members of society with sufficient and nutritious food continuously to meet their needs for a healthy and active life." This definition differs from the traditional concept of food security, which is associated with achieving self-sufficiency by relying on a country's resources and capabilities to produce its food locally. This difference makes the FAO's concept of food security more in line with economic transformations and the accompanying liberalization of international food trade.<sup>3</sup>

However, the concept of food security has evolved to reflect changes in the global environment and the emerging threats affecting food supplies and availability. In the past, food security focused on ensuring adequate quantities of food to meet population needs. But with technological advancements, environmental changes, and economic shifts, concepts of food security have expanded to include other factors such as access to food, proper nutrition, and environmental sustainability.

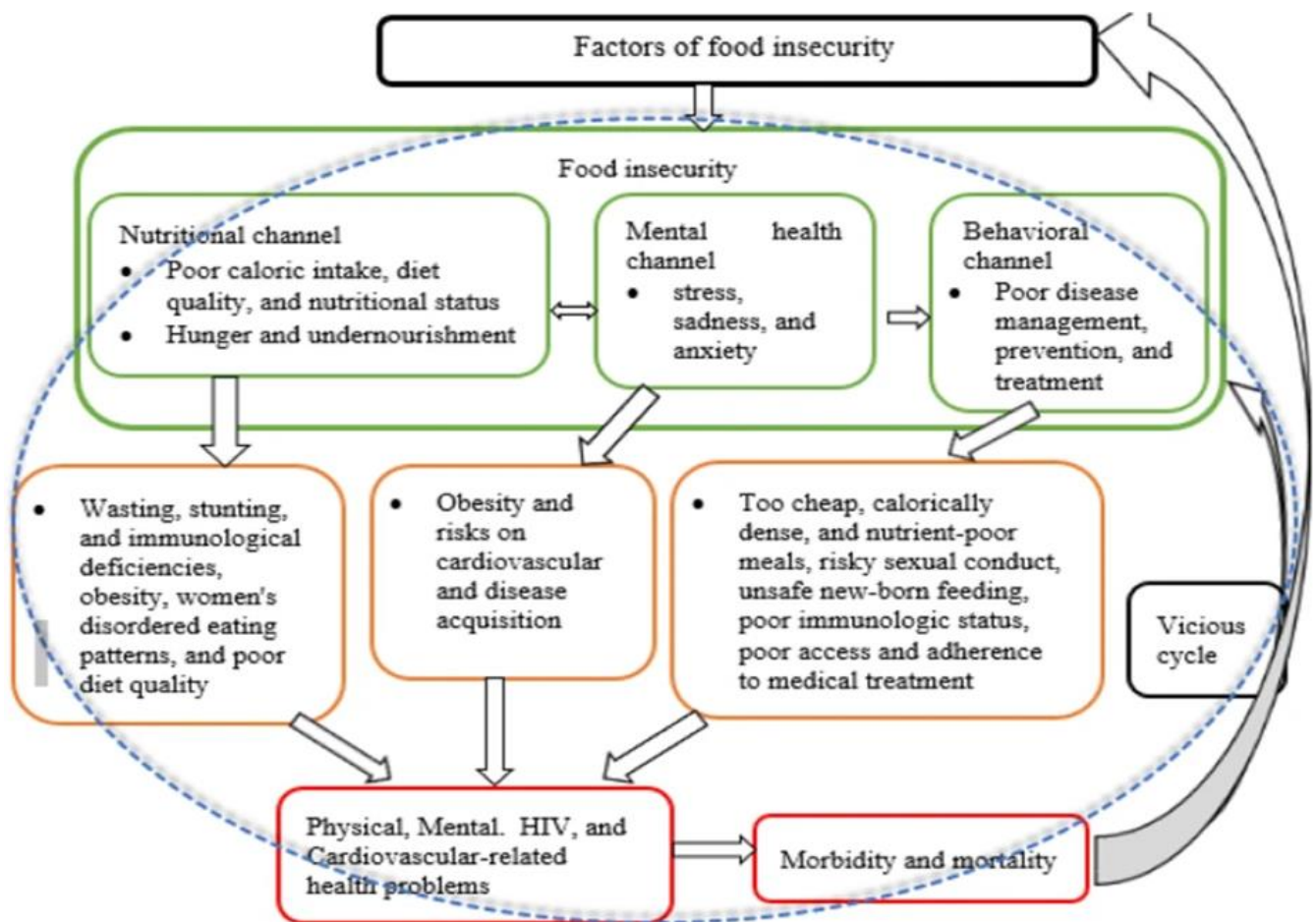
Currently, food security deals with multiple challenges, including traditional threats and biological threats. Traditional threats include agricultural production issues like lack of water resources, arable soil, climate changes, challenges related to agricultural infrastructure and technology, unbalanced global trade, poverty, and inequality. With the advancement of science and technology, new biological threats have emerged, posing significant challenges to food security. These biological threats include the spread of plant and animal diseases, epidemics, and foodborne illnesses. Outbreaks of these diseases and pandemics can lead to crop deterioration and shortages in meat and animal product supplies.<sup>4</sup>

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<sup>3</sup> Mohammed Djellouli et.al, "**Ethnopharmacological Study and Phytochemical Screening of Three Plants (Asteraceae Family) From the Region of South West Algeria**", Asian Journal of Natural & Applied Sciences Vol. 2 No. 2 (June 2013): pp. 59-64.

<sup>4</sup> Barrett, C. B., & Maxwell, D. G, "**Food Security and Sociopolitical Stability**" (Oxford: Oxford University Press, 2005), 10-15.

**Figure 1: Conceptual Framework for the Association between Threats and Impact on Food Security**



**Source :** Beyene, S.D. "The impact of food insecurity on health outcomes: empirical evidence from sub-Saharan African countries". *BMC Public Health* 23, 338 (2023). <https://doi.org/10.1186/s12889-023-15244-3>

In light of the biological threats related to food security, the following definitions can be provided:<sup>5</sup>

<sup>5</sup> **See:**

- World Health Organization (WHO). (2020). Food Safety and Zoonoses. <https://www.who.int/foodsafety/zoonoses/en/>
- Food and Agriculture Organization (FAO). (2019). The State of Food Security and Nutrition in the World 2019. <http://www.fao.org/3/ca5162en/ca5162en.pdf>
- Centers for Disease Control and Prevention (CDC). (2021). Foodborne Diseases. <https://www.cdc.gov/foodsafety/diseases/index.html>
- World Organisation for Animal Health (OIE). (2021). Animal Diseases and Food Safety. <https://www.oie.int/en/what-we-do/animal-diseases/>

- **Biological Food Security:** Refers to maintaining safe, healthy, and sustainable food supplies in the face of biological threats, such as plant and animal diseases, epidemics, and foodborne illnesses. Biological food security involves efforts to control the spread of diseases, prevent them, and effectively monitor food safety.

- **Biological Food Safety:** Means the measures and practices taken to prevent the transmission of diseases and harmful microbes through food and ensure the safety of the food consumed by the public. Biological food safety includes health and preventive standards in the production, manufacturing, distribution, storage, and preparation of food.

- **Foodborne Disease Surveillance:** Refers to the process of monitoring and tracking foodborne diseases and the measures taken to detect and control their spread. Foodborne disease surveillance involves collecting relevant data and information, conducting analyses and tests on food, water, and food sources to ensure their safety, and early detection of any biological threats.

- **Biological Threats to Food Security:** Refer to biological factors such as plant and animal diseases, parasites, bacteria, and viruses that affect food supplies, threaten food safety, and consumer health. Biological threats to food security include:

- **Plant Diseases:** Diseases that affect agricultural crops, leading to deterioration in their quality and quantity, caused by fungi, bacteria, or viruses.<sup>6</sup>
- **Animal Diseases:** Diseases that affect food-producing animals, including infectious diseases that can be transmitted from animals to humans through food, such as avian influenza and Middle East Respiratory Syndrome.<sup>7</sup>
- **Foodborne Diseases:** Diseases transmitted to humans through the consumption of food contaminated with harmful microbes, such as Salmonella, Listeria, and E. coli.
- **Epidemics and Pandemics:** Widespread diseases affecting humans and disrupting food supply chains, such as the COVID-19

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- Food and Agriculture Organization (FAO). (2008). The State of Food and Agriculture: Biofuels: Prospects, Risks, and Opportunities. <http://www.fao.org/3/a-i0680e.pdf>

<sup>6</sup> Food and Agriculture Organization (FAO). (2014). Good Practices for Biosecurity in the Pig Sector. <http://www.fao.org/3/i3849e/i3849e00.pdf>

<sup>7</sup> World Organisation for Animal Health (OIE). (2017). Manual of Diagnostic Tests and Vaccines for Terrestrial Animals. <https://www.oie.int/en/standard-setting/manual-of-diagnostic-tests-and-vaccines-for-terrestrial-animals/>

pandemic, which significantly impacted the food industry and food trade.<sup>8</sup>

## **Secondly: Food Security and its Threats in Algeria:**

This section is dedicated to identifying the reality of food security in Algeria by initially discussing the Global Food Security Index and then applying the Global Food Security Index to Algeria. This opens up a study of human security dimensions and a discussion on the levels of safety and food safety.

### **1. Global Food Security Index:**

The Global Food Security Index was designed and established by the Economist Intelligence Unit, the research and analysis division of The Economist Group, a leading global company in global business intelligence. Founded in 1946, it has 70 years of experience in assisting businesses, financial institutions, governments, and leading universities worldwide to understand how the world is changing, identifying opportunities to be seized, and risks to be managed. It provides business information, forecasting, and advice to more than 1.5 million decision-makers.

This index was created through the policy practice of the Economist Intelligence Unit and comprises the three pillars of food security: affordability, availability, quality, and safety, across 113 countries. This index is a quantitative and qualitative benchmark measure of performance, created from 28 indicators, providing an objective framework for assessing food security across a broad range of countries globally.<sup>9</sup>

By establishing a benchmark for food security, it enables users to explore issues surrounding food security, including rankings, outcomes, and policy and business process implications for future research.

In addition to assessing the affordability and availability of food and its quality, the model includes a category on natural resources and resilience. This category measures a country's exposure to the impacts of climate change; its exposure to natural resource risks; and how a country adapts to these risks. When applied, it serves as an adjustment to the food security scores of countries.

The dimensions of the index are explained as follows:

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<sup>8</sup> World Health Organization (WHO). (2021). COVID-19 and Food Safety: Guidance for Food Businesses. [https://www.who.int/publications/i/item/WHO-2019-nCoV-Food\\_Safety-2021.1](https://www.who.int/publications/i/item/WHO-2019-nCoV-Food_Safety-2021.1)

<sup>9</sup>Economist, T. (2018). Global Food Security Index. Retrieved from: <https://foodsecurityindex.eiu.com/>

- ❖ **Affordability:** Measures consumers' ability to purchase food, their exposure to price shocks, and the existence of programs and policies to support customers when shocks occur.
- ❖ **Availability:** Measures the adequacy of national food supplies, the risk of supply disruption, and the national capacity to deploy food efforts and research to expand agricultural production.
- ❖ **Quality and Safety:** Measures the nutritional diversity and quality of average meals, in addition to food safety.
- ❖ **Natural Resources and Resilience:** Measures a country's exposure to the impacts of climate change; its susceptibility to natural resource risks; and how a country adapts to these risks.<sup>10</sup>

## 2. Applying the Global Food Security Index to Algeria:

According to the 2018 assessment of the Global Food Security Index, Algeria ranked 69th out of 113 countries, with an index value of 52.1% (The Natural Resources and Resilience category does not contribute to the overall score). As for the sub-indicators, Algeria's results were as follows:<sup>11</sup>

- ✓ **Affordability:** Ranked 69, Index 51.4%.
- ✓ **Availability:** Ranked 75, Index 52.7%.
- ✓ **Quality and Safety:** Ranked 74, Index 52.4%.
- ✓ **Natural Resources and Resilience:** Ranked 71, Index 57.8%.

**Table 01: Algeria's Performance Based on the 2019 Food Security Score**

Global Ranking	Final Total	Affordability	Availability	Quality and Safety
<b>69</b>	52.1%	51.4%	52.7%	52.4%

**Source:** Global Food Security Index (GFSI), available at: <https://bit.ly/43ZrSZv> (Consulted on: 04/06/2023)

Table 2 illustrates Algeria's performance over 7 years:

**Table 2: Algeria's performance from 2012 to 2018:**

Ranking	2012	2013	2014	2015	2016	2017	2018	Change over 7 years
<b>69</b>	49.6	49.7	52.6	54	55.1	52	52.1	+2.5
<b>Change</b>		+0.1	+2.9	+1.4	+1.1	-3.1	+0.1	+2.5

<sup>10</sup> Ibid.

<sup>11</sup> Global Food Security Index (GFSI), available at: <https://bit.ly/43ZrSZv> (Consulté le: 14/06/2023).



**Source:** Global Food Security Index (GFSI), available at: <https://bit.ly/43ZrSZv> (Consulted on: 05/06/2023).

Discussing food security in Algeria, it's important to address the major threats to food security. Opening this discussion reveals numerous threats challenging food security and safety. As Algeria heavily relies on imports for agricultural and food products, and due to a set of local reasons and challenges, its food security is exposed to threats that extend beyond traditional to biological threats.

### 3. Threats to Food Security in Algeria:

The nature of food security threats in Algeria has changed. It used to focus on the main challenges facing the agricultural sector in Algeria, through attempts to achieve a significant increase in agricultural production to meet the growing demand for food and ensure a higher level of food security for the population. Among the reasons hindering this are:

- ❖ The weakness of Algerian agriculture and its structural incapacity to meet local demand.
- ❖ Resorting to imports to fill the production gap and ensure food security for the population, leading to a trade balance deficit, and continuous growth in foreign currencies allocated for food bills.<sup>12</sup>
- ❖ Fluctuations in the prices of main food products and their negative effects on importing countries, with Algeria heavily relying on imports to cover the basic needs of the population;<sup>13</sup>
- ❖ Unfavorable agricultural climatic conditions and the degradation of available ecological agricultural resources;<sup>14</sup>
- ❖ Scarcity and misuse of water resources due to inefficient irrigation methods, negatively impacting agricultural production and food security;<sup>15</sup>
- ❖ Insufficient investment, especially in agricultural research, which does not exceed on average 0.6% of the agricultural GDP.<sup>16</sup>

<sup>12</sup> Chabane, M. (2011). **Conservation Agriculture: A Pathway to Food Security in the Maghreb Countries? CIHEAM Mediterranean Options**: Series A. Mediterranean Seminars, p. 200.

<sup>13</sup> Algerian Ministry of Agriculture and Rural Development, "**Sustainable Food Security in the Mediterranean: What is the Situation and What are the Prospects**" (International Center for Advanced Mediterranean Agronomic Studies, 2014), p. 10.

<sup>14</sup> Chabane, **op.cit.**, p. 200.

<sup>15</sup> Arab Planning Institute, "**Development in the Agricultural Sector and Arab Food Security**", Development Bridge (2015):12.

- ❖ The absence of suitable governance structures to ensure institutional stability, transparency, accountability, and the rule of law, leading to ineffective decision-making;
- ❖ Inconsistency in policy setting, prioritizing policies, plans, programs, and funding.<sup>17</sup>

In addition to what has been mentioned earlier, it can be said that Algeria, like many other countries, faces challenges in the field of food security ranging from traditional threats to biological threats. Here are some challenges that can affect food security in Algeria:<sup>18</sup>

- **Climate Change:** Climate change is a major challenge affecting agricultural production and livestock in Algeria. Changes in rainfall patterns and temperature increases can have negative impacts on crops, pastures, and agricultural water resources.
- **Water Scarcity:** Algeria suffers from water scarcity, which can affect the productivity of the agricultural sector and limit the ability to achieve food security. Water scarcity requires sustainable management of water resources, adoption of efficient irrigation systems, and diversification of agricultural water sources.
- **Poverty and Inequality:** Poverty and inequality in access to food and agricultural resources can affect food security in Algeria. It is necessary to promote inclusive growth and economic development to improve income levels and economic opportunities for rural and impoverished communities.

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<sup>16</sup> Mourad Jabara. (2014/2015). **The Role of Sustainable Agricultural Development in Achieving Food Security in the Case of North African Countries.** A dissertation submitted for the Doctorate of Science in Economic Sciences. Chlef, Faculty of Economic, Commercial Sciences and Management Sciences, Algeria, p. 331.

<sup>17</sup> Committee on World Food Security. (2017). **The Global Strategic Framework for Food Security and Nutrition.**

<sup>18</sup> For more information on food security challenges in Algeria and traditional and biological threats, you can consult the following references:

- Algeria's National Decision on Food Security for the Period 2015-2019: <https://bit.ly/42V4iMN>
- FAO Report on Food Security in Algeria for 2020: <https://bit.ly/3X4dUDr>
- World Bank Report on Food Security in Algeria for 2017: <https://bit.ly/3P6DJRo>
- The World Bank report on agricultural challenges in Algeria and adaptation to climate changes for the year 2019: <https://bit.ly/44i3B19>

- **Biological Threats:** Biological threats include plant diseases, harmful insects, animal epidemics, and infectious diseases. These threats can affect agricultural crops and livestock, posing risks to food security.

### Thirdly, Biological Threats and Food Security Challenges in Algeria

In Algeria, there are numerous biological threats that pose challenges to food security in addition to issues that can affect food availability and access. Here is a brief overview of some of these challenges and threats:

- **Crop Diseases:** Plant diseases have led to significant crop losses in Algeria. For example, olive wilt, a fungal disease affecting olive trees, can significantly reduce olive oil production. It is necessary to implement measures for prevention, monitoring, and integrated disease management to minimize losses and protect food crops.<sup>19</sup>
- **Crop Pests:** Pests such as insects, moths, and mollusks cause significant damage to food crops in Algeria. For instance, the fall armyworm is a pest that can destroy corn and other grain crops. Therefore, there is a need to develop integrated pest management strategies, including the use of biological methods to reduce the use of chemical pesticides.
- **Drought and Water Stress:** Algeria faces arid and semi-arid climatic conditions, leading to limited water availability for agriculture. Drought and water stress can reduce crop productivity and increase the risk of food shortages. It is of great importance to promote drought-resistant agricultural practices, such as efficient irrigation, water conservation, and the selection of crop varieties adapted to arid conditions.
- **Rural Food Insecurity:** Rural areas in Algeria often face food insecurity issues due to poverty, lack of access to resources, and geographical isolation. It is important to implement sustainable rural development programs that improve the living conditions of rural populations, enhance livelihood diversification, and strengthen agricultural capacities.<sup>20</sup>

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<sup>19</sup> Kourat Tassadit, et.al, "**Modeling the Impact of Future Climate Change Impacts on Rainfed Durum Wheat Production in Algeria**" *Climate* 10, no. 4: 50(2022).

<https://doi.org/10.3390/cli10040050>

<sup>20</sup> Bouchentouf Salim and Benabdeli Kheloufi, "Water resources and food security in Algeria: Diagnosis and new strategy proposition", **African Journal of Agricultural Research** 17, no. 3 (2021): pp. 414-424.

- **Loss of Biodiversity:** Loss of biodiversity in Algeria can affect food security by reducing the availability of certain plant and animal species used as food sources. Conserving genetic resources and natural ecosystems is essential to maintain crop diversity and preserve traditional edible species.
- **Climate Change:** Climate change poses a significant challenge to food security in Algeria. Rising temperatures and weather variability can have negative effects on agricultural crops, including freshwater shortages and increased desertification. Adopting sustainable agricultural practices and promoting agricultural diversity to adapt to these challenges is necessary.<sup>21</sup>
- **Plant Threats:** Algeria faces biological threats such as plant pests and diseases that affect crops. Strengthening monitoring systems, early detection, and taking measures to reduce the spread of pests and develop crop resistance are necessary.
- **Plant Diseases and Harmful Insects:** Algeria suffers from numerous threats to agricultural crops and fruit trees due to plant diseases and harmful insects. Known threats in Algeria include powdery mildew affecting grain crops such as wheat and barley, and the whitefly affecting green plants.<sup>22</sup>
- **Foodborne Diseases:** Foodborne diseases pose a health threat and challenge in securing food. These diseases include food poisoning and infections caused by parasites, bacteria, and viruses contaminating food. Enhancing food safety standards and improving sanitary hygiene practices to reduce these diseases is essential.
- **Animal Security and Infectious Diseases:** Infectious animal diseases pose a threat to livestock and the production of animal products in Algeria. Developing disease monitoring and control systems and enhancing the safety of animal products are necessary.

To overcome these challenges, the Algerian government and relevant entities are working to enhance agricultural sustainability, diversify crops, develop innovative farming techniques, and promote scientific research in the agriculture sector. Solving these challenges requires joint efforts to enhance agricultural productivity, promote food safety, and provide the necessary resources to achieve food security in Algeria.

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<sup>21</sup> Rahal-Bouziane Hafida, "Climate change, biodiversity and agrobiodiversity: global view and particular case of Algeria", *American Journal of Agricultural Research* 2:3 (2017): pp. 1-11.

<sup>22</sup> Mohammed Djellouli et.al, "Ethnopharmacological Study and Phytochemical Screening of Three Plants (Asteraceae Family) From the Region of South West Algeria", *Asian Journal of Natural & Applied Sciences* Vol. 2 No. 2 (June 2013): Pp. 59-64.

**Conclusion/Recommendations:**

Algerian food security faces a range of challenges, including biological threats that add complexity to existing issues. Addressing these challenges requires a multifaceted approach that combines research, policy interventions, and stakeholder collaboration. Enhancing agricultural practices, investing in modern technologies, improving disease monitoring and response capabilities, and bolstering local food production will be crucial in mitigating the impact of biological threats and ensuring food security for the Algerian people. To address the food security challenges in light of biological threats in Algeria, some actions and policies can be taken or supported through:

- ✓ **Enhancing Plant Disease Monitoring and Surveillance:** Efforts to monitor and surveil plant diseases in Algeria should be strengthened by training farmers and technicians to recognize diseases, take appropriate preventative measures, and implement rapid control measures.
- ✓ **Developing Pest-resistant Cultivation:** The use of pest and insect-resistant farming practices should be enhanced, such as crop diversification, use of resistant varieties, and the application of biological control.
- ✓ **Promoting Sustainable and Organic Agriculture:** The transition towards sustainable and organic agriculture in Algeria should be encouraged by promoting environmentally friendly farming practices and improving natural resource management.
- ✓ **Enhancing Agricultural Research and Development:** Investment in agricultural research and development should be enhanced to develop resistant crop varieties, improve agricultural techniques, marketing, and risk management.
- ✓ **Enhancing Awareness and Education:** Awareness among farmers and consumers about the importance of biological challenges to food security and the exchange of best farming practices and modern technologies should be enhanced.
- ✓ **Developing Sustainable Irrigation:** The use of sustainable irrigation techniques such as drip irrigation and sprinkler irrigation should be promoted to improve the efficiency of agricultural water use and reduce wastage.
- ✓ **Improving Storage and Distribution:** Storage and distribution infrastructure should be improved to maintain crop quality and reduce post-harvest losses.

- ✓ **Encouraging Agricultural Diversity:** Agricultural diversity in Algeria should be encouraged to reduce reliance on a single crop and promote sustainable agricultural production.
- ✓ **Strengthening Policies and Legislation:** The development of appropriate agricultural policies and legislation should be strengthened to enhance food security and protect farmers and consumers from biological threats.
- ✓ **Policies and Governance:** Strong agricultural policies and governance frameworks are needed to enhance food security in Algeria. This includes implementing policies that lead to sustainable agriculture, fair allocation of resources, capacity building for farmers, and enhancing agricultural research and development, as well as coordinating among various stakeholders to ensure an integrated approach to food security.
- ✓ **Technology and Innovation:** Technology and innovation can play a crucial role in addressing biological challenges and enhancing food security. Research and development in areas such as genetic engineering, thermal processing techniques, and packaging should be promoted to improve food quality and safety.

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