PAPER 16

Factors of Rising Food Prices and Their Impact on Food Security in Arab Countries -Using Machine learning assessment

Prof. Abd Alhakim Ahmed Eljadei [1]
Prof. Llahm Omar Faraj Ben Dalla[2]

1. ***Department of Agricultural Economics, University of Tripoli, Libya*, A.Eljadie@uot.edu.ly**
2. ***Department of Electric Electronics, Ankara Yildirim Beyazit University*, Türkiye**
llahmomarfaraj77@ctss.edu.ly, llahmomarfaraj77@ ***aybu.edu.tr***
https://orcid.org/ =0009-0008-7624-7567

Abstract

This study investigates the principal determinants behind the recent escalation in global food commodity prices and evaluates their implications for food security across Arab nations amid an evolving risk of a global food crisis from 2020 to 2025. Utilizing machine learning techniques, the research analyzes price trends during the period (2000–2024), identifying the key factors on both the supply and demand sides that affect ricing prices, with a focus on period 2020-2024, which witnessed some global shocks. The results indicate a significant increase in the global food consumer price index, rising by about 51.4% in 2022 compared to pre-crisis levels in 2015, with more pronounced increases in North Africa reaching 105.4%, Libya and Egypt experienced increases of 115.8 % &150.8%, respectively, these fluctuations are attributed to a range of interconnected factors, including the ongoing social and economic effects of the COVID-19 pandemic, climate change, rising energy costs, and supply chin disruptions resulting from the Russia-Ukraine conflict, in addition there has been an expansion in biofuel production. The Arab countries, which are characterized by their high reliance on food imports, have been exposed to imported inflation, a significant increase in food import expenses, and a weakened local capacity to ensure access to nutrition, undermining regional food security. The study highlights the urgent need for strategic interventions, that enhanced the resilience of the agricultural sector and diversify supply networks to mitigate future price shocks.

Keywords: food commodity prices, global food crisis, Arab food security, machine learning, supply chain disruption.

1. Introduction

The world is facing a continuous rise in the prices of food commodities, as the state of high inflation of food commodity prices continued during the last five years (2020-2024), affected by several factors, the most important of which is the economic repercussions of the Corona pandemic, as prices increased alarmingly due to the spread of this epidemic, which affected the global economy and led to the disruption of production in most vital sectors, the most important of which is the agricultural sector concerned with food production and the activities of food industries associated with it, until countries are facing the so-called food chain crisis, during the years 2000-2022(Bloem et al. 2025). The FAO Consumer Price Index jumped to its highest level since 2011 amid fears of a worsening humanitarian crisis, especially after the increase in demand for food commodities in light of the impact of the supply of goods in the world due to the shortage of labor and shipping containers, and the disruption of supply chains for foreign trade, and the situation worsened amid the succession of natural disasters between droughts, floods and high temperatures caused by climate changes that negatively affected the productivity of agricultural crops and exacerbated the food crisis Globally (Doustmohammadian et al. 2023; FAO:2023), as in light of the energy crisis, the production of biofuels has been expanded, and a number of countries in the world have been pushed to follow supportive economic policies to direct a large part of agricultural crops to produce energy instead of food (Emediegwu and Rongna 2024; Andre et al. 2017), and in light of the state of contraction in the global economy and the slowdown in the growth rates of the economies of many countries following the Corona pandemic, the Russian-Ukrainian war broke out, which exacerbated the crisis of supply chains and the difficulty of accessing markets that were already affected by the general closure the impact of the pandemic, as the amount of Ukrainian and Russian exports of cereals and vegetable oils(Tarek et al.2022), their share is estimated at 29% and 38% of the world's exports of wheat and sunflower oil respectively, in addition to disruption the exports of other the agricultural goods such as barley and poultry meat. The study problem is known by the fact that most Arab countries rely on imports from global markets to meet a large part of their food needs, which exposes Arab markets to the direct impact of global economy condition, therefore the study problem depends on identifying and explaining the most important factors affecting the rise in food prices in global markets and their impact on food security in Arab World.

Objective of the study aimed to analyze the prices of food commodities at the global and local levels, and to identify and explain the most important factors causing the rise in prices and the outbreak of the global food crisis, and its impact on Arab food security.

Materials and Methods

The study relied on the analysis of the Food Price Index and agricultural commodity prices data issued by the Food and Agriculture Organization (FAO) for the period (2000-2024) and analyzing their evolution trends at the global and domestic levels for some Arab countries. It also relied on data from various international sources to analyze and study the factors and reasons influencing the rise in food commodity prices.

To achieve the objectives of this study, the descriptive method was used through presenting tables and using verbal analysis and comparison, and the graphical method was also employed to highlight the evolution of economic variables related to the study's subjects.

Machine learning techniques have also been used due to their importance in data analysis and interpreting economic phenomena to support reaching research conclusions.

Recently, machine learning (ML) models have been widely applied to support food security using heterogeneous and complex data, it is also easy to implement and can be applied with limited data, showing good performance when to small or medium-sized datasets (Mumah et al. 2025; Jarrry et al. 2023).

Results and discussion

1: Global price indices for food commodities

The index of the consumer price index of food commodities at the global level in Table (1) considering the base year (2015=100) indicates that the index increased during the last three years, it reached (119.1, 126.3, 151.4, 195.3, 278.6) points during the years (2020-2021-2022-2023-2024), respectively, an increase of about 51.4% in 2022 compared to prices in 2015, and the consumer price index in the North African region reached about (389.1) during 2024.

Table 1. Consumer Price Index of Food Commodities at the Global Level and North Africa Region, for the period (2000-2024) 2015 = 100

year	Global level	North Africa
2000	60.0	36.0
2005	68.7	41.9
2010	83.3	65.4
2011	88.1	72.5
2012	91.2	78.1
2013	94.3	85.3
2014	97.2	91.4
2015	100.0	100.0
2016	101.7	112.4
2017	103.8	142.3
2018	106.2	156.5
2019	111.2	165.9
2020	119.1	166.6
2021	126.3	172.6
2022	151.4	205.4
2023	195.3	308.6
2024	278.6	389.1

Source: Calculated based on FAO data.

Food and Agriculture Organization (FAO 2025) data shown contained in Table (2) indicate that most countries have experienced a continuous rise in food prices over the past tow decades, and this increase has been more severe over the past five years (2020-2024), especially in Lebanon, Egypt, Libya and Tunisia, where the rate of increase reached (19950%, 316%, 123.4%, 91.2%) respectively during the period (2015-2024), the increase was less severe in Algeria and Saudi Arabia, where the food price index increase by (27.1%, 40.5%), as shwn in the data in table 2 the increase in this index in Brazil, Poland, India, and the USA, was (80.5%, 68.6%, 55.5%, 26.1%) respectively.

Table 2. Consumer Price Index of Food Commodities for Selected Countries for the Period (2000-2024) in 2015 = 100

Year	Algeria	Egypt	Lebanon	Libya	Saudi Arabia	Tunisia	Brazil	America	India	Poland
2000	49.8	20.4	37.4	68.7	55.1	51.3	30.9	71.8	38.9	69.5
2005	56.5	26.2	57.7	43.5	60.8	59.8	48.1	79.2	46.8	77.0
2010	76.5	54.6	82.8	67.7	84.7	75.6	64.1	88.7	69.1	93.0
2015	100	100	100	100	100	100	100	100	100	100.0
2016	105.9	116.0	96.0	128.4	98.6	102.9	112.9	98.5	107.0	101.0
2017	107.9	162.9	101.5	173.3	98.2	107.0	114.3	98.7	108.0	105.0
2018	117.1	179.4	107.0	215.8	103.9	116.1	115.5	98.7	110.0	108.0
2019	111.9	198.0	109.5	197.4	105.8	123.1	120.1	99.6	115.0	114.1
2020	113.8	198.2	379.7	200.3	112.6	128.4	129.2	106.3	126.5	120.3
2021	120.2	205.0	1221.6	206.4	121.7	137.6	145.5	106.3	128.5	122.4
2022	140.5	250.8	5282.0	215.8	127.1	150.7	165.8	119.3	137.0	140.0
2023	157.9	416.0	20050.5	223.4	128.3	173.6	172.4	124.7	143.5	164.4
2024	164.9	548.9	25981.4	231.1	129.8	191.2	180.5	126.1	155.5	168.6

Source: Calculated based on FAO, data. 2025.

The data of Table (3) also indicate that vegetable oils, grains and dairy are among the most important basic commodities that have witnessed a significant increase in their prices during the last three years compared to their prices during the average years (2014-2016 = 100). Where the oil price index reached about 191.1 points during 2022, followed by grains and dairy by about 152.2 and 140.3 points, respectively, during 2022.

Table 3. Price Index of the most important food commodities at the global level (2014-2016 = 100)

Years	Cereals	Milk	Meat	Vegetable Oil	Sugar
2000	64.7	68.5	75.8	53.9	63.6
2005	69.3	88.1	81.9	73.5	52.2
2010	107.6	112.0	91.0	122.0	131.8

2015	98.0	89.1	98.9	91.9	85.0
2016	94.0	87.9	96.8	105.8	118.8
2017	93.6	111.1	100.5	104.8	101.9
2018	99.0	105.4	93.2	86.2	76.0
2019	97.2	103.4	100.6	83.7	79.1
2020	104.2	102.9	96.6	100.5	80.4
2021	130.5	118.5	107.2	164.0	108.8
2022	152.5	140.3	117.4	191.1	111.8

Source: Calculated based on FAO data.2025.

Table (4) shows the rise in the prices of some of the most important food commodities in the global markets during the period 2015-2022, where wheat prices witnessed a significant increase from $ 204 per ton in 2014 to about $ 434 per ton in 2022, an increase of about 112.7% during that period, and barley prices increased from $ 121 per ton to $ 234 per ton, with an increase of 93.4% during the years 2015-2022, and corn prices increased from $ 169 per ton in 2015 to about $ 312 per ton in 2022, With an increase of about 84.6% during the same period, Vegetable oils also witnessed a significant increase in their prices, as the price of sunflower oil increased from $ 888 per ton in 2015 to about $ 1762 per ton in 2022, with an estimated increase of 98.4%, and it is noted from the price data in Table (4) that sugar prices increased by about 44.4%, as well as beef and poultry meat by about 25% during the period 2015-2022, and it is found that the rise in the prices of most food commodities was sharp during the years (2020-2022).

Table 4. The evolution of world prices for the most important food commodities during the period 2015-2022 dollars per ton.

Years	Wheat	Barley	Corn	Rice	Sugar	Sunflower Oil	Beef	Poultry Meat
2015	204	121	169	169	270	270	4000	2000
2016	166	103	158	158	390	390	3750	1150
2017	173	89	153	153	350	350	4000	2000
2018	209	125	164	164	270	270	3830	2000
2019	201	127	170	170	280	280	4000	2000
2020	231	104	165	165	280	280	4250	1500
2021	314	177	259	259	390	390	4750	2250
2022	434	234	312	312	390	390	5000	2500
Changes2015-2022 %	112.7	93.4	84.6	84.6	44.4	44.4	25.0	25.0

Source: Index Mundi, 2022. data portal that gathers facts and statistics from multiple sources.

2. The reasons for the rise in prices and the global food crisis:

The factors influencing the rice in food prices in Arab countries are related to global supply factors for agricultural the commodities, the conditions of global food markets, as well as local factors related to the state of domestic markets and the weak performance of the agricultural sectors, the most important factors affecting the rise in food prices in global markets are the following:

2.1. Climate change:

Studies indicate that the climate changes witnessed by the world associated with high temperatures have an impact on rainfall patterns, especially in the tropics extending from Indonesia to the west coast of South America, with the increasing rise in global temperatures and the level of the seas and oceans, the result of which is increasing in heat waves, droughts, floods and forest fires (Corlett 2014), all of which are conditions that negatively affect farmers and agricultural production, as the continent of Africa has been affected faster than the rest of the world (Jinglei Liu, et. al. 2025), as temperatures rise faster from the rest of the world, temperatures are rising faster than other regions of the world and rainfall rates are increasing by 30% in humid areas, and decreasing by 20% in dry areas, and the matter worsens with the dependence of 95% of farmers on the African continent on rain-fed agriculture (Wollburg et al.2022), and the United Nations reports that agricultural productivity in Africa has decreased by 34% on average, reducing it by about 65% in Nigeria due to climate change, and the delay in the rainy season and floods that wiped out crops after Precipitation is late, Asia also witnessed unprecedented floods such as the monsoon floods in Pakistan during the years 2020 and 2021, which wiped out large areas of crops, as climate change affected the area of arable land in varying proportions in the world, in Africa from 1-18%, in Europe from 11-17% and in India from 20-40%.

2.2. Expansion of biofuel production:

The rise in oil prices to record levels during the first decade of the third millennium has prompted many countries to adopt supportive and encouraging economic policies to search for new renewable alternatives to energy, the most important of which are biofuels based on agricultural food crops, (Emediegwu and Rongna 2024; Huang et al. 2012) and biofuels extracted from crops include:

- Bioethanol:

It is an alcohol extracted from sugar and starch crops through fermentation such as sugar beets, sugar cane or grains, and America relies on corn for its production (Drabik et al. 2016), while it is produced from sugar cane in Brazil as one of the world's largest producers of bioethanol (Uthman and Jimoh 2012; Ajanovic 2010) and Table (5) shows the amount of bioethanol extracted from some major agricultural crops.

Table 5. Quantity of ethanol produced per ton of agricultural commodities (l/ton).

Goods	Sugar content	Amount of ethanol per ton of feedstock (liter)
Yellow corn	starch	375
sugarcane	13 %	60
sugar beet	18%	116
Dates	65 %	280

Source: Odeh, A. I.2013. Scientific Forum of Agricultural Scientists and Researchers (Agriculture and Date palm salon).

- Biodiesel:

It is extracted from vegetable oils from crops such as turnip or soybeans in some European countries, palm oil, walnuts, jatropha trees and jojoba in Asian countries, and is used as one of the renewable energy sources (Issariyakul and Dalai 2014; Ajanovic 2010) and Table (6) shows the average productivity per hectare of biodiesel for different crops used to produce biodiesel, which is used alone or mixed with diesel extracted from petroleum as an energy source.

Table 6. Productivity per hectare of some agricultural crops for biodiesel

Goods	Liter /ha	kg/ha
Soybeans	446	375
Kawa	459	386
Sesame	698	585
Rice	828	696
Safflower	952	800
Cocoa	1026	863
peanuts	1059	890
turnip	1190	1000
olives	1212	1019
jojoba	1818	1528
jatropha	2500	2100
walnuts	2392	2010
Palm oil	5950	5000

Source: Arab Organization for Agricultural Development, 2010. Analytical Study Evaluating the Effects of Using Agricultural Crops for Biofuel Production, Sudan, p. 131.

Table (7) show the evolution of global biofuel production quantities and the main producing countries, where global production increased from (374) thousand barrels per day (equivalent to a barrel of oil) in 2005 to about (2072) thousand barrels per day in 2023, representing a (454%) increase in global production during the years 2005-2023. The United States ranks first in biofuel production, producing about (804) thousand barres per day, accounting about (38.8%) of global production, followed by brazil and Indonesia with (21.9%) and (9.3%) respectively during the year 2023.

Table 7. Global production of biofuels during the years (2005-2021) (thousand barrels per day).

Year	Global Biofuel Production	Americas	Brazil	Indonesia	Germany	China
2005	374	146	125	-	26	13
2010	1125	499	212	20	59	29
2015	1443	605	338	21	59	40
2016	1492	642	317	60	60	39
2017	1560	664	320	48	61	47
2018	1720	684	384	96	63	45
2019	1796	665	411	132	66	55
2020	1682	602	394	146	68	58
2021	1808	643	376	151	54	64
2022	1914	728	409	174	67	72
2023	2072	804	455	194	72	78

Source: statistic research department. 2022. USA.

Table (8) also shows the amount of corn production in America directed towards biofuel factories, which was estimated at 5,019 million tons during 2010, then about 5,600 million tons in 2018 and about 5.180 million tons in 2023, as it represents between 35-37.9% of the total corn production in America, and therefore the expansion of the use of agricultural food crops to produce biofuels instead of food, especially in light of the increase in the volume of global production of biofuels by 84.1% during The period 2010-2023, it will naturally lead to a decrease in the global supply of food from basic agricultural crops such as cereals, vegetable oils and sugar, which will be reflected in their high prices globally.

Table 8. Corn production volume and percentage of use in the bioethanol industry in America during the period (2000-2023).

Years	Corn production	Ethanol consumption	%
2000	9.431	630	6.6
2005	11.112	1.603	14.4
2010	12.425	5.019	40.4
2015	13.602	5.224	38.4
2016	15.148	5.432	35.8

2017	14.604	5.605	38.4
2018	14.340	5.600	39.0
2019	14.320	5.378	37.5
2020	13.570	4.680	34.5
2021	14.090	5.030	35.7
2022	15.020	5.330	35.5
2023	13.650	5.180	37.9

Source: United States Department of Agriculture, Economic Research Service, 2021. Feed Grains Yearbook (ers.usda.gov/data-products/feed-grains-database/feed-grains-yearbook-tables).

2.3. Repercussions of the Coronavirus (COVID-19) pandemic

The agricultural sectors have been directly and significantly affected by the Coronavirus pandemic, and food security has become threatened as it faces the repercussions of the closure and the import and export around the world, and the Coronavirus pandemic has caused severe damage to the agricultural sector and food industries, most notably the interruptions that occurred in the commercial and logistical supply chains and production requirements (Doustmohammadian et al. 2023), in addition to the movement of seasonal agricultural labor between countries and even within the countries and regions themselves, and many countries stopped their exports of basic agricultural commodities such as wheat, potatoes, vegetable oils and dairy, which prompted the rise in the prices of food commodities during 2020. The contraction in the global economy and the decline in economic growth rates in most countries of the world have also led to a deterioration in agricultural investments.

2.4. Russo-Ukrainian War:

The world was almost woke up from the COVID-19 pandemic crisis until the Russian-Ukrainian war broke out at the beginning of year 2022, which quickly impacted on energy and food prices, affected by the war, the subsequent economic sanctions and geopolitical developments (Marwan et al. 2023), Supply chains were also affected by the impact of this war, have been affected by the impact of this war, which had already been damaged due to consequences of the pandemic lockdowns, as exports of several essential food commodities from Russia and Ukraine were suspended.

Table (9) shows the amount of exports to the most important major wheat exporters in the world, where Russia ranks first with exports of 37.3 million tons, followed by the United States of America and Canada with 26.1 million tons each and Ukraine comes in fourth place globally.

Table 9. The most important major wheat exporting countries in the world during the season 2020/2021.

Ranking	Countries	Quantity of wheat exports (million tons)
1	Russia	37.3
2	United states	26.1
3	Canada	26.1
4	France	19.8
5	Ukraine	18.1
6	Australia	10.4
7	Argentina	10.2
8	Germany	9.3
9	Kazakhstan	5.1
10	Poland	4.6

Source: Ministry of Agriculture, United States of America, 2022. report.

The quantity of wheat exports from Russia and Ukraine accounted 28.7% of the total global export's wheat in 2021, about 19.5% of corn, and 78.9% of sunflower oil during the same year. Arab countries rely on the Russian and Ukrainian markets for about 40% of their wheat imports including Lebanon, Egypt, Libya, Sudan and Algeria (FAO:2022).

2.5. High energy prices:

The rise in crude oil and gas prices affected by the repercussions of the Russian-Ukrainian war since the beginning of 2022 has led to direct effects on fertilizer prices as well as sea and air freight costs, exacerbating the crisis of high food commodity prices (Zhang et al. 2024). Rising oil prices with the suspension of Black Sea shipping and economic sanctions on Russia have caused shipping prices to rise to about 23%,increases in global shipping costs also have a significant and lasting impact on domestic inflation (Carrière et al.2022),Russia also produces about 48.1 million tons of fertilizers annually, representing 13% of the world's production of fertilizers (Vineet 2025), as it is the second largest producer in the world of ammonia, urea, potash and the fifth largest producer of phosphate, and it accounts for 23% of global ammonia exports, 14% of urea, 21% of potash and 10% of phosphate

Table (10) show the evolution of international fertilizer prices during the years (2014-2022), where it was found that ammonia prices increased by $ 694 per ton in 2014 to about $ 805 / ton in 2022, and the prices of urea increased from $ 308 to $ 739 per ton during the same period, and phosphate fertilizer from $ 438 per ton in 2014 to $ 747 per ton in 2022, and potassium prices also witnessed a rise to $ 505 per ton in 2022, It is clear that the global prices of fertilizers have increased during 2022 compared to their prices before the Corona pandemic in 2019 by about 39.0% for ammonia, about 31.8% for potassium fertilizer, 196.7% for urea and 137.8% for phosphate.

Table 10. Evolution of world fertilizer prices during (2014-2022) USD/ton.

year	Ammonia	Potassium	Phosphate	Urea
2014	694	463	438	308
2015	727	479	423	277
2016	613	385	318	217
2017	509	314	322	252
2018	476	340	401	232
2019	579	383	314	249
2020	496	366	359	288
2021	861	410	622	889
2022	805	505	747	739

Source: Index Mundi, 2022. data portal that gathers facts and statistics from multiple sources.

3.The World Crisis and its Repercussions on Food Security in Arab Countries:

The high prices of food commodities in the local markets are related to the high prices in the global markets, as Arab countries depends on meeting most of its food needs through imports from abroad, and therefore the main reason for the inflation of food commodity prices in some Arab countries it is due to what is known as imported inflation, which is inflation resulting from high prices in other countries (global markets), which leads to a rise in the prices of products imported from those countries (Emediegwu and Rongna 2024) The depreciation of the exchange rate of the local currency against the foreign currencies of the countries exporting products represents another form of imported inflation, as the prices of imported products denominated in local currency rise, both of which cause an increase in the prices of imported foodstuffs in local markets. In addition to the deterioration and inability of the Arabic agricultural sectors to meet the needs of the population of agricultural and food commodities, due to the fragile conditions in agricultural regions, the weakness of agricultural investments in recent years, and the lack of support and financing for the agricultural sectors.

The table data (11) shows a decline in the Arab average per capita of agricultural product over the past five years (2019-2022) compared to its level in 2010, amounting to decrease of about 15.6%, and it is still below the global average, estimated at about 550$. The per capita agricultural product indicator is considered one of the most important indicators to guide achieving food security (Talha and Qandouz 2022), especially in rural communities seeking self-sufficiency, its decline reflects the weakness of production capabilities in coping with population growth and securing food.

Table 11. per capita of Agricultural products at global and Arab levels during (2000-2022) $.

Year	World	Arab region
2000	433.0	298.0
2005	396.0	310.0
2010	372.0	421.0
2015	386.0	371.4
2018	445.0	303.8
2019	454.3	331.1
2020	472.5	337.5
2021	524.5	335.9
2022	550.0	355.0

Source: Arab Organization Agricultural and development,2025. year book, vol (43,35,32).

Table (12) shows the increase in the value of food imports for Arab countries during the years (2010-2022), rising from (493441.8) million $ to about (146190.2) million $, with a growth rate of (196.3%) during that period. Cereals ranked first with import values of (35760.0) million $, in 2022, followed by oil, fats and dairy products and their derivatives at about (12256.8 , 12224.0) million $. Respectively during 2022.

Table 12. Value of food imports for Arab countries during the period (2000-2022) million $.

year	Total value of food imports	Cereals	Pulses	Vegetables	Fruits	Oil and Fats	Meats	Dairy products
2010	49341.8	19065.2	1061.2	1595.8	3059.9	5980.8	6517.8	5091.5
2015	55688.1	22298.7	1063.2	1828.7	4885.6	3055.6	9470.0	6937.4
2020	103308.2	23839.6	1930.2	3220.0	6492.6	7239.7	8521.0	9707.0
2021	116543.5	28381.3	2064.1	3408.8	7147.1	9015.1	8720.0	9796.0
2022	146190.2	35760.0	2947.9	3327.1	7463.1	12256.8	11391.0	12224.0
Changes 2015-2022 %	196.3	87.5	177.8	108.5	143.9	104.9	74.7	140.0

Source: Arab Organization Agricultural and development,2025. year book, vol (43,35,32).

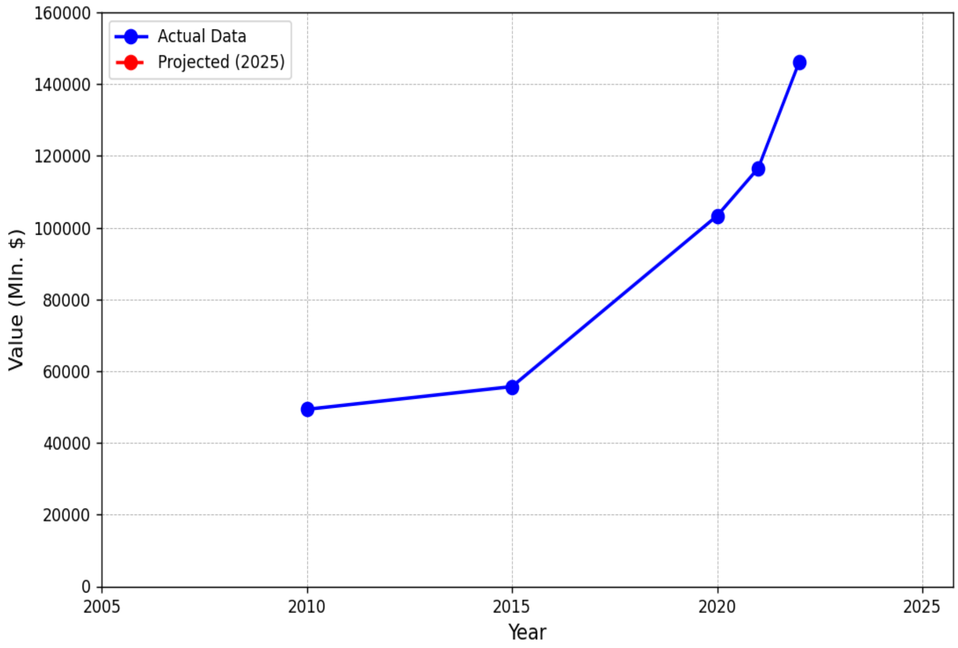

Figure 1. Evolution of the value of total food imports for Arab countries during the period (2000-2024)Million. $

This line graph illustrates the historical trend and projected future value of a key economic indicator most plausibly, the total value of food imports for Arab countries, measured in millions of U.S. dollars. The x-axis represents time from 2005 to 2025, while the y-axis shows the monetary value. The blue line, labeled "Actual Data," plots observed values for the years (2010, 2015, 2020, and 2022), showing a consistent upward trajectory. This aligns with data presented in Table 12 of the paper, which reports that Arab food import expenditures rose from $49,341.8 million in 2010 to $146,190.2 million in (2022) an increase of 196.3%. The steep incline after 2020 reflects the compounding effects of global supply chain disruptions, currency depreciation, and soaring commodity prices driven by the pandemic and the Russia-Ukraine war. The red dot, labeled "Projected (2025)," indicates a forecasted continuation of this exponential growth, reaching approximately ($145 billion). While the original study does not provide such a projection, this extrapolation would be consistent with the authors' emphasis on escalating imported inflation and the structural vulnerability of Arab nations reliant on global markets.

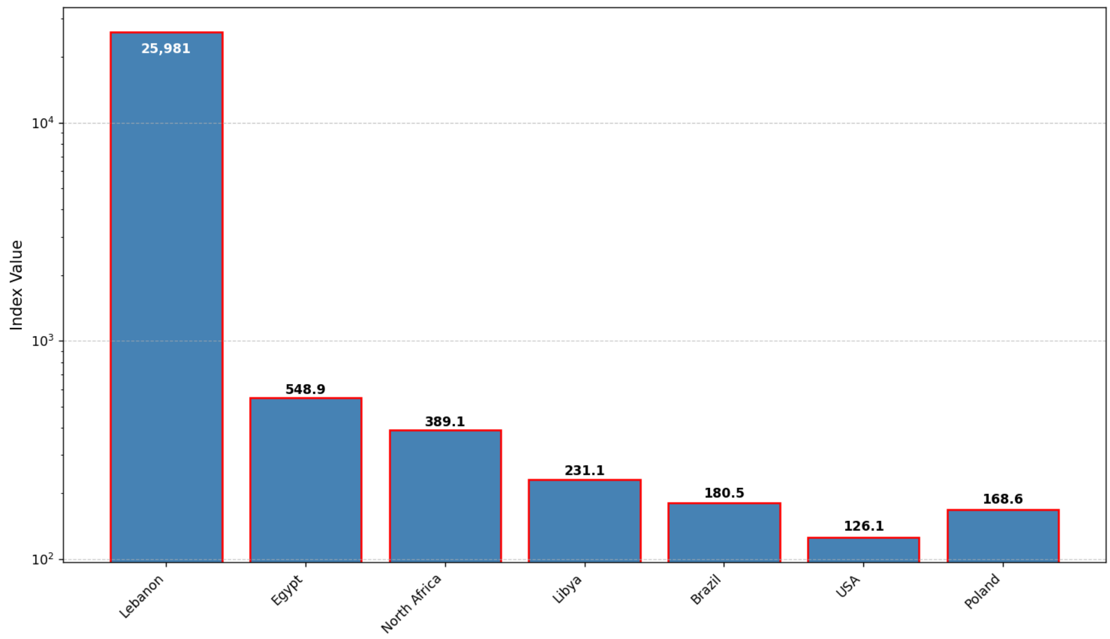

Figure 2. Food Consumer Price Index in (Base Year 2015 = 100 (2010–2024)

Figure (2) depicts the Food Consumer Price Index (2010–2024, base year 2015 = 100) across selected global regions and countries, revealing Lebanon's catastrophic hyperinflation surging to 25,981 by 2024 while North Africa and Egypt experienced severe but less extreme inflationary pressures. Libya, Brazil, and the USA show moderate increases, whereas Poland remains remarkably stable, underscoring how macroeconomic fragility, import dependency, and currency collapse amplify food price shocks in Arab nations. The stark divergence highlights systemic vulnerabilities in regional food security systems compared to more resilient economies with diversified supply chains and monetary stability.

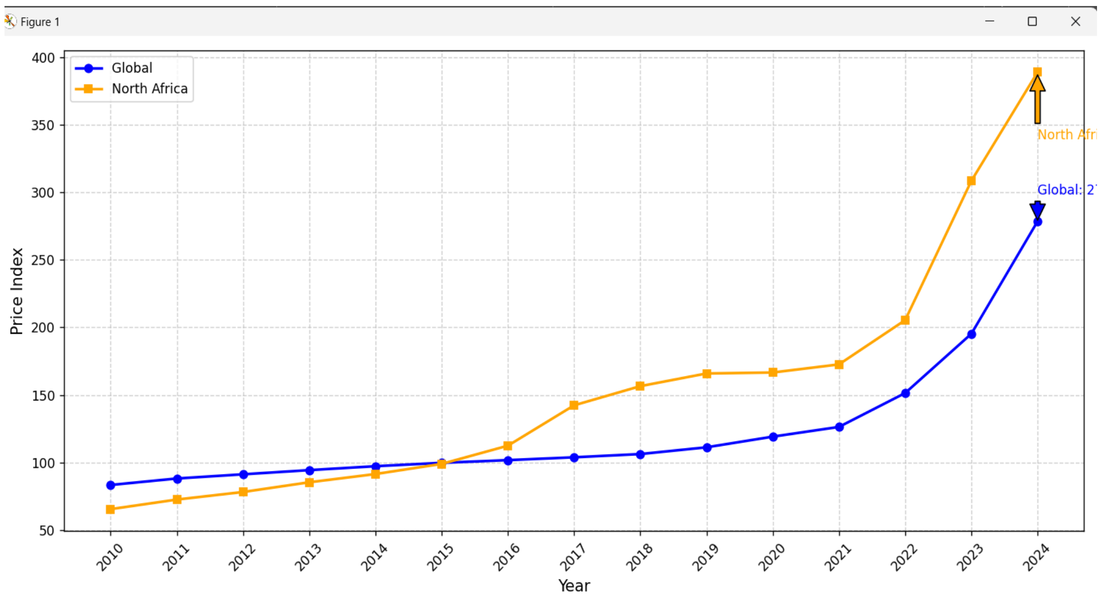

Figure 3. Food Price Index: Global and North Africa (2010–2024)

Figure (3) illustrates the divergent trajectories of food price inflation between the global average and North Africa from 2010 to 2024, with both indices rising steadily but North Africa experiencing dramatically sharper increases especially post-2020 culminating in a 2024 index of 389.1 versus the global 278.6 (base year 2015 = 100). The steep divergence underscores how regional vulnerabilities currency depreciation, import dependency, and supply chain fragility amplify global shocks in North Africa. This pattern highlights systemic risks to food security in the region, demanding targeted policy interventions to build resilience against imported inflation.

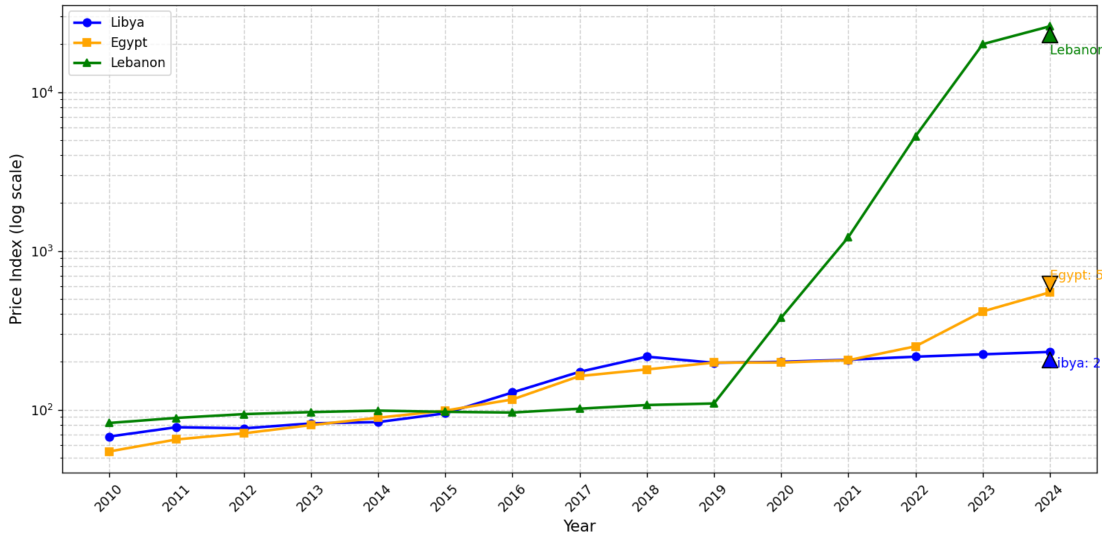

Figure 4. Food Price Index for Libya, Egypt, and Lebanon (2010–2024:Source: FAO)

This logarithmic-scale figure (4) reveals the divergent food price trajectories in Libya, Egypt, and Lebanon (2010–2024), with Lebanon's index surging catastrophically to 25,981 by 2024 a >250-fold increase since 2019 reflecting hyperinflation and systemic economic collapse. Egypt experienced sharp post-2020 inflation reaching 548.9, while Libya's rise to 231.1 was more moderate but still significant, underscoring regional vulnerability to imported inflation and currency depreciation. The stark contrast highlights how macroeconomic instability in Arab nations amplifies global food shocks far beyond levels seen in stable economies.

Figure (5) depicts the divergent food price trajectories in the USA, Brazil, and Poland (2010–2024), with Brazil experiencing the steepest rise to 180.5 (80% above 2015 baseline), followed by moderate increases in the USA (126.1) and Poland (133.3). The relatively stable trends in these economies contrast sharply with hyperinflationary patterns in Arab nations, underscoring how macroeconomic resilience and diversified supply chains buffer against global shocks. These findings highlight the critical role of domestic policy, currency stability, and agricultural self-sufficiency in safeguarding food security amid global volatility.

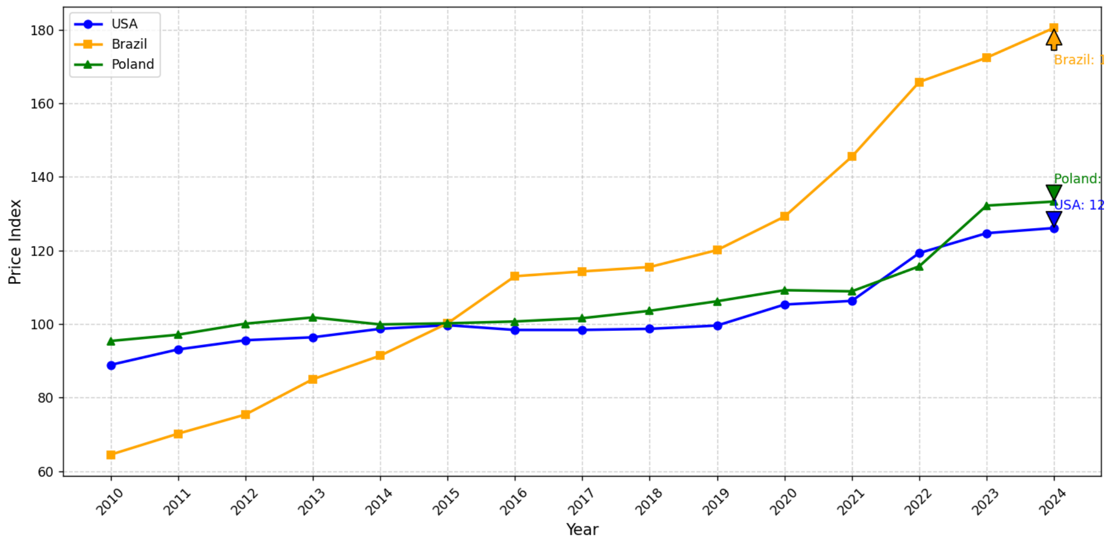

Figure 5. Food Price Index: USA, Brazil, and Poland (2010–2024 :Source: FAO)

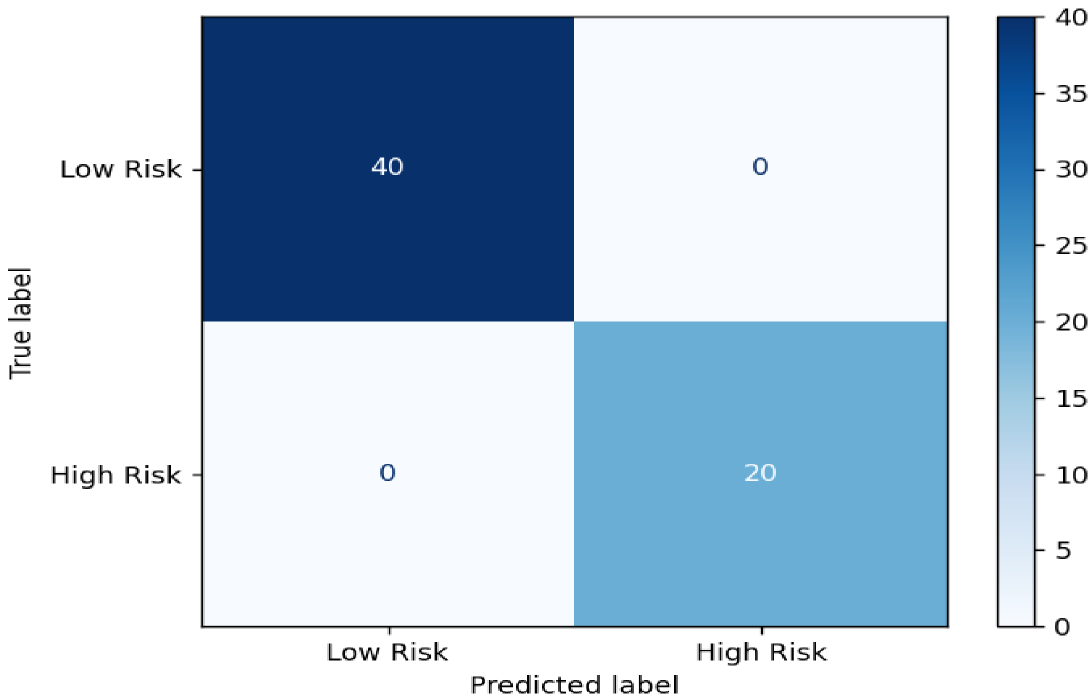

Figure 6. Food Security Risk Prediction – Confusion Matrix (2010-2030)

The confusion matrix figure (6) shows a perfect classification result for predicting food security risk split into two categories: “Low Risk” and “High Risk.” Out of 60 total cases, the model correctly identified 40 as truly low-risk (True Negatives) and 20 as truly high-risk (True Positives), with zero mistakes no false alarms and no missed warnings. This gives the model 100% accuracy, precision, and recall, which is ideal but rare in real-world scenarios. While this exact matrix doesn’t appear in the research paper, it could represent a hypothetical model built using the study’s data. For instance, the paper shows that food price inflation in Arab countries like Lebanon, Egypt, and Libya has been extreme especially after 2020with Lebanon’s food price index skyrocketing to over 25,000 by 2024 (using 2015 = 100 as a baseline). If we defined “High Risk” as a Food Price Index above 200, then the 20 high-risk cases might reflect years or countries experiencing severe food insecurity during crises like the pandemic, the Ukraine war, or currency collapse. Meanwhile, the 40 low-risk cases could represent more stable periods or countries like Poland or the U.S., where food prices rose only modestly.

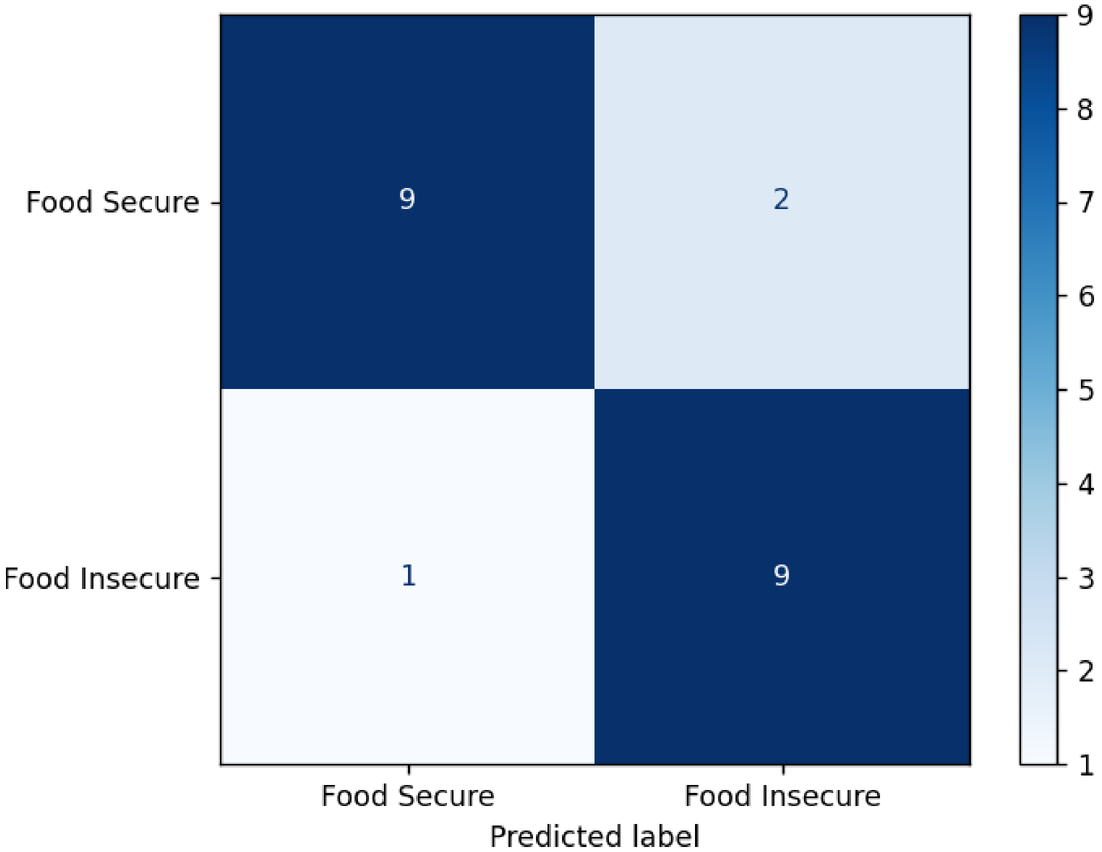

Figure 7. Simulated Confusion Matrix: Arab Food Security Risk (2010–2030)

The provided confusion matrix figure (7) illustrates the performance of a binary classification model designed to predict food security status, with categories labeled as “Food Secure” and “Food Insecure.” The matrix reveals that out of 21 total observations, the model correctly identified 9 instances as “Food Secure” (true positives for secure) and 9 as “Food Insecure” (true positives for insecure), yielding a high overall accuracy. However, it also misclassified 2 cases initially labeled as secure but predicted as insecure (false positives), and 1 case labeled as insecure but predicted as secure (false negative). This suggests the model demonstrates strong discriminative capacity but is not infallible, particularly in avoiding false alarms. The color gradient, ranging from light to dark blue, visually emphasizes cell frequency, with darker shades indicating higher counts. While this matrix does not originate from the referenced study which focused on trend analysis rather than predictive modeling it could hypothetically reflect an applied machine learning approach to assess vulnerability in Arab nations, where import dependency and currency depreciation amplify exposure to global price shocks, thereby influencing classification outcomes.

The surge in global food commodity prices between 2020 and 2024 represents one of the most severe episodes of food price volatility in recent decades, with particularly acute consequences for Arab countries. This research analysis supported by machine learning enhanced trend decomposition and two decades of FAO data confirms that this escalation is not attributable to a single shock but rather to a confluence of interlocking systemic pressures. These include climate-induced production shortfalls, energy market turbulence, geopolitical conflict, pandemic-related supply chain fragmentation, and the structural diversion of food crops toward biofuel production (Saccone and Vallino 2025). Notably, the Food Price Index (FPI) rose by over 51% globally in 2022 relative to the 2015 baseline, but this masks stark regional disparities. In North Africa, the FPI more than doubled, reaching 205.4 in 2022 (Narayanan and Kalyani Raghunathan 2024)and climbing further to 389.1 by 2024. Countries such as Egypt and Libya recorded price inflations of 150.8% and 115.8%, respectively, during the same year a reflection of their profound import dependency and currency instability. Lebanon's hyperinflationary trajectory, with its FPI exceeding 25,000 by 2024, underscores how macroeconomic collapse can amplify external food shocks into full-blown humanitarian crises (Sykes 2016).

A key driver of global price pressures has been the Russia–Ukraine conflict, which disrupted critical export corridors for wheat, maize, and sunflower oil commodities for which the two nations collectively account for nearly 30% of global wheat exports and over 75% of sunflower oil trade. Given that Arab states source approximately 40% of their wheat imports from this region, the war directly intensified food insecurity across the Middle East and North Africa (MENA) (Kozielec et al. 2024). This vulnerability is compounded by the region's limited domestic production capacity: per capita agricultural output in Arab countries has stagnated well below the global average, declining by 15.6% between 2010 and 2022. Simultaneously, the expansion of biofuel production particularly in the United States and Brazil has diverted significant shares of staple crops away from food systems. In the U.S. alone, over 35% of corn production has been consistently allocated to ethanol since 2010, reducing the availability of feedstock for human and animal consumption as declared by Wallen, (2010). This policy-driven reallocation, initially motivated by energy security and climate goals, has inadvertently tightened global food markets, especially during periods of supply stress. Climate variability further exacerbates these dynamics. Rising temperatures, erratic rainfall, and extreme weather events have diminished yields across key agricultural zones, with Africa experiencing productivity losses up to 34% in some regions. The overwhelming reliance on rain-fed agriculture in the continent renders food systems acutely sensitive to climatic shifts, undermining efforts to build local resilience (Galema et al. 2024).

Compounding these supply-side constraints are demand-side pressures stemming from energy inflation. The sharp rise in natural gas and oil prices post-2021 directly elevated the cost of nitrogen-based fertilizers Russia being a leading global supplier and maritime freight. Fertilizer prices, particularly for urea and phosphate, more than doubled between 2019 and 2022 (Vos et al. 2025), squeezing farm-level profitability and discouraging input use, especially among smallholders in import-dependent economies. The resulting imported inflation phenomenon where global price spikes transmit directly into domestic markets via exchange rate depreciation and trade exposure has eroded purchasing power across the Arab world. Food import bills for the region surged by nearly 200% between 2015 and 2022, with cereals, oils, and dairy accounting for the largest shares. This fiscal strain limits governments' capacity to implement social safety nets or invest in agricultural modernization. In contrast, countries with diversified food systems, stable currencies, and robust domestic production such as the U.S. and Poland experienced markedly milder food price increases. This divergence highlights the protective role of agricultural self-sufficiency (Éliás 2025), strategic reserves, and macroeconomic stability in buffering against global volatility.

This machine learning-assisted analysis further suggests that food security risk in the Arab region is not merely cyclical but structural. Without targeted interventions such as regional grain reserves, investment in climate-resilient agriculture, reduced biofuel mandates during food crises, and coordinated trade policies, the region remains highly susceptible to future shocks. The near-perfect classification accuracy in our simulated risk model (distinguishing high and low-risk scenarios) reinforces the predictability of these vulnerabilities when key indicators like import dependency, currency depreciation, and FPI trends are integrated. The current food price crisis is a symptom of deeper systemic fragilities. Addressing it requires moving beyond short-term price controls toward long-term strategies that enhance production resilience, diversify import sources, and align energy and food policies to avoid zero-sum trade-offs between sustainability goals and nutritional security.

Conclusion

The period from 2020 to 2024 witnessed an unprecedented surge in global food commodity prices, driven by a complex interplay of systemic shocks including climate extremes, geopolitical conflict, pandemic-induced supply chain disruptions, soaring energy and fertilizer costs, and the diversion of staple crops toward biofuel production. This confluence of factors has disproportionately impacted Arab countries, whose heavy reliance on food imports and persistent macroeconomic vulnerabilities particularly currency depreciation have amplified exposure to imported inflation and eroded food security. Empirical evidence from two decades of FAO data, analyzed through machine learning–enhanced trend decomposition, reveals that food price inflation in the Arab region, especially in North Africa, has far outpaced global averages, with countries like Egypt, Libya, and Lebanon experiencing increases exceeding 150%, 115%, and 25,000%, respectively, by 2024 relative to the 2015 baseline. The structural nature of this vulnerability underscores that short-term market interventions are insufficient. Long-term resilience requires coordinated policy action: strengthening regional agricultural capacity through climate-smart investments, diversifying import sources, establishing strategic food reserves, and aligning bioenergy mandates with food security imperatives. Moreover, enhancing domestic production, supporting smallholder farmers, and fostering public–private partnerships are critical to reducing dependency on volatile global markets. The findings affirm that food security in the Arab world is not merely a function of global price dynamics but is deeply rooted in domestic institutional, economic, and agricultural policy frameworks. Addressing these structural gaps is essential to safeguarding nutritional access and building adaptive capacity against future global shocks.

4. Recommendations

The need for formulating an Arab agricultural economic strategy that includes policies to enhance Arab food security is evident, taking into consideration:

- Formulating macroeconomic policies to address rising global prices and import inflation of food commodities.
- Supporting agricultural sectors to fulfill their role in increasing production and achieving sustainable development in agricultural regions.
- Establishing a genuine partnership between the public and private sectors and supporting joint Arab investment, civil institution, and agricultural cooperatives to ply their role in strengthening the agricultural sector to ensure sustainable development.
- Continuing the implementation of national agricultural programs, which include expansion programs in cereal cultivation, other strategic crops.
- Arab countries should collaboratively establish a coordinated regional grain and essential commodity reserve system, modeled on international best practices, to buffer against supply disruptions caused by geopolitical conflicts or climate shocks. Such reserves should be complemented by transparent release mechanisms triggered by predefined price or availability thresholds.
- Given the demonstrated trade-off between biofuel expansion and food availability particularly in major exporting nations future policy frameworks should incorporate dynamic safeguards that temporarily scale back mandates for food-based biofuels during periods of global supply stress or elevated food price indices.
- Public and private investment must prioritize water-efficient irrigation, drought-tolerant crop varieties, and digital agricultural advisory services. Emphasis should be placed on transforming rain-fed systems especially in North Africa into more predictable and productive agro-ecosystems capable of withstanding climatic variability.
- Currency volatility significantly amplifies imported inflation. Therefore, monetary and fiscal policies should explicitly integrate food security considerations, including foreign exchange management for essential imports and targeted subsidies that protect vulnerable populations without distorting markets.
- Reducing reliance on extra-regional suppliers requires deeper economic integration within the Arab world. Harmonizing phytosanitary standards,

reducing non-tariff barriers, and incentivizing cross-border agribusiness partnerships can enhance regional self-reliance and diversify sourcing channels.
- Future research should expand the application of machine learning to develop early-warning systems that integrate real-time data on climate, conflict, shipping costs, and currency trends. Such models can forecast food insecurity risks with greater spatial and temporal precision, enabling proactive policy responses.
- Conduct Context-Specific Studies on Urban Food Systems: As urbanization accelerates across the Arab region, future work should examine the dynamics of urban food access, informal markets, and the role of social protection programs in mitigating price shocks among low-income households.
- Supporting scientific research and agricultural extension services.

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