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The impact of the Russian-Ukrainian War on the food security of the Kingdom of Saudi Arabia

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Food security

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ABSTRACT

The economic and social impact of the Russian-Ukrainian war was the focus of this study, which aimed to assess its effect on the food security of the Kingdom of Saudi Arabia. To achieve its objectives, the study utilized published data, food security index measures, and standard economic analysis. The findings revealed that the Kingdom's food security environment index increased from 58.1% in 2012 to 69.9% in 2022, indicating moderate food security throughout this period. The index was lower than the estimated counterpart for the rest of the Gulf Cooperation Council countries but exceeded the global average (113 countries) by 12.38% in 2022. Furthermore, the study demonstrated that a 10% increase in the estimated food production index and real per capita income led to a 2.72% and 6.55% increase in the food security index, respectively. Conversely, a 10% rise in the estimated consumer price index for foodstuffs resulted in a 1.74% decrease in the food security index. Despite the challenges posed by the Russian-Ukrainian war, the food security index is projected to improve for the Kingdom of Saudi Arabia, expected to increase from 72.4% in 2024 to 75.6% in 2030, attributed to the country's policy of investing in agriculture abroad and focusing on local agricultural investments such as vertical expansion, protected agriculture, and agricultural practices. This strategic approach ensures high-quality produce and facilitates significant financial surpluses, enhancing the country's capacity to import goods from overseas.

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1 Introduction

Due to the outbreak of the Russian-Ukrainian war on February 24, 2022, there have been significant impacts on growth rates, economic development, and the prices of goods and services. Inflationary pressures have intensified in the Middle East and North Africa region, mainly due to the impact of the war on the quantity and value of food imports, leading to higher prices in international markets. In 2021, the inflation rate in the Middle East and North Africa reached 14.8%. Countries such as Iran, Lebanon, and Yemen are experiencing concerning inflation levels, with rates reaching 43%, 154%, and 30%, respectively (Acevedo et al. 2022). According to a study by the Ministry of Planning and International Cooperation, Republic of Yemen (2022), the Russian-Ukrainian war increased the inflation rate to 45% in 2022, possibly driven by the rise in oil and food prices. The high food prices and the risk of food insecurity are particularly harmful to low-income families, as they spend a significant portion of their income on food and energy, unlike wealthier families. The FAO Food Price Index for cereals, vegetable oils, sugar, meat, and dairy products has significantly increased. Specifically, the FAO Food Price Index rose from 135.8 in January 2022 to 160.3 in March 2022, then declined to 117.3 in February 2024 (Figure 1).

The data in Figure 1 shows that the Russian-Ukrainian war has significantly impacted foreign trade and supply chains for food commodities. This is a major concern for global food security because Russia is the world's largest wheat exporter. Russia and Ukraine account for over a third of global grain exports (FAO 2024). More than 50 countries, including Saudi Arabia, Libya, Djibouti, Yemen, Lebanon, and Tunisia, rely on Russia and Ukraine for at least 30% of their wheat imports. As a result of the war, food prices have risen by 40 to 60 percent. Global supplies of food products such as wheat, barley, corn, and sunflower oil are anticipated to decrease by 10-50% (Abdel Shafi 2022). The war has also led to a decline in foreign trade for Central Asian countries with Russia and Ukraine, exacerbating the deficit in their trade balance. Additionally, the war has posed challenges for these countries regarding benefiting from their natural and petroleum resources (Abdel Nabi 2022).

Some economic studies have focused on the impact of the Russian-Ukrainian war on the Kingdom of Saudi Arabia. For instance, a study by Ghanem et al. (2023a) measured the impact of the war on consumer prices for food products. This study showed an increase in the world food price index and total population of Saudi Arabia by 10%, leading to a 1.22% and 4.95% increase in the consumer price index for food products, respectively. The consumer price index for food products is expected to continue to increase, reaching 137.7 in 2022, which is 12.2% higher than the 122.78 index in 2021.

In a study by Ghanem et al. (2023b), the impact of the Russian-Ukrainian war on the value of imports and the food trade balance of the Kingdom of Saudi Arabia was examined. The study found that a 10% increase in the world food price index leads to a 6.98%

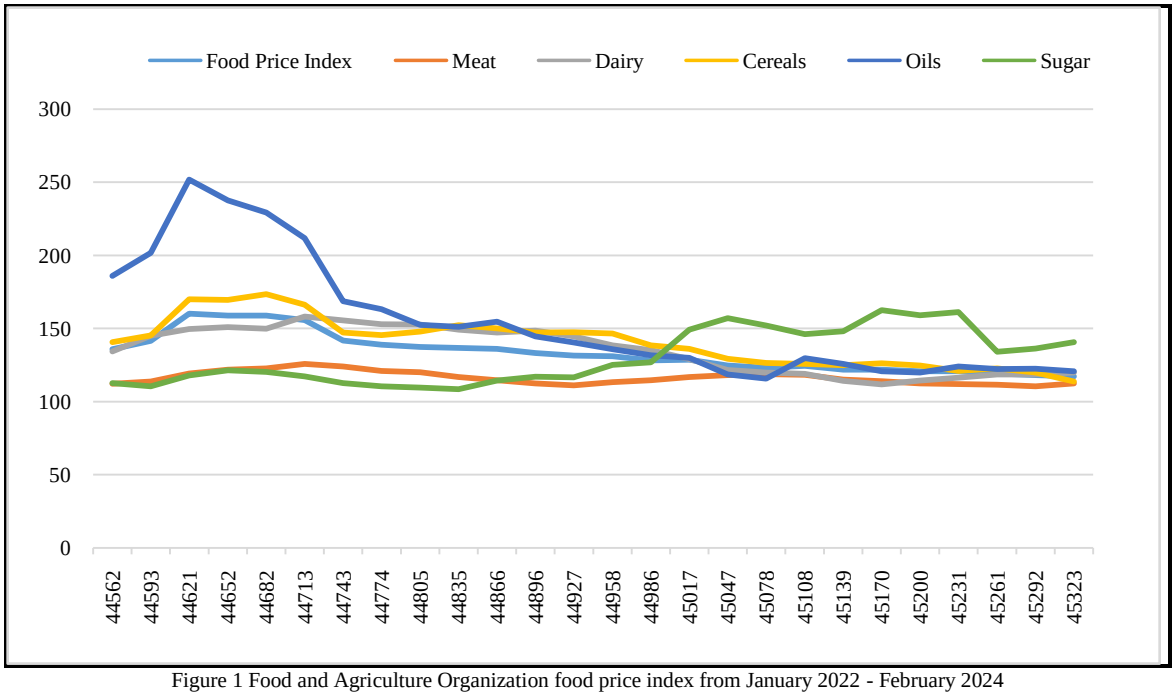

Figure 1 Food and Agriculture Organization food price index from January 2022 - February 2024

(Source: Food and Agriculture Organization (FAO), March 8, 2024).

rise in the value of food imports and a 7.87% increase in the food trade deficit. Additionally, a 10% increase in the food production index results in a 1.88% decrease in the value of food imports. Furthermore, increasing the value of food exports by 10% reduces the food trade deficit by 5.24%. With the food price index reaching 145.8, the value of food imports and the food trade deficit have increased by 37.1% and 44.5%, respectively, compared to the current situation in 2021. Al-Bashabsheh (2023) also highlighted that the COVID-19 pandemic and the conflict in Ukraine have reduced global food supply and increased food prices. The conflict in Ukraine has particularly impacted European countries that rely on Russian gas passing through Ukraine. Furthermore, in a study by Meligi and Salem (2023), it was revealed that the Russian-Ukrainian war has had negative repercussions on the Arab Republic of Egypt, and it is expected that the value of the food security index will decline by about 24% between 2022 and 2027.

Despite the positive outlook for producing basic food commodities, climate change, increasing geopolitical tensions, and sudden policy changes pose risks to global food production systems. These risks could upset the balance of supply and demand and weaken the expected performance of foreign trade and food security. The foreign trade volume in coarse grains, rice, vegetable oils, fats, sugar, milk products, meat, and fish is expected to decrease between 2023 and 2024. Additionally, the value of global food imports is expected to increase to $2 trillion in 2023, which is a $35.3 billion, or 1.8%, increase over its 2022 level (FAO, 2023). The continuation of the Russian-Ukrainian war has impacted the supply of food commodities, leading to increased costs of obtaining them. As a result, the periods of production adequacy and import coverage for domestic consumption decrease, reducing the surplus directed to developing strategic stocks and food security factors. Maintaining a safe strategic stock that allows the continued flow of food commodities to local markets can help the state control inflation and rising prices for food commodities. This study uses an econometric methodology to estimate the impact of the Russian-Ukrainian war on the future of food security for the Kingdom of Saudi Arabia. The research also includes a comparative economic analysis of the food security index between the Kingdom of Saudi Arabia and the rest of the Gulf Cooperation Council countries and the global average. Furthermore, the study estimates the proposed model to assess the impact of the Russian-Ukrainian war on the level of food security in the Kingdom of Saudi Arabia from 2000-2022 and predicts the future of food security for the Kingdom of Saudi Arabia until 2030.

2 Materials and Methods

To achieve the objectives of this study, we relied on published data from the Food and Agriculture Organization (FAO) and the General Authority for Statistics in Saudi Arabia. We also used data from the Global Food Security Environment Index (GFSI) issued by the Economist Impact Foundation in England. This index depends on several metrics, including:

Table 1 The relative weight of the criteria for measuring the food security environment index.

Measure	Relative weight%	Measure	Relative weight%
Affordability**:**	30.00	Food security and access obligations	12.61
Change in average food cost	23.85	Quality and safety**:**	22.5
Percentage of population below the global poverty line	19.23	Dietary diversity	19.50
Inequality-adjusted income index	16.92	Nutritional standards	20.33
Agricultural trade	19.23	Availability of micronutrients	19.51
Food safety net program	20.77	Protein Quality	20.33
Availability**:**	25.0	Food Safety	20.33
Access to agricultural inputs	11.71	Sustainability and resilience**:**	22.5
Agricultural research and development	11.71	Exposure to risks	17.00
Farm infrastructure	9.01	water	16.50
Agricultural production fluctuation	11.26	land	16.50
Food loss	11.26	Oceans, rivers and lakes	15.50
Supply chain infrastructure	9.91	Political commitment to resilience	19.00
Adequacy of supply	11.71	Disaster risk management	15.50
Political and social barriers to access	10.81		

Source: Economist Impact (2023), Global Food Security Index (2023), and the GFSI website navigation guide

Table 2 The range used to describe the food security situation.

Range	Describe the food security situation
80- 100	Very Good
70- 79.9	Good
55- 69.9	Moderate
40- 54.9	Weak
0- 39.9	Very Weak

Source: Economist Impact (2023), Global Food Security Index (2023), the GFSI website navigation guide

1. Affordability: Measures the ability of consumers to purchase food, exposure to rising prices, and the availability of programs and public policies to control prices.
2. Availability: Measures the adequacy of national food supplies, the risk of supply disruption, and the country's ability to provide food and support scientific research efforts to expand production.
3. Quality and Safety: Measures the variety and quality of diets and food safety.
4. Natural Resource Sustainability and Resilience: Measures the country's exposure to the impact of climate change and natural resource risks and its ability to adapt to them.

The Food Security Environment Index is calculated based on the relative weight of the metrics mentioned above, as represented in Table 1. The food security situation is described in Table 2.

This study also relied on the proposed model consisting of three behavioural equations, which can be expressed as follows:

$$Y_1 = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + e_1 \ldots\ldots\ldots\ldots\ldots (1)$$

$$Y_2 = b_0 + b_1\hat{Y}_1 + b_2X_5 + b_3X_6 + e_2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$Y_3 = c_0 + c_1\hat{Y}_1 + c_2\hat{Y}_2 + c_3X_7 + e_3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The model we're proposing includes the following variables:

I. Endogenous Variables: These depend on three variables indicating the country's ability to produce food. They are expressed by the food production index (Y1), the consumer price index for food commodities (Y2), and the global food security index for the Kingdom of Saudi Arabia (Y3).
II. Exogenous Variables: There are seven of these: cropped area in thousand hectares (X1), agricultural labour in thousand workers (X2), amount of water used for agricultural purposes in billion m3 (X3), value of agricultural investments in million riyals (X4), World Food Price Index (X5), total population in million people (X6), and real per capita income in thousand riyals (X7).

The proposed model was estimated using the ordinary least squares method. This was chosen because the matrix of internal variables has a diameter of one, and all numbers above this diagonal take the number zero as shown in below table (Gujarati, translated and reviewed by Odeh 2015).

Since the model used is based on time series data, the problem of autocorrelation of the residuals may arise. It is detected using several tests, and the most important of which are: (i) the Durbin-Watson test, whose value ranges between zero and four ($0 \leq DW \leq 4$), (ii) the Breusch- Godfrey Serial Correlation LM test, if the probability value (P-value) is greater than the level of significance (α), this indicates that there is no autocorrelation between the random errors, but if the probability value is less than the level of significance, this indicates the presence of autocorrelation between the random errors.

3 Results and Discussion

3.1 The disparity in the level of food security between the KSA and the rest of the Gulf Cooperation Council countries and the global average

The Global Food Security Index (GFSI) has been published by Economist Impact for 113 countries worldwide since 2012. The index considers factors such as food costs, availability, quality, and safety, natural resources, and resilience. Analyzing the food security level in the Kingdom of Saudi Arabia from 2012 to 2022,

External variables							Internal variables		
X_7	X_6	X_5	X_4	X_3	X_2	X_1	Y_3	Y_2	Y_1
0	0	0	$-a_4$	$-a_3$	$-a_2$	$-a_1$	0	0	1
0	$-b_3$	$-b_2$	0	0	0	0	0	1	$-b_1$
$-c_3$	0	0	0	0	0	0	1	$-c_2$	$-c_1$

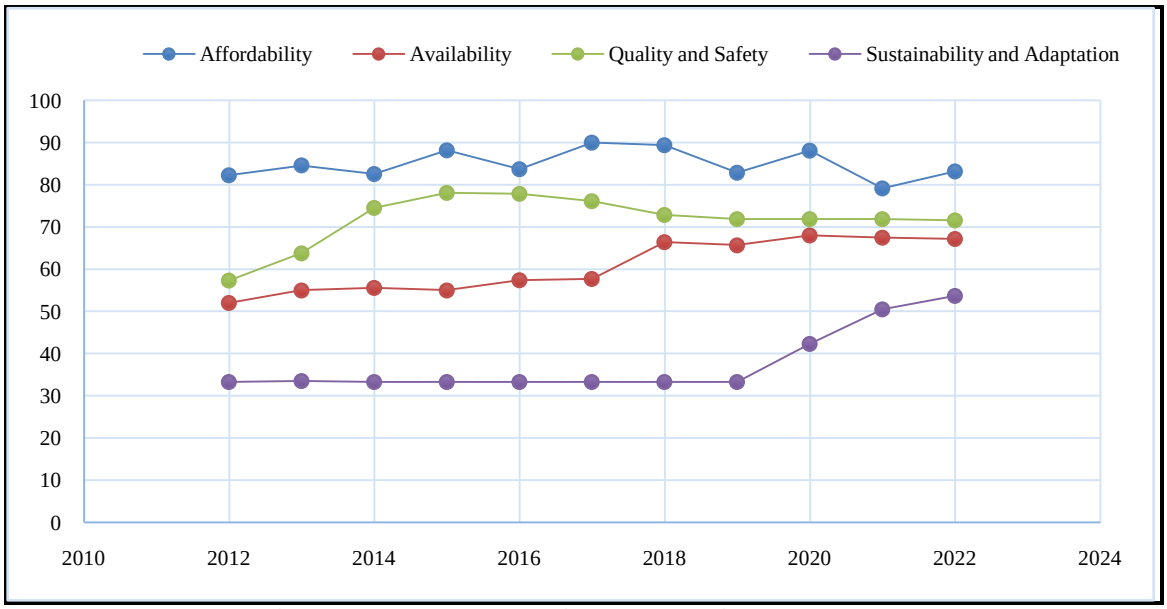

Figure 2 Components of the Global Food Security Index for the Kingdom of Saudi Arabia during the period 2012-2022 (Source: Economist Impact, Global Food Security Index: Country Ranking 2021, Retrieved on June 3, 2022, from https:// impacteconomist.com/sustainability/project/food-security-index/Index)

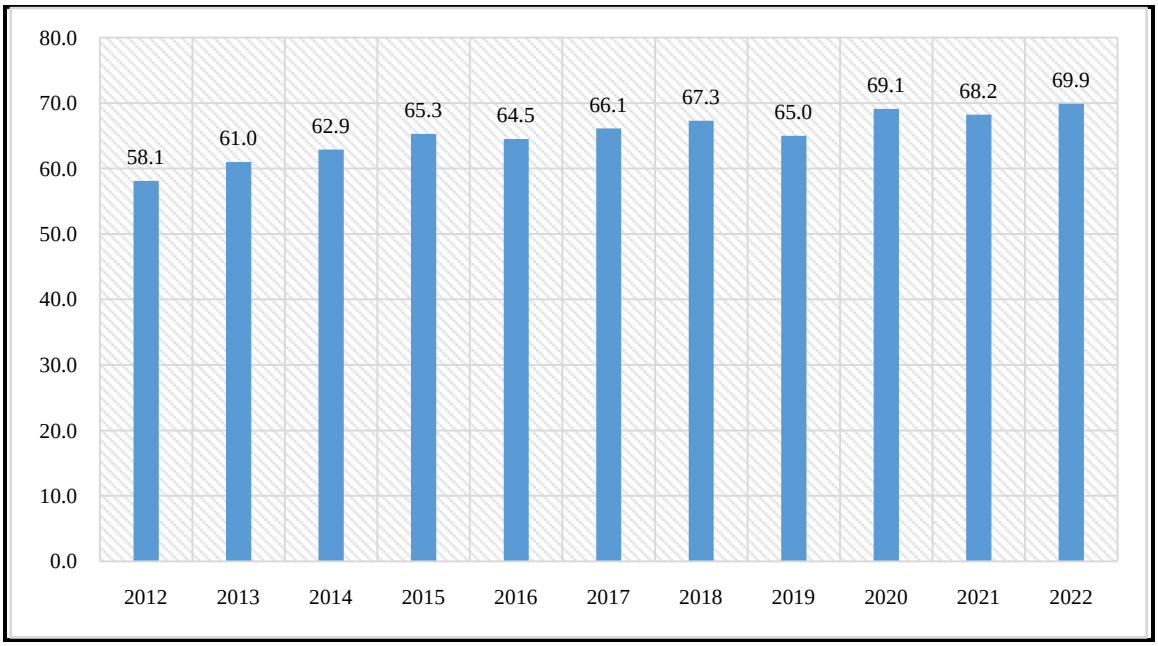

Figure 3 Global food security index for the Kingdom of Saudi Arabia during the period 2012- 2022 (Source: Data contained in Figure 2).

we can see that the ability to afford food ranged from a low of 79.2% in 2021 to a high of 90.0% in 2017, averaging 84.9%. Food availability ranged from a low of 52.0% in 2012 to a high of 68.0% in 2020, averaging at 60.7% annually. The measure of food quality and safety ranged from a low of 57.3% in 2022 to a high of 78.1% in 2015, with an average of 71.6% annually. The measure of natural resources sustainability and resilience ranged from 33.3% between 2012 and 2019 to a high of 53.7% in 2022, averaging 37.6% annually. Overall, the food security environment index for the Kingdom of Saudi Arabia ranged from a low of 58.1% in 2012 to a high of 69.9% in 2022, with an average of 65.2% from 2012 to 2022. This data reveals disparities in food security levels between Saudi Arabia and other Gulf Cooperation Council countries and the global average.

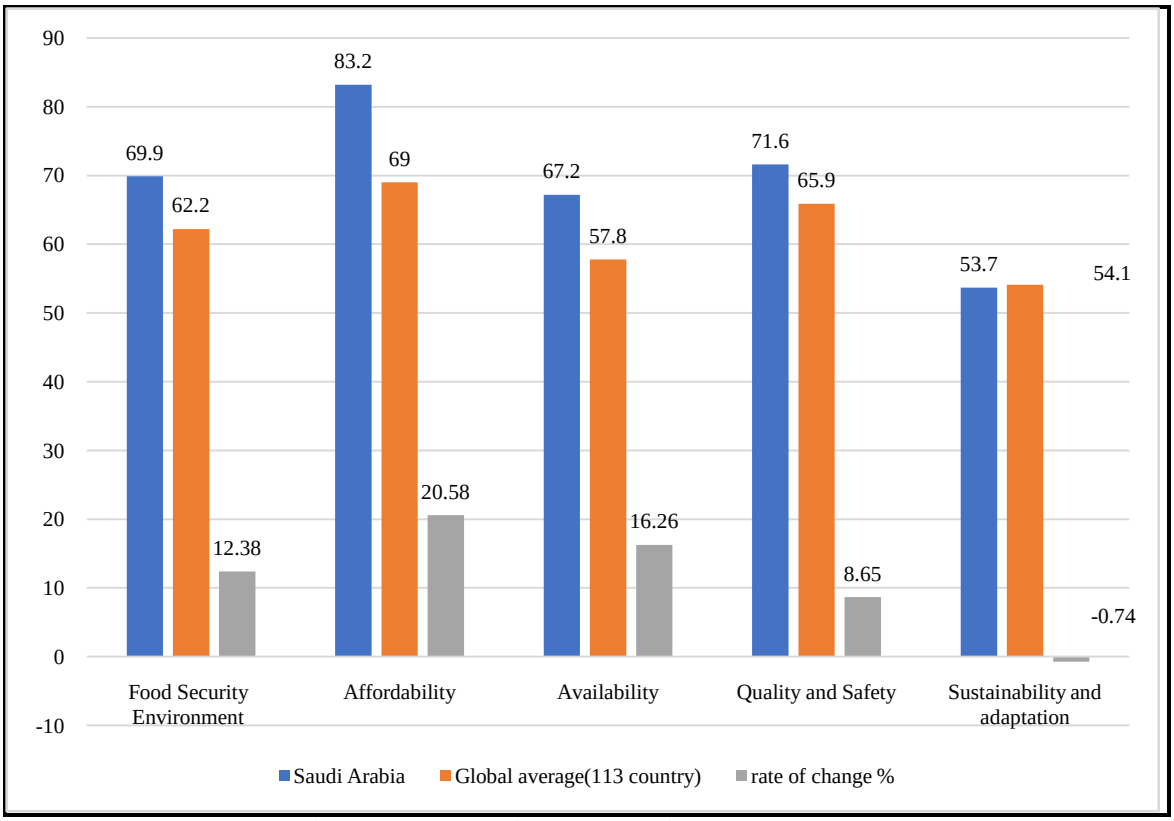

Figure 4 Comparison between global food security indicators for the Kingdom of Saudi Arabia and the global average (113 countries) in 2022 (Source: Economist Impact, Global Food Security Index: Country Ranking 2021, Retrieved on June 3, 2022, from https:// impacteconomist.com/ sustainability/project/food-security-index/ Index)

By comparing the measures of the Food Security Environment index for the Kingdom of Saudi Arabia with the global average (113 countries) in 2022, it is clear from the data presented in Figure 4 that the measure of food affordability, food availability, quality and food safety for the Kingdom of Saudi Arabia exceeds the global average (113 countries), at rates of 20.58%, 16.26%, and 8.65% for each of them, respectively, in 2022. The measure of natural resource sustainability and resilience for the Kingdom of Saudi Arabia falls short of the global average by a small rate of 0.74% in 2022. Finally, the Global Food Security Environment index for the Kingdom of Saudi Arabia exceeds the global average (113 countries), with a rate of 12.38% in 2022.

An economic analysis of the global food security environment index was conducted for the Gulf Cooperation Council (GCC) countries. The data in Table 3 shows that the United Arab Emirates had a moderate level of food security from 2012 to 2017, which improved to a good level by 2022. Qatar's food security situation was moderate in 2012 and became good from 2013 to 2022. The Sultanate of Oman had moderate food security from 2012 to 2015, which improved to a good level from 2016 onwards. Bahrain, Saudi Arabia, and Kuwait had moderate food security from 2012 to 2022, except for Bahrain, which had a neutral food security situation in 2022.

On average, the Global Food Security Environment Index ranked Qatar first among the GCC countries, followed by Oman, the UAE, Bahrain, Kuwait, and Saudi Arabia. In 2022, the United Arab Emirates ranked 23rd, Qatar 30th, Oman 35th, and Bahrain 38th globally, according to the Global Food Security Index. Saudi Arabia ranked 41st, and Kuwait ranked 50th. The food security situation in the GCC was relatively stable, with low variation in the Food Security Environment Index scores during the study period. The coefficient of variation ranged from 2.8% for Kuwait to 9.0% for the United Arab Emirates.

The data in Table 4 shows that the Global Food Security Index scores for the Gulf Cooperation Council countries in 2022 compared to 2012-2021 have changed. The scores remained positive for the United Arab Emirates, Kingdom of Saudi Arabia, and Bahrain, indicating an improvement in global food security for these countries in 2022. However, the score for the State of Qatar decreased to 72.4 in 2022 from its previous score between 2014 and 2017-2021. Similarly, the global food security index for the Sultanate of Oman decreased to 71.2 in 2022 from its score between 2017-2021. Kuwait's global food security index declined to 65.2 in 2022 from its score between 2012-2014 and 2018-2021.

Table 3 Global food security environment index of the Gulf Cooperation Council during the period 2012-2022

Year	United Arab Emirates	Qatar	Oman	Bahrain	Saudi Arabia	Kuwait
2012	63.2	69.9	57.4	64.7	58.1	65.7
2013	61.4	70.1	59.4	64.5	61.0	66.7
2014	62.1	72.8	64.6	65.9	62.9	67.2
2015	61.5	72.0	64.4	65.2	65.3	64.5
2016	60.3	72.0	70.1	65.5	64.5	63.1
2017	63.9	73.0	71.3	66.1	66.1	64.7
2018	71.6	73.0	73.3	69.5	67.3	68.0
2019	72.9	73.8	72.2	69.4	65.0	68.7
2020	73.7	74.0	72.0	68.6	69.1	68.4
2021	73.6	74.6	72.3	69.3	68.2	68.0
2022	75.2	72.4	71.2	70.3	69.9	65.2
average	67.22	72.51	68.02	67.18	65.22	66.38
Standard deviation	6.05	1.48	5.63	2.22	3.54	1.86
Coefficient of variation(%)	9.00	2.04	8.27	3.31	5.43	2.80
Rank among 113 countries in 2022	23	30	35	38	41	50

Source: Economist Impact, Global Food Security Index: Country Ranking 2021, Retrieved on June 3, 2022, from https://impact economist.com/sustainability/project/food-security-index/index.

Table 4 The food security index score change for the Gulf Cooperation Council countries in 2022 compared to 2012-2021.

.Year	United Arab Emirates	Qatar	Oman	Bahrain	Saudi Arabia	Kuwait
2012	12.0	2.5	13.8	5.6	11.8	-0.5
2013	13.8	2.3	11.8	5.8	8.9	-1.5
2014	13.1	-0.4	6.6	4.4	7.0	-2.0
2015	13.7	0.4	6.8	5.1	4.6	0.7
2016	14.9	0.4	1.1	4.8	5.4	2.1
2017	11.3	-0.6	-0.1	4.2	3.8	0.5
2018	3.6	-0.6	-2.1	0.8	2.6	-2.8
2019	2.3	-1.4	-1.0	0.9	4.9	-3.5
2020	1.5	-1.6	-0.8	1.7	0.8	-3.2
2021	1.6	-2.2	-1.1	1.0	1.7	-2.8

Source: Data in Table 3

3.2 Estimating the proposed model to measure the impact of the Russian-Ukrainian War on food security

The proposed model aims to analyze the impact of the Russian-Ukrainian war on food security in the Kingdom of Saudi Arabia from 2000 to 2022. The study used stepwise multiple regression analysis in both linear and double logarithmic forms, and the results indicated the superiority of the logarithmic equations presented in Table 5 (Gujarati, translated and reviewed by Odeh 2015).

It is evident from the estimated behavioural equations of the proposed model that:

1. A 10% change in each of the following factors: cropped area (X1), agricultural labour (X2), agricultural loans (X3), and the amount of water used for agricultural purposes (X4) results in a corresponding change in the Kingdom of Saudi Arabia's ability to produce food (food production index) by 1.95%, 3.41%, 1.24%, and 2.04% respectively.

Table 5 Estimated behavioural equations for the proposed model during the period 2000-2022

$\text{Ln}\hat{Y}_1 = 0.595 + 0.195\text{Ln}X_1 + 0.341\text{Ln}X_2 + 0.124\ \text{Ln}\ X_3 + 0.204\ \text{Ln}\ X_4\ (2.45)^{*}(3.82)^{**}(3.59)^{**}(2.43)^{*}(4.85)^{*}$ $R^2 = 0.95, F = 85.50, D.W = 1.46, \text{Arch test} = 0.01$
$\text{Ln}\ \hat{Y}_2 = 1.853 - 0.294\ \text{Ln}\hat{Y}_1 + 0.265\ \text{Ln}\ X_5 + 0.915\text{Ln}\ X_6 + 0.559\text{AR}(1)(6.20)^{**}(-2.47)^{*}(2.85)^{*}(5.75)^{**}(3.89)^{**}$ $R^2 = 0.91, F = 64.04\ \ D.W = 1.63, \text{Arch test} = 0.16$
$\text{Ln}\ \hat{Y}_3 = 0.703 + 0.272\text{Ln}\hat{Y}_1 - 0.174\ \text{Ln}\ \hat{Y}_2 + 0.655\text{Ln}\ X_7 + 0.432\text{AR}(1)\ (2.45)^{*}(2.38)^{*}(-4.16)^{**}(3.49)^{**}(2.21)^{**}$

Source: Statistical analysis of the data used in this study.

Table 6 Indicators measuring the efficiency of the estimated equations of the proposed model during the period 2000-2022.

Indicator	First	Second	Third
Root Mean Squared Error	0.081	0.131	0.043
Mean Absolute Error	0.052	0.108	0.032
Mean Abs. Percent Error	0.562	2.930	0.762
Theil Inequality Coef.	0.009	0.051	0.008

Source: Equations of the model estimated in this study.

2. Increasing the estimated food production index (Ŷ1) by 10% leads to a 2.94% decrease in the consumer price index for food in the Kingdom of Saudi Arabia. Additionally, a 10% change in the world food price index (X5) and the total population of the Kingdom of Saudi Arabia (X6) results in a corresponding change in the consumer price index for food by 2.65% and 9.15%, respectively.
3. A 10% change in the country's food production capacity (the estimated food production index) and the real per capita income (X7) leads to a corresponding change in the food security index by 2.72% and 6.55%, respectively. An increase in the estimated food consumer price index (Ŷ2) by 10% leads to a 1.74% decrease in the food security index.

According to the D.W test, the behavioural equations of the proposed model are free from the problem of autocorrelation of the residuals. Furthermore, according to the Arch Test, there is no autocorrelation in the series variance. The estimated model is also characterized by efficiency in representing the data used in the estimation, based on indicators measuring the efficiency of the models, including the U-Theil inequality coefficient, whose value is close to zero (Table 6).

3.3 Predicting the future of food security in the Kingdom of Saudi Arabia until 2030

The future of food security for the Kingdom of Saudi Arabia until 2030 was forecasted by analyzing internal and external variables in a proposed model to measure the impact of the Russian-Ukrainian war on food security. General trend equations were utilized to predict the external variables in Table 7, and their predictive ability was evaluated using the indicators listed in Table 8. It's important to note that the Ministry of Environment, Water and Agriculture has restructured the crop composition, excluding water-depleting

Table 7 Estimated general trend equations for the explanatory variables included in the proposed model from 2000-2022.

variable	F	R^2	equation
Cropped area	27.29	0.57	$\text{Ln}\hat{X}_1 = 7.121 - 0.024T$ $(112.85)^{**}(-5.22)^{**}$
Agriculture labor	24.52	0.71	$\hat{X}_2 = 364.94 + 51.77T - 2.22T^2$ $(8.81)^{**}(6.51)^{**}(-6.94)^{**}$
Agriculture loans	10.27	0.51	$\hat{X}_3 = 1959.25 - 277.84T + 14.04T^2$ $(4.00)^{**}(-2.95)^{**}(3.69)^{**}$
Water quantity used for irrigation	9.53	0.31	$\text{Ln}\hat{X}_4 = 3.038 - 0.023T$ $(29.36)^{**}(-3.04)^{**}$
World food price index	31.29	0.60	$\text{Ln}\hat{X}_5 = 4.083 + 0.035T$ $(47.61)^{**}(5.59)^{**}$
Total population	349.36	0.94	$\text{Ln}\hat{X}_6 = 3.028 + 0.021T$ $(201.32)^{**}(18.69)^{**}$
Real per capita income	84.59	0.80	$\text{Ln}\hat{X}_7 = 4.186 + 0.015T$ $(180.63)^{**}(9.20)^{**}$

**Significant at the 1% probability level (Source: Data contained in this study)

Table 8 Indicators for measuring the efficiency of the general trend equations estimated for the explanatory variables included in the proposed model.

variable	Root Mean Squared Error	Mean Absolute Error	Mean Abs. Percent Error	Theil Inequality Coef.
Cropped area	0.139	0.115	1.72	0.010
Agriculture labor	56.48	43.73	7.79	0.049
Agriculture loans	66.77	46.51	4.61	0.022
Water quantity used for irrigation	0.229	0.185	7.05	0.041
World food price index	0.190	0.168	3.71	0.021
Total population	0.033	0.028	0.863	0.005
Real per capita income	0.051	0.041	0.935	0.006

Source: equations listed in table 7

Table 9 Predictive values of the internal and external variables of the proposed model until 2030

Variable	2024	2025	2026	2027	2028	2029	2030
Cropped area in thousand hectares	534.5	534.5	534.5	534.5	534.5	534.5	534.5
Agriculture labour in thousand	400.0	400.0	400.0	400.0	400.0	400.0	400.0
Agriculture loans in a million riyals	3788.3	4226.4	4692.7	5187.1	5709.5	6260.1	6838.7
The amount of water used in irrigation in billion m3	7.24	7.06	6.89	6.72	6.55	6.37	6.20
World food price index	142.3	147.4	152.6	158.1	163.7	169.5	175.6
Total population in millions of people	34.92	35.66	36.42	37.19	37.98	38.78	39.61
Real individual income in thousand riyals	95.68	97.13	98.59	100.08	101.60	103.13	104.69
Food production index	198.0	199.7	201.3	202.8	204.2	205.3	206.5
Consumer price index for food	129.4	132.8	136.4	140.0	143.7	147.6	151.7
Food security index	72.4	73.0	73.5	74.1	74.6	75.1	75.6

Source: Equations in tables 5, 7

crops, with the most significant being green fodder. As a result, the cropped area decreased to 534.5 thousand hectares in 2022. Therefore, it was assumed that the cropped area and agricultural labour would remain unchanged from 2022 until 2030.

The endogenous variables were predicted by substituting the exogenous variables' predictive values into the proposed model's equations. According to the model, real per capita income is expected to increase from 95.68 thousand riyals in 2024 to 104.69 thousand riyals in 2030. Despite the decline in crop area, which reached 534.5 thousand hectares in 2022 and led to a decrease in the plant production index, it is anticipated that the estimated index for food production will increase from 198.0 in 2024 to 206.5 in 2030. This is due to the state's efforts to develop livestock and increase the animal production index. Despite the impact of the Russian-Ukrainian war on the internal and external variables of the proposed model, the food security index is expected to improve for the Kingdom of Saudi Arabia, increasing from 72.4 in 2024 to 75.6 in 2030 (Table 9).

Conclusion

Due to the outbreak of the Russian-Ukrainian war on February 24, 2022, global and local prices of food products such as meat, dairy, grains, vegetable oils, and sugar have increased. A study of the current food security situation in the Kingdom of Saudi Arabia revealed that the food security environment index increased from 58.1% in 2012 to 69.9% in 2022, with an annual average of 65.2%. This indicates that the food security situation remained moderate during 2012-2022. When comparing the food security environment index among the Gulf Cooperation Council countries, it was found that the State of Qatar ranked first, followed by the Sultanate of Oman, United Arab Emirates, Bahrain, Kuwait, and the Kingdom of Saudi Arabia. The lower level of food security in the Kingdom of Saudi Arabia, compared to the rest of the Gulf Cooperation Council countries, can be attributed to several factors, the most important of which are: (i) the Kingdom of Saudi Arabia has the largest population among the Gulf countries, (ii) a decrease in the average real per capita income of 92.75 thousand riyals compared

to its counterparts in the other Gulf Cooperation Council countries in 2022, (iii) a decrease in the food affordability index of 83.2% compared to its estimated counterpart in the other Gulf Cooperation Council countries, except for the State of Kuwait in 2022, (iv) A decrease in the food availability index of 67.2% compared to its estimated counterpart in the States of Qatar and United Arab Emirates in 2022, (v) a decrease in the food quality and safety index of 71.6% compared to its estimated counterpart in the other Gulf Cooperation Council countries, except for the State of Kuwait in 2022, and (vi) a decrease in the natural resources sustainability and resilience index of 53.7% compared to its estimated counterpart in the United Arab Emirates at 55.2% in 2022. Despite the impact of the Russian-Ukrainian war on the internal and external variables of the proposed model, the food security index is projected to improve for the Kingdom of Saudi Arabia. It is expected to increase from 72.4 in 2024 to 75.6 in 2030 due to the state adopting the Saudi agricultural investment policy abroad and directing local agricultural investments towards vertical expansion, protected agriculture, and good agricultural practices, in addition to achieving significant financial surpluses, leading to an increase in the state's ability to import from abroad.

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Ethical Clearance

It is certified that no animal or human model was used during the study, so there is no need for any ethical clearance.

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