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Analysis of the linkages between food security indicators and economic growth in Algeria using principal component analysis (PCA) for the period 2013–2024.

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Abstract:

This study examines the relationship between food security and economic growth in Algeria during 2013–2024 using a descriptive-analytical approach and Principal Component Analysis (PCA/ACP). The findings reveal a strong association between food security and economic growth indicators, with the first two principal components explaining a significant share of the total variance. The study also shows that dependence on food imports and low agricultural production hinder food self-sufficiency. It concludes that diversifying income sources and strengthening agricultural production are essential for achieving sustainable food security in Algeria.

Keywords: food security, economic growth, agricultural production, energy supply; growth rate

Jel Classification Codes: O18, O47, C38

1. INTRODUCTION

Economic development and national stability depend on several fundamental pillars, among which food security occupies a strategic position. Food security is not limited to the availability of sufficient food; it also reflects a country's capacity to ensure continuous access to adequate food and to support sustainable development. It is therefore closely linked to the effectiveness of economic policies and the productive capacity of key sectors, particularly agriculture and the food industry. Achieving food security requires a balance between domestic production and the use of international trade to compensate for shortages in the domestic market.It also reflects a country's ability to balance local production, which is necessary to achieve self-sufficiency, with dependence on foreign trade to cover shortages in domestic markets through imports. From this perspective, food security reflects individuals' capacity to obtain and secure food, as well as the state's productive capacity and real level of development. This efficiency can be measured using various food security indicators, such as the agricultural production indicator, which reflects the state's ability to supply food, as well as indicators related to food deficiency. A country's level of food security is assessed over the medium or long term to determine its stability and the state's ability to sustain it.

In this context, economic growth reflects a country's capacity to increase production and strengthen economic stability, thereby contributing to the availability of goods and services, including food. Higher levels of economic growth and income can improve purchasing power and facilitate individuals' access to adequate food. Conversely, macroeconomic challenges such as inflation and unemployment may weaken household purchasing power and create additional pressures on food security. Therefore, the relationship between economic performance and food security is multidimensional and reflects the interaction between production, income, prices, and employment.In this sense, economic growth expresses the real volume of production in the country, contributing to economic stability and helping to cover market needs for food. Improvements in economic performance directly impact food security by

enhancing the ability of Algerian individuals to improve their food situation. Increases in domestic output and per capita income raise purchasing power, which positively impacts food consumption. Conversely, stability in food security supports economic stability, helps reduce poverty rates and strengthens food sustainability.

- **Importance of the Study:**

The importance of this study lies in introducing food security and its most important indicators, as well as examining the evolution of their performance through the performance of economic growth indicators. This is due to the direct relationship and mutual influence between food security indicators and economic growth indicators.

- **Previous studies:**

- Razika study (12–22 December 2024): 'Food Security in Algeria in Light of the Most Important Indicators (2020–2023)' Reality and Challenges', Global Policy Journal. The study aimed to determine the status of food security in Algeria through its indicators and highlight the most significant challenges to improving the level of food security. It concluded that food security is one of the most important foundations of societal security and that Algeria recorded medium levels of food security.

- Khalifa Seddam Husayn, Selami Ahmad and Janfi (2024): 'A Study of Food Availability Indicators and Their Impact on Measuring Food Security in Algeria', Journal of the Economics of Money and Business. This study seeks to identify the most important indicators adopted to measure food availability. It also aims to analyse food availability indicators in Algeria for the period 2000–2019. Several results were reached, the most important of which are that food availability indicators showed a notable improvement during the study period and that the share of dependence on food imports declined significantly.

- Zolotareva and Zecca (2024) examined food security and sustainable development in West Africa. The study was based on the four dimensions of food security—availability, accessibility, utilization, and stability—and used publicly available country-level data covering the period 2001–2022. Principal Component Analysis (PCA) was employed to construct a

consolidated food security index. The results revealed significant differences in food security conditions across the countries studied, particularly regarding the stability dimension. The study emphasized the importance of improving policies and regional cooperation to strengthen food security and sustainable development.

Compared with previous studies, this study examines food security and economic growth indicators jointly in Algeria during 2013–2024 using Principal Component Analysis (PCA). This approach highlights the main patterns of association among the selected indicators.

- **Study problem**

Food security in Algeria is closely related to economic conditions, including economic growth, income, inflation, and unemployment. Given the interaction between these factors and food security indicators, the study seeks to answer the following question:

What is the nature of the relationship between economic growth and food security indicators in Algeria between 2013 and 2024?.

- **Sub-questions**

- What is the relationship between economic growth and agricultural production in Algeria during the period 2013–2024?
- What is the relationship between inflation and food security indicators in Algeria during the period 2013–2024?

- **Study hypotheses**

-There is a positive correlation between food security indicators and certain economic growth indicators in Algeria.

- There is a positive relationship between economic growth and agricultural production in Algeria.
- There is a negative relationship between inflation and food security indicators in Algeria.

- **Objectives of the Study**: The study aims to:

- Examine the evolution of selected food security indicators in Algeria.
- Explore the relationships between food security and economic growth indicators using PCA.

- **Method of the study**

This study uses an analytical descriptive approach and Principal Component Analysis (PCA) as an exploratory statistical tool to study the relationship between the variables.

- **Scope of the Study**

This study is limited to Algeria as its geographical scope and covers the period from 2013 to 2024. The study focuses on selected food security and economic growth indicators and examines their relationships using Principal Component Analysis (PCA).

2. Analytical reading of food security indicators in Algeria

2.1 Concept of food security

Food security is considered the fundamental pillar that contributes to sustaining individuals and ensuring the continuity of life on Earth. Consequently, different countries strive to achieve food security by meeting basic food needs, either through domestic production or import coverage. In this context, several definitions of food security have been provided by thinkers and organisations, including the following:

2.1.1Definition by the World Food Organization: The World Food Organization defines food security as "Providing food for all members of society in the quantity and quality necessary to meet their needs on a continuous basis in order to live a healthy and active life" **(Yatto, 2024, p. 460)** According to this definition, the World Food Organization believes that the state is responsible for providing food for its citizens, either by ensuring its internal production or by importing food from other countries to cover its deficit.

2.1.2 Second definition: Food security is defined as follows "Ensuring that all members of society have access to sufficient and high-quality food at all times to guarantee a healthy, active and productive life." **(Belkacem & Malika, 2009, p. 6)**

2.1.3 Third definition: It can also be defined as "The ability of all individuals at all times to access sufficient food to ensure a healthy and active life" **(Rebai, 2022, p. 264)** Accordingly, the state is required to strive to achieve food security for individuals within societies at all times, regardless of the country's economic conditions. Since food is essential for human

dignity and health, food security consists of providing food to everyone.

2.1.4

2.2 Dimensions of food security

Food security is based on a set of fundamental dimensions that determine whether or not it is achieved. These dimensions are as follows:

2.2.1 Food availability :Availability is an important dimension of food security. While supplying a sufficient amount of food to the population is necessary, it is not sufficient. It is also a condition for ensuring adequate access to food, i.e. ensuring that individuals receive sufficient amounts of food of an appropriate quality. Availability refers not only to the quantity of food, but also to its quality. Indicators for evaluating availability include the extent to which food energy supplies are sufficient across different types of food, as well as the percentage of calories per 'mukid' **(Makid & Ben Ayad, 2018, p. 3)**

2.2.2 Access to food: Ensuring access to food means ensuring that all individuals receive a sufficient and suitable amount at all times. This includes purchasing power and the level of real income for those who are able to earn. It also includes food assistance for those who are unable to earn an income. Furthermore, it encompasses market integration and ease of access. **(Seddam & Selami, 2024, p. 100)**

2.2.3Food stability Food stability: Food stability refers to the ability to obtain food continuously without risking the loss of this ability due to a particular crisis. In other words, individuals must be able to obtain adequate food at all times without facing any risk of losing access in order to reach the stage of food security;

2.2.4 Utilisation of food: Utilisation of food includes two groups of variables The first group includes variables that determine the ability to benefit from food. The second group includes the outcomes of food utilisation, which are reflected in diseases such as osteoporosis and anaemia, and in the number of women of reproductive age and children under five who are underweight or stunted. **(Ward & Guermiya, 2021, pp. 68-69)**

2.3 Food security indicators in Algeria: In this section, we will analyse the evolution of food security indicators in Algeria between 2013 and 2024.

2.3.1 Food import indicator: Food imports are one of the indicators that reflect food security. They show how self-sufficient the state is and how much it relies on external markets to meet its food needs. Therefore, food imports are among the most important indicators of the degree to which a state depends on foreign supply to meet the food requirements of different groups within society. This applies to Algeria, where imports constitute a key pillar of foreign trade and food security. Algeria relies on imports to cover shortages of essential food commodities in the local market, particularly given the relatively low level of domestic production and increasing population growth. The following table presents the evolution of food imports relative to the size of imports in the Algerian market**:**

Table 01: Evolution of Food Imports as a Percentage of Total Imports in Algeria (2013–2024).

Year	2013	2014	2015	2016	2017	2018
Indicator	19	20	19	19	20	16.87
Year	2019	2020	2021	2022	2023	2024
Indicator	17.23	21.72	23.75	26.75	23.16	24.22

Source: World Bank report on development indicators in Algeria for 2024. www.albankaldowli.org

The figures in the table indicate that food imports as a share of total imports in Algeria during the period 2013–2024 witnessed multiple changes. They recorded a continuous increase, rising from 19% of total imports in 2013. This upward trend continued until 2017, when the share reached approximately 20%. There was a slight decline in 2018, followed by a further slight change in 2019, which can be attributed to an increase in domestic output alongside the imposition of import restrictions. The indicator then returned to an upward trend, reaching 24.22% in 2024. The increase in Algeria's food imports is primarily due to the weakness of local agricultural production, caused by factors such as drought and insufficient investment in the agricultural sector, which suffers from a shortage of agricultural land and water resources. Consequently, Algeria has had to rely on imports to cover shortages in the domestic food market, particularly given the continuous increase in demographic growth, which outpaces production. Therefore, filling the gap in the domestic market requires reliance on imports to secure food for citizens. In 2024, these imports were

estimated at USD 12.4 billion, most of which consisted of basic commodities such as sugar, coffee and cereals. Algeria has also adopted policies to encourage local production and reduce dependence on external markets.

2.3.2 Agricultural Production Indicator: Agricultural production is an economic activity based on plant and livestock production to meet food needs and achieve national food security and self-sufficiency. Algeria's goal is to ensure food availability and achieve self-sufficiency by developing agricultural production. This will be clarified as follows:

Table 02: Evolution of agricultural production in Algeria for the period 2013–2024 (in USD billions).

Year	2013	2014	2015	2016	2017	2018
Indicator	17.9	18.46	19.75	20.06	19.26	19.9
Year	2019	2020	2021	2022	2023	2024
Indicator	20.41	20.9	20.5	21.6	22.24	23.42

Source: World Bank report on development indicators in Algeria for 2024. www.albankaldowli.org

The data in Table 02 show an overall increase in agricultural production in Algeria, rising from USD 17.9 billion in 2013 to USD 23.42 billion in 2024, despite some fluctuations during the period. This evolution reflects improvements in agricultural production and investment. However, the sector remains insufficient to achieve full food self-sufficiency, which contributes to continued reliance on food imports.

2.3.3 Food Energy Supply Indicator: The food energy supply reflects the quantity of food energy available for daily consumption by individuals, obtained from different food commodities, whether from domestic production or imports. As food energy supply is measured in kilocalories per person per day, it indicates the extent of food availability in the country and consequently the level of food security. It is therefore one of the most important indicators used to assess food security levels in a country. For this reason, the following table examines the level of food energy supply in Algeria:

Table 03: Evolution of the Food Energy Supply Index in Algeria for the Period 2013–2024 (kilocalories).

Year	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*
Indicator	3400	3425	3402	3414	3411	3446
Year	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*
Indicator	3493	3442	3454	3463	3463	3463

Sources: - Arab Organization for Agricultural Development (AOAD), Report 2022–2023, https://www.aoad.org/ , - FAO (Food and Agriculture Organization of the United Nations), 2024, https://www.fao.org/home/ar

The figures in Table 03 reflect the level of food energy supply in Algeria during the period 2013–2024. It can be seen that the value of food energy per person (in kilocalories) was around 3400 in 2013, increasing to approximately 3463 in 2024. The average for the period 2013–2024 is approximately 3,400 kilocalories per person. This result is mainly due to Algeria's heavy reliance on cereals and oils in its daily consumption, whether produced locally or imported from global markets. This suggests that Algeria has the capacity to provide its population with a food-energy system. Consequently, it can achieve relatively good levels of food security, despite relying significantly on imports rather than complete domestic production.

2.3.4 Food deprivation index: The food deprivation index (also referred to as hunger), as defined by the FAO, reflects the proportion of people who do not have access to sufficient and adequate food energy for a healthy and active life — that is, they consume insufficient amounts of food. This index therefore directly reflects a country's food adequacy. As food deprivation is one of the most important indicators of a country's level of food security, the following table shows the proportion of food deprivation in Algeria:

Table 04: Clarification of the Food Deprivation Index in Algeria (%), for the period 2013–2024

Year	2013	2014	2015	2016	2017	2018
Indicator	8	8	8	7.9	7	6.9
Year	2019	2020	2021	2022	2023	2024
Indicator	8	8	9	9	9	8

Source**:** FAO's State of the World Food and Agriculture Report 2024, https://www.fao.org/home/ar

The data in Table 04 show that the food shortage indicator remained

relatively low during 2013–2024, fluctuating between 6.9% and 9%. It declined from 8% in 2013 to 6.9% in 2018, before increasing to 9% during 2021–2023 and then falling to 8% in 2024. Overall, the indicator reflects continued food insecurity among part of the population despite improvements in food availability.

2.3.5 Food Price Index: This indicator measures the rate of change in the prices of the most widely consumed food commodities. In Algeria, the food price inflation indicator fluctuates depending on the availability of essential food supplies in markets with high demand. It is also influenced by global prices and the exchange rate. Therefore, the inflation index reflects the extent to which the state can consistently ensure that the necessary quantities of consumer goods are available in markets. The following table shows the development of the food price inflation rate in Algeria over the study period, based on the available data.

The following table shows the development of the food price inflation rate in Algeria over the study period, based on the available data.

Table 05: Evolution of food prices in Algeria for the period 2013–2024

Year	2013	2014	2015	2016	2017	2018
Indicator	3.3	2.9	4.8	6.4	5.6	4.3
Year	2019	2020	2021	2022	2023	2024
Indicator	2	2.4	7.2	9.3	9.3	4.5

Source: FAO Global Food Reports, https://www.fao.org/home/en

Based on the figures in the above table, we can see that the food price inflation index in Algeria recorded several fluctuations between increases and decreases over the period 2013–2024. In 2013, it stood at 3.3%, and then continued to rise and fall at relatively similar rates until 2020. This can be attributed to the relative stability of food commodities in Algeria during that period, which was accompanied by the availability of the required quantities of consumer goods in Algerian markets, whether through domestic agricultural production or imports from global markets.

From 2021 to 2023, however, a significant increase was observed. This was primarily due to the health crisis that affected the world, namely the pandemic caused by the SARS-CoV-2 virus, which disrupted both the local and global economy. As a result, international trade was affected, leading to

disruptions in food supply chains. Additionally, the political crisis between Ukraine and Russia contributed to changes in energy and food prices, driving up prices globally and subsequently affecting Algeria's economy.

Finally, in 2024, the index declined again due to improvements in domestic production, thanks to the state's support for the agricultural sector, as well as relative stabilisation in global markets during that year.

3. Performance of Economic Growth Indicators in Algeria

Economic growth is highlighted as one of the most important economic topics, especially as economic analysis shifts from the partial level to the aggregate (macroeconomic) level. Economic growth is reflected through the performance of economic indicators, which express the strength of a given economy relative to others. This is linked to the total volume of goods and services produced over a specific period—usually one year—in terms such as per capita share and production rate. Through these measures, it becomes possible to assess levels of food security. To gain a deeper understanding of economic growth, we will address the following elements:

3.1 Theoretical framework of economic growth: Economic growth is considered a primary driver of a country's growth process. In this section, we present a definition of economic growth and its most important dimensions.

3.1.1 Concept of economic growth: Economic growth is one of the most common economic concepts. It has been defined in various ways, including the following:

A. Economic growth is defined as: 'the increase in the quantities produced over the long term within the boundaries of a given country, where—due to this continuity in production—changes in economic structures may occur' **(Kader, 2013, p. 63)**

B. It is also defined as: 'the occurrence of an increase in GDP (gross domestic product) or in national income in a manner that achieves an increase in the average per capita share of real income' **(Maheieddine Hamdai, 2008/2009, p. 3)**

Economic growth reflects a country's capacity to produce goods and services across various sectors over a period of time, usually one year,

which contributes to increasing national income. This, in turn, is reflected in the country's development and its ability to achieve self-sufficiency through its productive capacity. This enables it to supply its domestic markets, particularly in sensitive sectors such as agriculture and industry.

3.1.2 Foundations of economic growth: Economic growth rests on a set of pillars, or determinants, through which economic activity can be produced and developed across different sectors within the economy. Accordingly, the foundations of economic growth are as follows:

A. Labour: Labour is one of the most important factors affecting economic growth. The key element in labour supply is the population — its size, quality and demographic structure (including the population pyramid). An increase in population implies an increase in the labour supply. However, the impact of population growth on per capita income must also be considered (whether it increases or decreases). In this context, population growth can stimulate economic activity and growth. Therefore, it is crucial to prioritise training and developing core technical skills, as this has a positive impact on productivity and consequently economic growth. **(Messaoud & Khalifa , 2019, p. 119)**

B. Natural resources: Natural resources are considered a necessary factor in achieving desired development. Countries and governments can use these resources to formulate plans based on the available potential and implement them in stages in accordance with specific objectives in all economic, social and cultural fields, particularly in the early stages of development. At this stage, countries often urgently need resources from any source. Ideally, these resources would come from the country's own capacities, whether from its natural wealth or the national economy. Even if it becomes necessary to resort to less preferable methods, such as borrowing from the central bank or other institutions, these tools remain justified in the early stages of development, provided spending is not wasted and expenditure is controlled in a balanced and targeted way to achieve the set goals. There is a general consensus that the availability of these resources plays a pivotal role in the early stages of development, particularly when the aim is to increase the capital needed for development processes in all sectors. In that

case, the development goal is achieved and progress can be made **(Araba & Belaid, 2020, p. 3)**

C. Technological progress: Technological progress is one of the most important factors in determining economic growth. This factor is defined by how effectively societies can use technological advancements to improve production levels. When production improves, so do individuals' incomes, raising their standard of living. This can only be achieved by developing and applying technical and technological knowledge quickly. **(Hidouchi, 2015, p. 356**) is especially relevant in the current era of globalised production, which relies on technology and the latest innovations, such as artificial intelligence in management and productivity development.

3.2 Analysis of the Evolution of Economic Growth Indicators: In this section, we will analyse the evolution of economic growth indicators affecting food security. We will include inflation and unemployment in the analysis because they reflect the overall state of the economy at a macro level. They may be indirectly linked to food security through their impact on purchasing power and food stability, as follows:

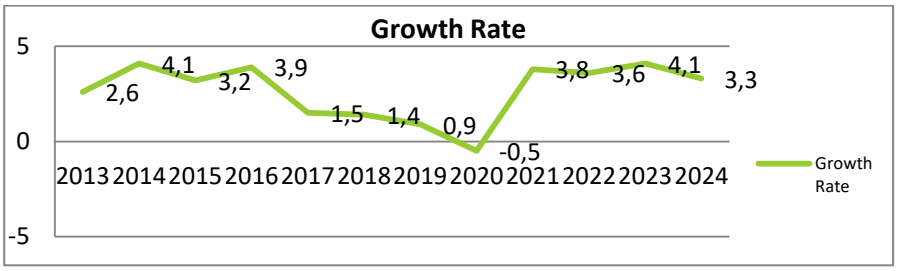
3.2.1 The economic growth rate indicator: The growth rate measures the change in the value of goods and services produced within a given country and is often calculated over a financial year. Therefore, GDP growth rates reflect the real value of effective and productive investments in the economy resulting from sound policies and economic reforms. Growth rates also demonstrate a country's ability to support its markets and achieve self-sufficiency, particularly in agriculture, one of the most sensitive sectors. Growth in this sector supports food security by relying on local production. Consequently, the cost of food decreases. To determine how this indicator has evolved in Algeria, we will examine the growth rate evolution for the period 2013–2024, based on available statistics, as shown in Table 06:

Table 06: Explanation of the evolution of the economic growth rate in Algeria (2013–2024).

Year	2013	2014	2015	2016	2017	2018
Growth Rate	2.6	4.1	3.2	3.9	1.5	1.4
Year	2019	2020	2021	2022	2023	2024
Growth Rate	0.9	0.5-	3.8	3.6	4.1	3.7

Source: World Bank report on Algeria's development indicators for 2024. www.albankaldowli.org

Figure 1: A descriptive statement showing the evolution of growth rates in Algeria for the period 2013–2024.



Source: prepared by the researcher based on statistics in Table 06.

The data in Table 06 show that Algeria's economic growth rate fluctuated considerably during 2013–2024. The growth rate increased from 2.6% in 2013 to 4.1% in 2014, before declining gradually during 2015–2019 and reaching its lowest level of -0.5% in 2020. This decline reflects the slowdown in economic activity during this period. From 2021 onward, economic growth recovered, reaching 3.8% in 2021, 3.6% in 2022 and 4.1% in 2023, indicating a gradual improvement in economic performance. Overall, the fluctuations in economic growth reflect changes in economic conditions during the study period and are relevant to the interpretation of its relationship with food security indicators.

3.2.2 GDP per capita indicator: This indicator shows how much each person in the country receives from the gross domestic product (GDP). It is calculated by dividing GDP by the population. It is used to measure individuals' ability to obtain goods and services within the country. Therefore, it reflects the standard of living and the level of welfare in society. It also reflects individuals' ability to achieve food security through their purchasing power **(Zoubida, 2023, p. 134)** An increase in GDP per capita means individuals are better able to buy goods and improve their standard of living, especially with regard to food. This is reflected in Algeria's GDP per capita. The data in the next table shows Algeria's per capita figure over the average period 2013–2024, as follows:

Table 07: GDP per capita (2013–2024) Unit: US dollars ($).

Year	2013	2014	2015	2016	2017	2018
Share of	5494	4187	3945	4111	4153	3973
Year	2019	2020	2021	2022	2023	2024
Share of	4468.5	3743.5	4160.6	4961.6	5364	5631

Source: World Bank report on Algeria's development indicators for 2024: www.albankaldowli.org

The data in Table 07 show fluctuations in GDP per capita during 2013–2024. It decreased from USD 5,494 in 2013 to USD 3,945 in 2015, followed by moderate fluctuations during 2016–2019. The indicator reached its lowest level of USD 3,743.5 in 2020, reflecting the decline in economic activity during this period. From 2021 onward, GDP per capita increased progressively, reaching USD 4,961.6 in 2022 and USD 5,631 in 2024. Overall, the evolution indicates a gradual recovery in individual economic income after 2020, which may contribute to improving households' capacity to access food.

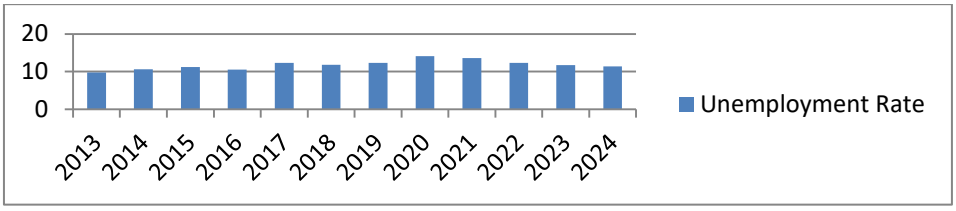
3.2.3 Unemployment Rate Indicator: Unemployment is an economic concept that connects the social and economic aspects of life within a country. It is also one of the basic indicators that reflects people's living conditions and their ability to achieve food security, primarily through income. Unemployment refers to people who are capable of working but are not employed, even though they are actively seeking work **(Ahmad, 2004, p. 205)** It can also refer to individuals who are above a certain age, able and willing to work, but unable to find employment at the prevailing wage rate **(Guarretini & Richard , 1999, p. 202)**. Unemployment is therefore considered an indicator of economic growth and development. Generally, the lower the unemployment rate, the higher the economic growth rate tends to be. This is because unemployment is one of the most important indicators of internal economic balance. The next table and figure present Algeria's unemployment rate performance. These indicators reflect Algeria's economic growth and, consequently, its level of food security. This is based on the available statistics for the specified period, as follows**:**

Table 08: Explanation of the evolution of the unemployment rate in Algeria for the period 2013–2024.

Year	2013	2014	2015	2016	2017	2018
Unemployment	9.8	10.6	11.2	10.5	12.3	11.8
Year	2019	2020	2021	2022	2023	2024
Unemployment	12.3	14.10	13.6	12.3	11.7	11.4

Source: World Bank report on Algeria's development indicators for 2024.

Figure 02 illustrates the evolution of unemployment rates in Algeria from



Source: prepared by the researcher based on the data in Table 08.

Table 08 shows that Algeria's unemployment rates during the period 2013–2024 were generally low compared to previous years. The rate reached 9.8% in 2013, indicating that Algeria's economic reform programmes helped reduce unemployment compared to the 1990s, when it exceeded 30%. This improvement was also influenced by the security situation Algeria experienced during this period. These conditions affected the labour market and both domestic and foreign investment. Consequently, Algeria was less attractive to investors during those earlier periods. Another factor was the increase in global energy (oil and gas) prices, which raised Algeria's hydrocarbon revenues and contributed to an improvement in the labour market. However, unemployment increased again between 2014 and 2017 due to the recent oil crisis, which caused a significant decline in hydrocarbon prices. This decline was driven by reduced demand linked to stagnation in some developed economies. The unemployment rate reached its highest level in 2017, at 12.3%. It then rose again in 2020, mainly due to the impact of the 2020–22 global pandemic, which affected the overall economy and contributed to a slowdown in the labour market. This was due to the shutdown of activities and suspension of work in some sectors, such as tourism and trade. In 2024, unemployment showed a clear decrease, due to improved economic conditions and a recovery in job opportunities.

This has led to better living conditions for Algerian individuals and supports food security. Without work and income, individuals cannot afford to buy food.

3.2.4 Inflation indicator in Algeria: Inflation is the phenomenon of an increase in the general level of prices. It can also be defined as an unusual increase in the money supply and payment methods used compared to the quantity of goods and services available to buyers during a specific period **(Belkadi, 2013, p. 141)** In other words, inflation often results from an increase in demand alongside a decline in supply. Inflation is one of the most important economic indicators affecting food security because it directly reduces citizens' ability to purchase goods, especially food. This is because inflation leads to higher prices, often due to rising demand and limited supply. Inflation in Algeria has fluctuated, alternating between increases and decreases. This is illustrated by the statistics in the following table:

Table 9 illustrates the evolution of the inflation rate in Algeria (2013–2024).

Year	2013	2014	2015	2016	2017	2018
Inflation	3.26	2.92	4.78	6.4	5.59	4.45
Year	2019	2020	2021	2022	2023	2024
Inflation	2	2.4	7.2	9.3	9.3	4

Source: World Bank report on Algeria's development indicators for 2024, www.albankaldowli.org

The figures in Table 9 show that Algeria recorded high inflation rates during the period 2013–2024. However, at the beginning of 2013, inflation was relatively low, at about 3.26%. This can be attributed to the economic reforms implemented with international institutions during that period. These reforms contributed to changes in the money supply, as well as through an economic recovery/relief program, which increased public spending and affected inflation rates—leading to a decline. After that, inflation continued to decrease and then increase again. Overall, Algeria's inflation rates appear to be influenced by political changes, including various economic and monetary policy reforms. In theory, these changes should be automatic reactions to supply and demand, but in practice this is not always the case. When investments are directed towards productive sectors, this increases supply, which, by making goods more available,

tends to reduce prices and lead to a real decrease in inflation. In recent years, however, inflation rose again in 2022 and 2023 as a consequence of the global economic slowdown caused by the pandemic. It was also affected by ongoing security conflicts, especially the Russia–Ukraine war, which impacted supplies and global food supply chains. This contributed to the rise in inflation. In 2024, inflation fell noticeably again. This improvement is linked to the initial results of Algeria's economic reforms.

4. Statistical study of food security and economic growth indicators in Algeria using PCA (Principal Component Analysis) :

Principal Component Analysis (PCA) is used as a multivariate exploratory technique to examine the relationships among the selected food security and economic growth indicators in Algeria during 2013–2024. The analysis focuses on the first two principal components (F1 and F2), which explain the largest share of the total variance and reveal the main patterns of association among the variables.

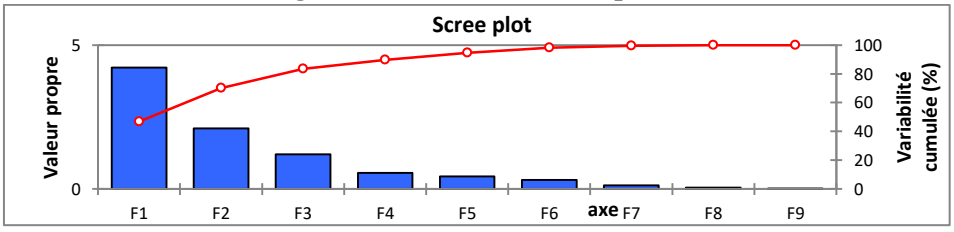
4.1. Eigenvalues and explained variance (inertia rate).

Table 10 shows the eigenvalues and the inertia/explained variance rates (for food security and economic growth indicators for the period 2013–2024).

	F1	F2	F3	F4	F5	F6	F7	F8	F9
Eigenvalue	4.214	2.105	1.201	0.556	0.438	0.317	0.124	0.043	0.000
Variance (%)	46.825	23.393	13.344	6.183	4.866	3.526	1.378	0.483	0.001
Cumulative %	46.825	70.218	83.562	89.745	94.611	98.138	99.515	99.999	100.000

Source: Outputs of the XL-STAT software (2019).

Figure 03: Graphical representation of the eigenvalues of the food security and economic growth indicators for the period 2013–2024.



Interpretation

The first factor axis (F1) explains 46.82% of the total variance, while the second factor axis (F2) explains 23.39% of the total

inertia/explained variance. Therefore, together, F1 and F2 explain approximately 70.22% of the total variance.

This percentage is good and appropriate for representing the data, meaning that most of the statistical information contained in the study indicators can be explained using these two factors. This also makes it easier to analyse the relationships between the food security and economic growth indicators.

4. 2. Correlation of study variables with the main components

In this part of the statistical study, we will analyse and interpret the correlations between the different main variables represented by the food security and economic growth indicators in Algeria. These variables are explained by the main components, namely the first and second axes (F1 and F2). The correlation is shown as follows:

Table 11: Correlation of the variables with the main components for the food security and economic growth indicators (2013–2024).

	F1	F2	F3	F4	F5
Food imports	0.870	0.148	-0.025	0.193	-0.370
Agricultural production	0.706	0.452	0.284	-0.301	-0.059
Food energy supply	0.447	0.671	0.389	-0.068	0.405
Food shortage	0.811	0.020	0.016	0.529	0.136
Inflation in food prices	0.853	-0.211	-0.390	-0.242	0.031
Economic growth rate	0.609	-0.676	0.025	0.111	0.225
GDP per capita (sometimes called "per capita share of GDP")	0.528	-0.308	0.708	-0.073	-0.225
Inflation rate	0.831	-0.210	-0.427	-0.237	0.056
Unemployment rate	0.185	0.888	-0.364	0.106	-0.103

Source: Outputs of the XL-STAT software (2019).

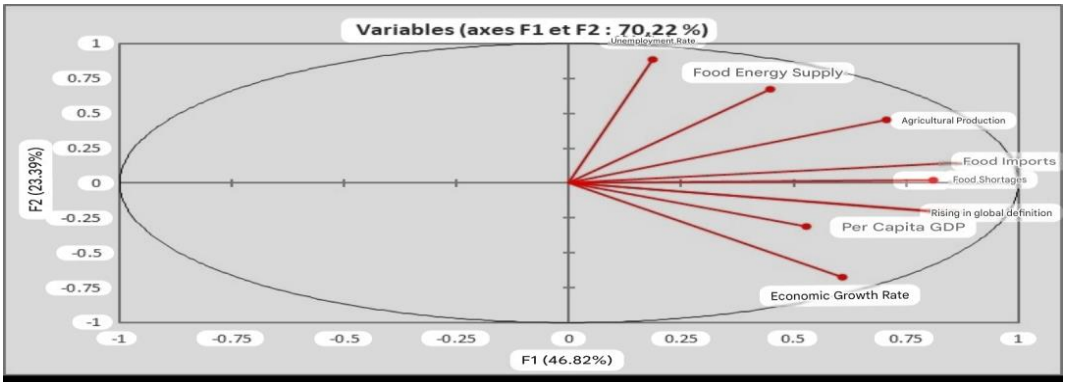
Interpretation

The results show that F1 is strongly and positively associated with food imports (0.870), food price inflation (0.853), inflation rate (0.831), and food shortage (0.811). It also shows a relatively strong association with agricultural production (0.706) and a moderate association with economic growth (0.609) and GDP per capita (0.528). The relationship with food energy supply (0.447) and unemployment (0.185) is weaker.

F2 is strongly and positively associated with unemployment (0.888) and food energy supply (0.671), while its association with economic growth is negative (-0.676). The remaining variables show relatively weak correlations with F2.

4.3Strengths and weaknesses of the study according to the key indicators (2013–2024): Based on the correlation circle between the food security and economic growth indicators, we can infer the main strengths and weaknesses of these indicators, as well as the strength of their influence on each other, as follows:

Figure 04 shows the correlation between the food security and economic growth indicators in Algeria for the period 2013–2024.



Source: Outputs of the XL-STAT Program (2019).

The correlation circle shows that F1 is mainly associated with food imports (0.870), food price inflation (0.853), inflation (0.831), food shortage (0.811), and agricultural production (0.706), while F2 is mainly associated with unemployment (0.888) and food energy supply (0.671). Economic growth is negatively associated with F2 (-0.676). Together, F1 and F2 explain 70.218% of the total variance.

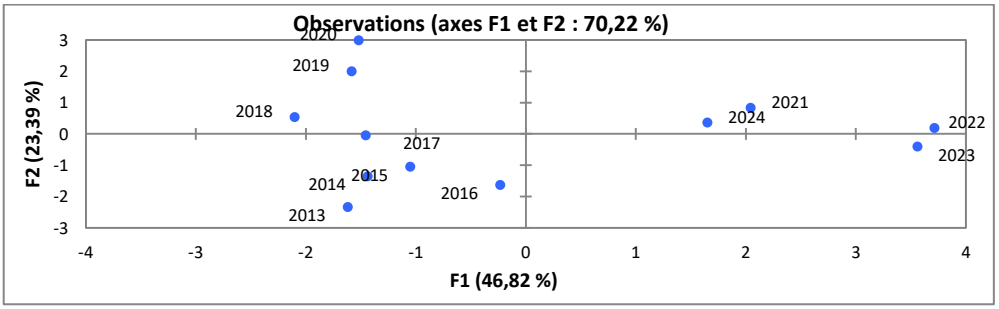
Agricultural production remains important for food security but is insufficient to eliminate import dependence. Food imports show the strongest association with F1, reflecting their role in meeting domestic demand. Food shortage is strongly associated with F1 (0.811), indicating its close statistical relationship with the other food security and economic indicators. Food energy supply is mainly associated with F2. Overall, the

results highlight the main statistical associations among the selected indicators.

4.4 Performance of Food Security and Economic Growth Indicators for the Period 2013–2024

In this section of the statistical study, we will address changes in the indicators over the study period. This is in accordance with the ACP analysis presented previously.

Figure 5 shows a graphical representation of the study indicators for the period 2013–2024.



Source: Outputs of the XL-STAT Programme (2019).

Based on the PCA scores, three main periods can be identified:

2013–2017: Weak economic growth and greater dependence on food imports. The decline in oil prices from 2014 reduced public resources and affected agricultural support and import financing.

2017–2020: Relative improvement in economic and food security indicators, supported by agricultural development and continued food imports. The year 2020 was exceptional due to the COVID-19 pandemic.

2021–2024: A clear improvement compared with the previous periods, reflecting more favourable economic and food security conditions and economic recovery.

Overall, the PCA scores show changes in the joint pattern of food security and economic growth indicators across the study period.

4.5 Relationship Between the Results and the Study Hypotheses:

The results of the Principal Component Analysis provide evidence of significant associations between several economic growth and food security indicators in Algeria during the period 2013–2024. The first principal

component (F1) explains 46.825% of the total variance, while the second component (F2) explains 23.393%, with the two components together accounting for 70.218% of the total variance. Agricultural production shows a strong positive correlation with F1 (0.706), while the economic growth rate presents a moderate positive correlation (0.609). These results indicate an important association between economic performance and agricultural production, providing support for the first hypothesis (H1).

Regarding the second hypothesis (H2), the results show strong positive correlations between food price inflation (0.853), the general inflation rate (0.831), and F1. This finding confirms the importance of inflation as a major dimension associated with the food security indicators. However, since PCA identifies associations rather than causal effects, the results do not directly confirm a negative causal relationship between inflation and food security. Therefore, H2 is only partially supported and should be interpreted as evidence of a significant association between inflation and food security conditions in Algeria.

5. CONCLUSION

In conclusion, achieving food security in Algeria requires strengthening local production to meet domestic demand, ensure stable food availability, and reduce external dependence. This study examined the relationship between economic growth and food security indicators during 2013–2024 using Principal Component Analysis (PCA).

The results show a relative improvement in food security indicators and reveal a common pattern between food security and economic growth indicators. Food imports remain important in meeting domestic demand, while agricultural production and food energy supply represent important dimensions of the observed relationships. These findings highlight the need to strengthen domestic agricultural production and reduce dependence on external food sources.

5.1 Results of the study:

- Algeria has achieved a relative improvement in food security indicators, mainly due to improvements in some economic indicators

and an increase in the country's ability to provide food.

- The study shows that Algeria recorded low levels of the food deficit indicator, which is attributable to the effectiveness of supplying food to the markets, either through agricultural production or food imports.
- Algeria improved its economic growth indicators, which was reflected in individuals' enhanced capacity to achieve food security.
- The results of the principal component analysis indicate a link and a common trend between food security and economic growth indicators.
- Agricultural production and energy/fuel supply indicators are among the most influential factors in determining the level of food security in Algeria.
- The increased reliance on food imports to compensate for agricultural production shortages in order to meet food demand reflects weak agricultural production in Algeria and makes the country vulnerable to external fluctuations.

5.2 Recommendations:

To ensure local self-sufficiency and consequently build sustainable food capacity for individuals within the Algerian market, a set of measures must be taken. Therefore, we propose the following recommendations:

- Strengthen domestic agricultural production to improve food self-sufficiency.
- Reduce dependence on food imports, particularly for basic commodities.
- Support agricultural investment and improve production efficiency.
- Develop policies to control food price inflation and protect purchasing power.
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7. Appendices:

Observation	F1	F2	F3	F4	F5	F6	F7	F8	F9
2013	-1.617	-2.340	1.214	0.666	-0.758	-1.023	0.100	0.075	-0.001
2014	-1.435	-1.364	0.210	1.071	0.484	0.613	-0.541	-0.153	-0.013
2015	-1.049	-1.058	-0.862	0.214	0.041	0.562	0.561	0.053	0.003
2016	-0.232	-1.633	-0.787	-0.489	0.509	0.463	0.369	-0.166	0.013
2017	-1.451	-0.053	-1.240	-0.965	-0.847	-0.295	-0.430	0.153	0.013
2018	-2.099	0.531	-0.325	-1.354	0.521	-0.108	-0.231	-0.013	-0.019
2019	-1.582	1.992	1.481	0.150	1.210	-0.530	0.041	-0.024	0.016
2020	-1.516	2.980	-0.500	0.657	-0.951	0.115	0.400	-0.147	-0.009
2021	2.047	0.825	-1.285	1.012	0.373	0.064	-0.262	0.420	0.003
2022	3.718	0.182	-0.487	0.085	-0.261	-0.391	-0.294	-0.455	0.006
2023	3.562	-0.413	0.237	-0.492	0.372	-0.498	0.407	0.134	-0.016
2024	1.653	0.352	2.345	-0.556	-0.695	1.029	-0.120	0.124	0.004

	F1	F2	F3	F4	F5	F6	F7	F8	F9
2013	0.224	**0.470**	0.127	0.038	0.049	0.090	0.001	0.000	0.000
2014	**0.341**	0.308	0.007	0.190	0.039	0.062	0.048	0.004	0.000
2015	0.302	**0.307**	0.204	0.013	0.000	0.087	0.086	0.001	0.000
2016	0.013	**0.632**	0.147	0.057	0.062	0.051	0.032	0.007	0.000
2017	**0.377**	0.000	0.275	0.167	0.128	0.016	0.033	0.004	0.000
2018	**0.633**	0.040	0.015	0.263	0.039	0.002	0.008	0.000	0.000
2019	0.240	**0.380**	0.210	0.002	0.140	0.027	0.000	0.000	0.000
2020	0.177	**0.685**	0.019	0.033	0.070	0.001	0.012	0.002	0.000
2021	**0.528**	0.086	0.208	0.129	0.018	0.001	0.009	0.022	0.000
2022	**0.946**	0.002	0.016	0.000	0.005	0.010	0.006	0.014	0.000
2023	**0.924**	0.012	0.004	0.018	0.010	0.018	0.012	0.001	0.000
2024	0.267	0.012	**0.537**	0.030	0.047	0.103	0.001	0.001	0.000

	F1	F2	F3	F4	F5	F6	F7	F8	F9
2013	5.169	21.681	10.227	6.644	10.933	27.471	0.677	1.072	0.050
2014	4.071	7.367	0.307	17.185	4.466	9.869	19.640	4.506	10.534
2015	2.174	4.429	5.159	0.686	0.032	8.304	21.147	0.533	0.753
2016	0.106	10.557	4.303	3.587	4.935	5.619	9.145	5.259	11.474
2017	4.166	0.011	10.664	13.940	13.636	2.290	12.437	4.463	10.090
2018	8.712	1.115	0.734	27.435	5.169	0.305	3.594	0.034	23.715
2019	4.950	15.705	15.214	0.336	27.876	7.371	0.115	0.113	16.771
2020	4.542	35.148	1.736	6.471	17.192	0.344	10.732	4.121	5.416
2021	8.285	2.691	11.460	15.347	2.642	0.107	4.631	33.807	0.716
2022	27.329	0.131	1.646	0.109	1.295	4.014	5.799	39.698	2.189
2023	25.092	0.674	0.390	3.623	2.635	6.518	11.120	3.462	17.337
2024	5.405	0.489	38.160	4.638	9.188	27.787	0.964	2.933	0.955