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Hungarian University of Agriculture and Life Sciences

Key Driving Forces of Food Security in Kyrgyzstan

Thesis of the PhD dissertation

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Gödöllő, Hungary

2025

Hungarian University of Agriculture and Life Sciences

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1. INTRODUCTION

1.1 Background

Food security remains one of the most pressing global challenges of the 21st century, closely linked to economic stability, social well-being, and sustainable development. Despite significant international efforts, such as the United Nations' Sustainable Development Goals (SDG 2: Zero Hunger), millions worldwide still face hunger and malnutrition due to disruptions in agricultural systems, climate change, and socio-political instability (FAO, 2023; IFPRI, 2019; WFP, 2021).

Globally, food security is increasingly threatened by economic inequalities, volatile food prices, and environmental degradation. Climate change has emerged as a critical factor, intensifying weather unpredictability and diminishing agricultural productivity (Bozsik et al., 2024; IPCC, 2022). Additionally, recent global events such as the COVID-19 pandemic exposed vulnerabilities in supply chains, amplifying food insecurity in many regions (FAO, 2023; Nugroho et al., 2023). Geopolitical conflicts further exacerbate these challenges by disrupting key agricultural exports and supply routes (WFP, 2021).

In Kyrgyzstan, a landlocked and mountainous nation in Central Asia, food insecurity is demonstrated through a complex interaction of economic, environmental, and political factors. The country's transition from a centrally planned economy to a market-oriented system in the 1990s significantly impacted its agricultural sector, leading to reduced state support, fragmented landholdings, and a decline in productivity (ADB, 2014; Spoor, 1999). These changes disproportionately affect rural communities, where approximately 63% of the population resides and remains heavily reliant on small-scale farming (Serova & Yanbykh, 2023).

Economic constraints further amplify food insecurity in Kyrgyzstan, with over 60% of household income allocated to food, leaving limited resources for other essential needs (WFP, 2023). The reliance on imported staples exposes the nation to global market fluctuations, further straining accessibility and affordability. Concurrently, environmental vulnerabilities such as climate-induced extreme weather events and unevenly distributed water resources pose significant risks to agricultural productivity and rural livelihoods (IPCC, 2022; World Bank, 2021).

This research is essential for its potential to provide a comprehensive understanding of these complex and interrelated factors driving food insecurity in Kyrgyzstan. By analyzing the economic, environmental, and political dimensions of food security, the research aims to uncover the root causes of these challenges and propose actionable recommendations for policymakers and stakeholders. Such insights are critical for developing targeted long-term strategies that enhance

food production, improve access to nutritious foods, and build relevant resilience against future challenges.

1.2 Research Objective

The primary objective of this study is to examine the interaction between economic, environmental, and political factors influencing food security in Kyrgyzstan. The objectives are structured as follows:

- To assess the impact of economic factors such as GDP per capita (PPP), inflation (consumer prices), and income inequalities on food security.
- To evaluate the influence of environmental factors, including annual average temperature and precipitation variability, on food security elements.
- To determine the role of political stability and corruption control in shaping food security outcomes.

1.3 Research Questions

The goal of the study is to address the complex and multidimensional factors influencing food security in Kyrgyzstan. In this study, food security is assessed through two key dimensions: the prevalence of undernourishment and the per capita consumption levels of nine basic food products, which are consistent with the Law on Food Security of the Kyrgyz Republic (CDB KR, 2023). Based on the introduction, the research has 4 research questions:

- How do economic factors, such as GDP per capita, inflation, and income inequalities, affect the prevalence of undernourishment and the consumption of basic food products in Kyrgyzstan?
- What is the role of political stability and corruption control in shaping access to food and nutritional adequacy in Kyrgyzstan?
- How do environmental factors, like annual average temperature and precipitation, impact food consumption and undernourishment in Kyrgyzstan?
- What is the combined effect of economic, political, and environmental factors on food security in Kyrgyzstan?

1.4 Hypotheses

The hypotheses for this study are formulated based on the research questions as follows:

H1: Economic variables such as GDP per capita, inflation, and income inequalities significantly affect both the prevalence of undernourishment and per capita food consumption in Kyrgyzstan.

- H1a: Higher GDP per capita improves food security by increasing purchasing power and reducing reliance on subsistence agriculture.

- H1b: Income inequality worsens food insecurity by limiting access to nutritious food for lower-income households.
- H1c: Inflation negatively affects food security by reducing real incomes and raising the cost of essential food items.

H2: Environmental changes, including variations in temperature and precipitation, have a significant impact on food availability, consumption patterns, and undernourishment in Kyrgyzstan.

- H2a: Rising temperatures lower agricultural yields, particularly for staple crops.
- H2b: Unpredictable rainfall patterns lead to water shortages and droughts, reducing crop and livestock productivity.

H3: Political stability and governance quality are crucial to ensuring food security in Kyrgyzstan.

- H3a: Higher political stability is associated with improved food consumption and reduced undernourishment due to efficient policy implementation and resource allocation.
- H3b: Corruption weakens food security by misdirecting resources away from vital agricultural and nutrition programs.

H4: Economic, environmental, and political factors interact in shaping food security outcomes in Kyrgyzstan, both in terms of undernourishment and food consumption.

- H4a: The effect of inflation on food security is stronger in politically stable environments.
- H4b: The effect of GDP on food insecurity is stronger when corruption is better controlled.

2. METHODOLOGY AND DATA

This study employs a quantitative research design to investigate the comprehensive impact of economic, political, and environmental factors on food security in Kyrgyzstan. Food security, in this research, is defined through two complementary dimensions, like the prevalence of undernourishment (PoU) and the consumption of nine basic food products (potato, vegetables, fruit, meat, milk, sugar, egg, vegetable oil, and bread). The PoU indicator reflects caloric sufficiency and long-term patterns of nutritional deprivation, whereas the food consumption data provide insights into dietary access, diversity, and affordability. This dual approach aligns with the FAO's definition of food security, which emphasizes not only the availability of food but also reliable access to sufficient, safe, and nutritious food that meets people's dietary needs.

2.1 Data Collection

The research employed time series data. The secondary data were collected from 2002 to 2022. Data for the analysis were sourced from reputable and publicly accessible databases. Economic indicators, including GDP per capita PPP, inflation, and the Gini coefficient, were obtained from the World Bank (WB) and the International Monetary Fund (IMF). Political factors, such as political stability and control of corruption, were retrieved from the World Governance Indicators (WGI). Environmental data, including temperature and precipitation metrics, were sourced from the Climate Change Knowledge Portal of the World Bank Group (CCKP WB) and other relevant climate databases. The dependent variables, comprising PoU and the consumption of basic food products, were collected from the Food and Agriculture Organization (FAO) and the National Statistical Committee of the Kyrgyz Republic.

2.2 Data Preparation

The study used eight explanatory variables and ten dependent variables to represent the food security of the country, including nine basic product consumptions and the prevalence of undernourishment as indicated in Table 1.

Prior to analysis, the data were thoroughly reviewed and prepared. For time series data, stationarity was checked using the Augmented Dickey-Fuller (ADF) test, and non-stationary series were appropriately transformed (i.e., differencing) to meet the assumptions of the regression model (Gujarati, 2004).

Table 1. Variables and data sources for the study

Dependent Variables	**Symbol**	**Source**
Prevalence of Undernourishment (%) (3-year average)	PoU	FAOSTAT
Consumption of Bread and bakery products	ConsBread	NSC KR
Consumption of Potatoes	ConsPotato	NSC KR
Consumption of Vegetables and melon	ConsVeg	NSC KR
Consumption of Fruit and berries	ConsFruit	NSC KR
Consumption of Meat and meat products	ConsMeat	NSC KR
Consumption of Milk and dairy products	ConsMilk	NSC KR
Consumption of vegetable oil	ConsOil	NSC KR
Consumption of Sugar	ConsSugar	NSC KR
Consumption of Eggs	ConsEgg	NSC KR
Independent Variables		
Political:		
Political Stability and Absence of Violence/Terrorism (percentile rank)	POLST	WGI
Control of Corruption	CC	WGI
Economic:		
GDP per capita PPP	GDP	WB
Inflation, Consumer Prices (annual %)	INF	IMF
Gini Coefficient	GINI	IMF
Environmental:		
Annual Average Temperature	Tave	CCKP WB
Annual Maximum number of consecutive dry days	Dry	CCKP WB
Annual Maximum number of consecutive wet days	Rainy	CCKP WB

Source: Elaborated by author.

2.3 Regression Analysis

The study employs multiple regression analysis to explore the relationship between food security and a set of economic, political, and environmental variables. This method was selected due to its suitability for analyzing continuous time-series data and its capacity to estimate the individual and combined effects of multiple independent variables on a single dependent variable. Importantly, multiple regression offers clarity in interpretation and straightforward implementation (Field, 2009; Gujarati, 2004).

$$Y_i = \beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \beta_3 X_{3,i} + \ldots + \beta_n X_{n,i} + \varepsilon_i \quad (1)$$

Where:

Y_i is the dependent variable (e.g., potato consumption, PoU, etc.); β_0 is the intercept; $\beta_1, \beta_2, \beta_3, \ldots, \beta_n$ are the coefficients for the independent variables; $X_{1,i}$, $X_{2,i}$, $X_{3,i}$, …, $X_{n,i}$ are the independent variables (e.g., GDP, inflation, etc.); ε_i is the error term.

Comprehensive regression models incorporating economic, political, and environmental factors were also developed to provide a holistic understanding of the factors impacting food security and consumption patterns.

2.4 Diagnostic Tests

To ensure the validity and reliability of the regression models, several diagnostic tests were conducted:

- *Multicollinearity*: Variance Inflation Factor (VIF) was used to detect multicollinearity among independent variables. A VIF value greater than 10 indicates high multicollinearity.
- *Heteroskedasticity*: The Breusch-Pagan test was employed to detect heteroskedasticity in the residuals. Significant p-values indicate the presence of heteroskedasticity.
- *Autocorrelation*: The Durbin-Watson statistic was used to check for autocorrelation in the residuals. Values close to 2 suggest no significant autocorrelation, while values far from 2 indicate positive or negative autocorrelation.

2.5 Interpretation of Results

The interpretation of regression results focused on the significance and direction of coefficients for each independent variable:

- **Economic Factors**: GDP per capita, inflation, and income inequality were examined for their effects on food consumption patterns and food security. Higher GDP generally indicates better economic conditions, leading to improved food security. Inflation impacts the cost of living and food affordability, while income inequality affects equitable access to food.
- **Political Factors**: Political Stability and Corruption Control were included to understand their influence on food security. These factors are critical in creating a conducive environment for economic growth and development, which in turn impacts food security.
- **Environmental Factors**: Temperature and Precipitation were analyzed to assess their impact on agricultural productivity and food availability. Extreme weather conditions can significantly affect crop yields and food supply, thus influencing consumption patterns.

3. RESULTS

3.1 Descriptive Analysis of Variables

Descriptive Statistics of Food Consumption and Prevalence of Undernourishment. The descriptive analysis provides an overview of the consumption patterns of nine basic food products in Kyrgyzstan and the prevalence of undernourishment (PoU) as an indicator of food security (Table 2).

Table 2. Descriptive Statistics of Consumption and Prevalence of Undernourishment

Variables	Mean	SD	Min	Max
Potatoes	48.20455	5.96741	40.8	64.2
Vegetables and melon	76.60909	6.718979	64.6	84.6
Fruit and berries	24.60455	6.504173	8.4	34.8
Meat and meat products	17.98182	3.56339	12.6	22.8
Milk and dairy products	87.06818	5.691965	79.2	100.6
Sugar	13.9	1.986142	11.8	20.1
Eggs	62.07273	13.51716	49.4	94.8
Vegetable Oil	10.36818	1.154035	8.2	11.9
Bread and bakery products	121.1636	24.33165	14.8	140.4
Prevalence of Undernourishment	7.422727	2.533759	4.6	14.6
N	22			

Source: Author's calculation using STATA 16.0 program

Potatoes: The average per capita potato consumption is 48.20 kg/year, with a standard deviation of 5.97, indicating moderate variability. The minimum consumption observed is 40.8 kg, while the maximum is 64.2 kg. These values suggest that while potatoes are a staple food, consumption fluctuates over the years, possibly influenced by economic accessibility and production levels.

Vegetables and melon: The average vegetable consumption is 76.61 kg/year, higher than potatoes, with a standard deviation of 6.72. Consumption ranges from 64.6 kg to 84.6 kg, demonstrating relatively consistent availability and accessibility over time.

Fruit and berries: Fruit consumption averages 24.60 kg/year, with a larger variability (SD = 6.50) compared to vegetables. The minimum value is 8.4 kg, significantly below the average physiological norm, highlighting the physical and economic inaccessibility of fruits for a substantial portion of the population.

Meat and meat products: Meat consumption is notably low, averaging 17.98 kg/year with a standard deviation of 3.56. The range of 12.6–22.8 kg underscores significant underconsumption relative to recommended dietary norms, likely due to affordability challenges.

Milk and dairy products: Milk consumption is the highest among all products, with an average of 87.07 kg/year and a standard deviation of 5.69. Values range

from 79.2 kg to 100.6 kg, suggesting relatively better physical availability compared to other products.

Sugar: The average sugar consumption is 13.90 kg/year, with a smaller variability (SD = 1.98). The minimum value is 11.8 kg, indicating limited affordability for low-income households.

Eggs: Egg consumption shows significant variability, with an average of 62.07 kg/year and a standard deviation of 13.52. Consumption ranges from 49.4 kg to 94.8 kg, reflecting inconsistent economic accessibility across years.

Vegetable Oil: Consumption of vegetable oil averages 10.37 kg/year with minimal variability (SD = 1.15), suggesting stable patterns of usage, although the low average highlights limited affordability.

Bread and bakery products: Bread consumption is the highest among all basic products, averaging 121.16 kg/year, but with a larger standard deviation (24.33). The range of 14.8–140.4 kg indicates that bread remains the primary staple in Kyrgyzstan, although consumption varies significantly, possibly due to price fluctuations and household income disparities.

The prevalence of undernourishment, an indicator of food insecurity, averages 7.42% with a standard deviation of 2.53%, ranging from 4.6% to 14.6%. These figures reflect persistent food insecurity in Kyrgyzstan, with peaks potentially driven by economic and climatic factors.

Descriptive Statistics of Economic, Political, and Environmental Indicators. The analysis of economic, political, and environmental factors provides critical insights into the broader context influencing food security in Kyrgyzstan (Table 3).

Political Indicators. *Political Stability and Absence of Violence/Terrorism:* The mean index value is 23.00, with a standard deviation of 7.69, ranging from 11.59 to 39.68. This variability highlights periods of significant political instability, which can disrupt food supply chains and reduce the population's ability to access basic food products.

Control of Corruption: The average score for control of corruption is 10.86, with a standard deviation of 3.53, indicating moderate variation over time. The minimum value of 4.31 and maximum value of 17.14 suggest persistent challenges in governance, potentially affecting the equitable allocation of resources and the efficiency of food security policies.

Table 3. Descriptive Statistics of Economic, Political, and Environmental Indicators

Variables	Mean	SD	Min	Max
Political Stability and Absence of Violence/Terrorism	23.00063	7.686012	11.5942	39.68
Control of Corruption	10.86258	3.526673	4.30622	17.14286
GDP per capita PPP	3749.291	1351.246	1986.151	6572.383
Inflation, Consumer Prices	6.990909	5.693932	.4	24.5
Gini Coefficient	29.76818	2.805333	26.4	37.4
Annual Average Temperature	.8086364	.3988113	-.09	1.5
Annual Maximum number of consecutive wet days	80.33627	7.984725	65.96	99.01
Annual Maximum number of consecutive dry days	94.99939	8.691203	84.23	116.75
N	22			

Source: Author's calculation using STATA 16.0 program

Economic Indicators. *GDP per Capita PPP:* The average GDP per capita is $3,749.29, with a substantial standard deviation of $1,351.25, ranging from $1,986.15 to $6,572.38. This wide range reflects significant economic disparities over time, which are likely to influence the affordability and accessibility of food for different segments of the population.

Inflation (Consumer Prices): Inflation averages 6.99%, with a high standard deviation of 5.69%, ranging from a low of 0.4% to a peak of 24.5%. Such variability indicates periods of economic instability, which could increase food prices and reduce purchasing power for households.

Gini Coefficient: The Gini coefficient, representing income inequality, has a mean value of 29.77, with a standard deviation of 2.81, ranging from 26.4 to 37.4. This range indicates moderate to high levels of inequality, which can exacerbate disparities in food access and affordability across socioeconomic groups.

Environmental Indicators. *Annual Average Temperature:* The average temperature is 0.81°C, with a standard deviation of 0.40°C, ranging from -0.09°C to 1.5°C. While the variation is relatively low, even small shifts in temperature can impact agricultural productivity, particularly in regions dependent on traditional farming practices.

Consecutive Wet Days: The mean number of consecutive wet days is 80.34, with a standard deviation of 7.98, ranging from 65.96 to 99.01. This indicator reflects precipitation patterns, which play a crucial role in crop growth and water availability.

Consecutive Dry Days: The mean number of consecutive dry days is 94.99, with a standard deviation of 8.69, ranging from 84.23 to 116.75. Extended dry periods may result in drought conditions, reducing crop yields and exacerbating food insecurity, particularly in regions without irrigation infrastructure.

The interplay of food consumption trends, undernourishment levels, and contextual factors underscores the complexity of food security in Kyrgyzstan. While some progress has been made in ensuring physical availability for certain products like bread and vegetables, economic accessibility remains a critical challenge, compounded by political instability and environmental risks.

3.2 Impact of Socio-Economic Factors on Food Security

The analysis investigates the impact of economic factors, specifically GDP per capita, inflation, and income inequality (Gini coefficient), on food security in Kyrgyzstan. The dependent variables include the consumption of nine basic food products and the prevalence of undernourishment (PoU). The results provide insights into how economic conditions influence dietary patterns and nutritional outcomes in the country (Table 4).

Gross Domestic Product (GDP). The results indicate that GDP per capita has a significant impact on several aspects of food security in Kyrgyzstan. Specifically, there is a statistically significant negative relationship between GDP per capita and potato consumption ($\beta = -0.00326$, $t = -7.51$, $p < 0.01$). This suggests that as GDP per capita increases, the consumption of potatoes decreases. A possible explanation for this trend is that higher income levels lead to dietary diversification, with households consuming a broader range of food products beyond staple foods like potatoes. In contrast, a significant positive relationship is observed between GDP per capita and vegetable consumption ($\beta = 0.00358$, $t = 3.52$, $p < 0.05$). As GDP per capita rises, so does vegetable consumption. This indicates that higher economic prosperity allows households to afford more vegetables, enhancing nutritional quality.

Table 4. The results of multiple regression analysis for economic factors

	ConsPotato	ConsVeg	ConsFruit	ConsMeat	ConsMilk	ConsSugar	ConsEgg	ConsOil	ConsBread	PoU
GDP	-0.00326***	0.00358**	0.00250**	0.00194***	-0.00155	0.000148	0.00972***	0.000419	-0.00284	-0.00163**
	(-7.51)	(3.52)	(3.00)	(5.39)	(-1.01)	(0.33)	(7.03)	(1.59)	(-1.58)	(-3.02)
INF	0.0130	0.420*	-0.245	-0.0422	-0.178	0.0609	-0.214	0.0342	-0.466	0.0411
	(0.12)	(2.19)	(-1.59)	(-0.77)	(-1.06)	(1.03)	(-1.14)	(1.36)	(-0.63)	(0.80)
GINI	0.220	0.540	-0.714	-0.349*	0.118	0.284	0.373	-0.112	-2.833	-0.0988
	(0.50)	(1.10)	(-1.15)	(-2.69)	(0.29)	(0.86)	(0.81)	(-1.31)	(-0.83)	(-0.65)
_cons	53.78**	44.19*	38.21	21.41***	90.63***	4.478	16.03	11.89**	219.4*	16.17*
	(3.88)	(2.58)	(1.93)	(4.41)	(5.07)	(0.41)	(0.89)	(3.35)	(2.11)	(2.48)
N	22	22	22	22	22	22	22	22	22	22

t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Author's calculation using STATA 16.0 program

Similarly, GDP per capita positively influences fruit consumption ($\beta = 0.00250$, $t = 3.00$, $p < 0.05$). An increase in income enables households to purchase more fruits, contributing to a balanced and healthy diet. The results show a significant positive relationship between GDP per capita and meat consumption ($\beta = 0.00194$, $t = 5.39$, $p < 0.01$). Higher income levels typically lead to increased meat

consumption, reflecting improved economic conditions and dietary preferences shifting towards protein-rich foods.

However, the relationship between GDP per capita and milk consumption is not statistically significant ($\beta = -0.00155$, $t = -1.01$), suggesting that changes in income levels do not substantially affect milk consumption patterns in Kyrgyzstan. No significant relationship is found between GDP per capita and sugar consumption ($\beta = 0.000148$, $t = 0.33$), indicating that sugar consumption remains relatively stable regardless of income changes. There is a significant positive relationship between GDP per capita and egg consumption ($\beta = 0.00972$, $t = 7.03$, $p < 0.01$). As household incomes increase, egg consumption also rises, reflecting better access to protein sources. The relationship between GDP per capita and oil consumption is not statistically significant ($\beta = 0.000419$, $t = 1.59$), suggesting that oil consumption is not strongly influenced by economic changes. GDP per capita does not significantly impact bread consumption ($\beta = -0.00284$, $t = -1.58$), indicating that bread remains a consistent part of the diet irrespective of income levels. A significant negative relationship exists between GDP per capita and the prevalence of undernourishment ($\beta = -0.00163$, $t = -3.02$, $p < 0.05$). This suggests that higher GDP per capita reduces the prevalence of undernourishment, highlighting the importance of economic growth in improving food security and nutritional outcomes.

Higher GDP per capita significantly increases the consumption of vegetables, fruits, meat, and eggs while decreasing the prevalence of undernourishment. In contrast, potato consumption decreases as GDP per capita rises, reflecting dietary diversification with higher income levels. Milk, sugar, oil, and bread consumption do not show significant changes with variations in GDP per capita.

Inflation (INF). The results show varied impacts of inflation on food security. Inflation does not significantly affect potato consumption ($\beta = 0.0130$, $t = 0.12$). However, there is a significant positive relationship between inflation and vegetable consumption ($\beta = 0.420$, $t = 2.19$, $p < 0.10$), indicating that higher inflation may lead to increased vegetable prices, potentially affecting consumption. Inflation does not significantly impact the consumption of fruits, meat, milk, sugar, eggs, oil, bread, or the prevalence of undernourishment. This suggests that inflationary pressures do not substantially alter these consumption patterns or undernourishment rates in Kyrgyzstan.

Inflation significantly affects vegetable consumption, possibly due to price increases, but does not have a substantial impact on the consumption of other food products or the prevalence of undernourishment.

Income Inequality (GINI). The Gini coefficient, representing income inequality, shows mixed effects on food security. There is a significant negative relationship between income inequality and meat consumption ($\beta = -0.349$, $t = -2.69$, $p < 0.05$), indicating that higher income inequality reduces meat consumption. This suggests

that economic disparity may limit access to protein-rich foods for lower-income households. Income inequality does not significantly impact the consumption of other basic food products or the prevalence of undernourishment. This implies that while income inequality affects meat consumption, it may not have a pronounced effect on other dietary components or overall undernourishment rates.

The multiple regression analysis of economic factors demonstrates that GDP per capita is a critical determinant of food security in Kyrgyzstan, significantly influencing the consumption of several basic food products and reducing undernourishment. Inflation and income inequality have more nuanced impacts, affecting specific food items and consumption patterns. These findings underscore the importance of economic growth and equitable distribution of income in enhancing food security and nutritional outcomes.

3.3 Impact of Political Factors on Food Security

The multiple regression analysis examines the influence of political factors on food security in Kyrgyzstan, focusing on political stability (POLST) and corruption control (CC). The dependent variables include the consumption of nine basic food products and the prevalence of undernourishment (PoU). The results shed light on how political conditions and governance affect dietary patterns and nutritional outcomes (Table 5).

Table 5. The results of multiple regression analysis for political factors

	ConsPotato	ConsVeg	ConsFruit	ConsMeat	ConsMilk	ConsSugar	ConsEgg	ConsOil	ConsOil	PoU
POLST	-0.113	0.257	0.0321	0.122	0.158	-0.0871	0.532	-0.00144	-0.00144	0.0858
	(-0.47)	(0.92)	(0.15)	(0.81)	(0.63)	(-1.33)	(1.11)	(-0.02)	(-0.03)	(0.68)
CC	-0.494	-0.721	1.062**	0.353	-0.117	-0.155	1.235*	-0.00791	-0.00791	-0.270*
	(-1.07)	(-1.85)	(3.40)	(1.88)	(-0.44)	(-1.59)	(2.36)	(-0.11)	(-0.12)	(-2.14)
_cons	56.17***	78.54***	12.33*	11.34***	84.70***	17.58***	36.42***	10.49***	10.49***	8.382**
	(9.81)	(13.44)	(2.43)	(4.02)	(17.34)	(11.28)	(4.00)	(10.14)	(11.54)	(3.27)
N	22	22	22	22	22	22	22	22	22	22

t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Author's calculation using STATA 16.0 program

Political Stability (POLST). The results of the multiple regression analysis indicate that political stability does not have a statistically significant impact on the consumption of most food products or the prevalence of undernourishment. Specifically, the relationship between political stability and potato consumption is not significant (β = -0.113, t = -0.47), indicating that changes in political stability do not significantly alter potato consumption patterns. Similarly, the consumption of vegetables (β = 0.257, t = 0.92), fruits (β = 0.0321, t = 0.15), meat (β = 0.122, t = 0.81), milk (β = 0.158, t = 0.63), sugar (β = -0.0871, t = -1.33), eggs (β = 0.532, t = 1.11), and oil (β = -0.00144, t = -0.02) are not significantly affected by political stability. The prevalence of undernourishment (PoU) also shows no significant relationship with political stability (β = 0.0858, t = 0.68),

suggesting that political stability alone may not be a strong determinant of food security in Kyrgyzstan.

So, political stability does not significantly impact the consumption of the nine basic food products, nor does it significantly affect the prevalence of undernourishment. This suggests that other factors may play a more critical role in determining food security in Kyrgyzstan.

Control of Corruption (CC). The results of the multiple regression analysis show that corruption control has a significant impact on certain aspects of food security. There is a significant positive relationship between corruption control and fruit consumption ($\beta = 1.062$, $t = 3.40$, $p < 0.05$). This indicates that effective corruption control measures can lead to increased fruit consumption, possibly by improving the efficiency of food distribution systems and reducing the diversion of resources. Additionally, a significant positive relationship is observed between corruption control and egg consumption ($\beta = 1.235$, $t = 2.36$, $p < 0.10$). This suggests that better governance and reduced corruption can enhance access to protein-rich foods such as eggs.

However, the relationship between corruption control and potato consumption is not statistically significant ($\beta = -0.494$, $t = -1.07$), indicating that corruption control does not substantially affect potato consumption patterns. Similarly, corruption control does not have a significant impact on the consumption of vegetables ($\beta = -0.721$, $t = -1.85$), meat ($\beta = 0.353$, $t = 1.88$), milk ($\beta = -0.117$, $t = -0.44$), sugar ($\beta = -0.155$, $t = -1.59$), oil ($\beta = -0.00791$, $t = -0.11$), or the prevalence of undernourishment ($\beta = -0.270$, $t = -2.14$, $p < 0.10$).

Corruption control significantly increases the consumption of fruits and eggs, reflecting the positive impact of improved governance on food security. However, it does not significantly affect the consumption of other food products or the prevalence of undernourishment.

In conclusion, the analysis of the multiple regression analysis demonstrates that political stability does not significantly impact food security in Kyrgyzstan, as measured by the consumption of nine basic food products and the prevalence of undernourishment. In contrast, corruption control plays a more substantial role, significantly increasing the consumption of fruits and eggs. These findings suggest that efforts to reduce corruption and improve governance can enhance food security, particularly in terms of increasing access to diverse and nutritious foods.

3.4 Impact of Environmental Factors on Food Security

The analysis of multiple regression analysis investigates the impact of environmental factors, including average temperature (Tave), the number of rainy days (Rainy), and the number of dry days (Dry), on food security in Kyrgyzstan. The dependent variables include the consumption of nine basic food products and

the prevalence of undernourishment. These results provide insights into how environmental conditions influence dietary patterns and nutritional outcomes in the country (Table 6).

Table 6. The results of multiple regression analysis for environmental factors

	ConsPotato	ConsVeg	ConsFruit	ConsMeat	ConsMilk	ConsSugar	ConsEgg	ConsOil	ConsBread	PoU
Tave	0.391	6.538**	-3.934	1.026	2.324	0.614	3.811	0.0479	-17.42	-0.269
	(0.11)	(3.08)	(-1.14)	(0.55)	(0.99)	(0.50)	(0.76)	(0.07)	(-0.95)	(-0.26)
Rainy	0.000352	-0.407**	-0.132	-0.173*	-0.000432	0.000781	-0.406*	-0.0366	0.754	0.0605
	(0.00)	(-2.94)	(-1.63)	(-2.47)	(-0.00)	(0.02)	(-2.26)	(-1.44)	(0.88)	(1.73)
Dry	0.0849	0.0783	-0.119	-0.0394	-0.114	0.0321	-0.100	0.0139	-0.661	-0.00788
	(0.58)	(0.69)	(-0.71)	(-0.46)	(-0.98)	(0.88)	(-0.30)	(0.62)	(-1.23)	(-0.13)
_cons	39.79*	96.59***	49.73*	34.82**	96.04***	10.29	101.1*	11.95***	137.5*	3.525
	(2.47)	(6.34)	(2.56)	(3.32)	(4.79)	(1.90)	(2.79)	(4.50)	(2.47)	(0.56)
N	22	22	22	22	22	22	22	22	22	22

t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Author's calculation using STATA 16.0 program

Average Temperature (Tave). The results of the analysis indicate that average temperature has a varied impact on food security in Kyrgyzstan. Specifically, there is a significant positive relationship between average temperature and vegetable consumption ($\beta = 6.538$, $t = 3.08$, $p < 0.05$). This suggests that higher average temperatures may lead to increased vegetable consumption, possibly due to improved growing conditions for vegetables. However, the relationship between average temperature and the consumption of fruits is not statistically significant ($\beta = -3.934$, $t = -1.14$), indicating that temperature variations do not substantially affect fruit consumption.

For other food products, the relationships are also not statistically significant. Potato consumption ($\beta = 0.391$, $t = 0.11$), meat consumption ($\beta = 1.026$, $t = 0.55$), milk consumption ($\beta = 2.324$, $t = 0.99$), sugar consumption ($\beta = 0.614$, $t = 0.50$), egg consumption ($\beta = 3.811$, $t = 0.76$), oil consumption ($\beta = 0.0479$, $t = 0.07$), and bread consumption ($\beta = -17.42$, $t = -0.95$) are not significantly affected by average temperature changes. Additionally, the prevalence of undernourishment (PoU) is not significantly influenced by average temperature ($\beta = -0.269$, $t = -0.26$).

The average temperature significantly increases vegetable consumption, possibly due to better growing conditions. However, it does not significantly impact the consumption of other basic food products or the prevalence of undernourishment.

Number of Rainy Days (Rainy). The number of rainy days has a significant impact on certain aspects of food security. There is a significant negative relationship between the number of rainy days and vegetable consumption ($\beta = -0.407$, $t = -2.94$, $p < 0.05$), suggesting that an increase in rainy days may reduce vegetable consumption, potentially due to adverse effects on vegetable crops. Similarly, a significant negative relationship is observed between the number of rainy days and meat consumption ($\beta = -0.173$, $t = -2.47$, $p < 0.10$), indicating that increased rainfall might adversely affect meat production and consumption.

Additionally, there is a significant negative relationship between the number of rainy days and egg consumption ($\beta = -0.406$, $t = -2.26$, $p < 0.10$), suggesting that more rainy days may negatively impact egg production and consumption. However, the number of rainy days does not significantly affect the consumption of potatoes ($\beta = 0.000352$, $t = 0.00$), fruits ($\beta = -0.132$, $t = -1.63$), milk ($\beta = -0.000432$, $t = -0.00$), sugar ($\beta = 0.000781$, $t = 0.02$), oil ($\beta = -0.0366$, $t = -1.44$), or bread ($\beta = 0.754$, $t = 0.88$). The prevalence of undernourishment is also not significantly influenced by the number of rainy days ($\beta = 0.0605$, $t = 1.73$).

An increase in the number of rainy days significantly reduces the consumption of vegetables, meat, and eggs, possibly due to adverse effects on crop and livestock production. It does not significantly impact the consumption of other food products or the prevalence of undernourishment.

Number of Dry Days (Dry). The number of dry days does not have a statistically significant impact on the consumption of most food products or the prevalence of undernourishment. Specifically, there is no significant relationship between the number of dry days and the consumption of potatoes ($\beta = 0.0849$, $t = 0.58$), vegetables ($\beta = 0.0783$, $t = 0.69$), fruits ($\beta = -0.119$, $t = -0.71$), meat ($\beta = -0.0394$, $t = -0.46$), milk ($\beta = -0.114$, $t = -0.98$), sugar ($\beta = 0.0321$, $t = 0.88$), eggs ($\beta = -0.100$, $t = -0.30$), oil ($\beta = 0.0139$, $t = 0.62$), and bread ($\beta = -0.661$, $t = -1.23$). The prevalence of undernourishment is also not significantly affected by the number of dry days ($\beta = -0.00788$, $t = -0.13$).

In conclusion, the regression analysis shows that environmental factors, particularly average temperature and the number of rainy days, significantly influence food security in Kyrgyzstan. Higher average temperatures lead to increased vegetable consumption, while more rainy days reduce the consumption of vegetables, meat, and eggs. However, the number of dry days does not have a significant impact on food security indicators. These findings highlight the importance of considering environmental conditions in efforts to improve food security and agricultural productivity in Kyrgyzstan.

3.5 Combined Impact of Economic, Political, and Environmental Factors on Food Security.

This section provides an interpretation of the combined impact of economic, political, and environmental factors on food security in Kyrgyzstan. The analysis includes the consumption of nine basic food products and the prevalence of undernourishment as dependent variables. The results offer a comprehensive understanding of how these diverse factors interact and influence food security (Table 7).

Political Stability. The results indicate that political stability does not have a statistically significant effect on the consumption of most food products. However, political stability significantly affects the prevalence of

undernourishment (β = -0.182, t = 4.44), indicating that improved political stability may help reduce undernourishment rates. While political stability does not significantly impact the consumption of most food products, it has a weak negative effect on sugar consumption (β = -0.089, p = 0.05), suggesting that political conditions may affect consumption choices for specific staples.

Table 7. The results for combined economic, political, and environmental factors

	PoU	ConsPotato	ConsVeg	ConsFruit	ConsMeat	ConsMilk	ConsSugar	ConsEgg	ConsOil
POLST	-0.182***	-0.044	-0.060	-0.055	-0.009	0.295	-0.089*	0.295	-0.043
	(4.44)	(-0.30)	(-0.42)	(-0.38)	(-0.16)	(1.77)	(-2.83)	(1.54)	(-1.50)
CC	-0.211	-0.022	-0.807	0.711*	0.093	-	-	0.277	-0.146
	(-1.60)	(-0.05)	(-1.98)	(2.24)	(0.62)			(0.66)	(-1.78)
GDP	-0.001**	-0.004***	0.004**	0.003**	0.002***	-0.002*	-0.001	0.010***	0.001*
	(-4.20)	(-4.35)	(3.96)	(3.04)	(5.11)	(-2.21)	(-1.10)	(8.30)	(2.81)
INF	-0.008	-0.100	0.211	-	-0.001	-	-	-	-0.041
	(-0.12)	(-0.45)	(0.96)		(-0.02)				(-0.92)
GINI	0.100	-0.096	0.255	-0.050	-0.327	-	0.200	1.203	-0.218*
	(0.74)	(-0.20)	(0.54)	(-0.10)	(-1.85)		(0.82)	(1.91)	(-2.30)
Tave	0.472	3.391	2.601	-5.639	0.216	4.051	0.134	-6.119	0.209
	(0.67)	(1.29)	(0.99)	(-2.10)	(0.22)	(1.33)	(0.22)	(-1.73)	(0.40)
Rainy	0.0145	-0.213	-0.118	-	-0.016	-0.108	-0.019	0.099	0.017
	(0.39)	(-1.59)	(-0.87)		(-0.30)	(-0.62)	(-0.72)	(0.57)	(0.61)
Dry	-0.014	0.111	0.109	-0.082	0.041	-0.152	-0.008	-0.170	0.058
	(-0.37)	(0.82)	(0.80)	(-0.73)	(0.80)	(-0.94)	(-0.22)	(-1.11)	(2.09)
POLST * INF	-	-	-0.086*	-	-0.024*	0.029	-	-	-0.007
			(-2.98)		(-2.27)	(0.67)			(-1.28)
CC * GDP	-0.001**	-	-	-	-	-0.003	-	-	-
	(-3.16)					(-0.93)			
_cons	0.567	71.78**	61.23*	21.25	17.38*	100.8**	13.87*	-8.594	10.83*
	(0.09)	(3.47)	(2.89)	(1.28)	(2.19)	(4.08)	(2.44)	(-0.31)	(2.51)
N	22	22	22	22	22	22	22	22	22
R-squared	0.908	0.753	0.828	0.732	0.915	0.467	0.601	0.905	0.764
(Prob > F)	0.000	0.006	0.002	0.001	0.000	0.177	0.004	0.000	0.011

t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Author's calculation using STATA 16.0 program

Corruption Control. The analysis reveals that corruption control does not have a direct statistically meaningful influence on undernourishment; however, it positively affects fruit consumption (β = 0.711, p < 0.05), implying that improved governance can enhance access to nutritious food.

Importantly, interaction terms reveal governance's moderating role: the interaction between GDP and corruption control (CC x GDP) is negative and significant for PoU (β = -0.001, p < 0.01). It indicates that economic growth more effectively reduces undernourishment when corruption is controlled and institutions are strong. Likewise, the interaction between political stability and inflation (POLST x INF) is negatively associated with vegetable and meat consumption, suggesting that inflation undermines the food security benefits of stable governance.

Gross Domestic Product. The results indicate that GDP per capita has a significant impact on several aspects of food security. Specifically, there is a significant negative relationship between GDP per capita and potato consumption ($\beta = -0.004$, $t = -4.35$, $p < 0.001$) and milk consumption ($\beta = -0.002$, $t = -2.21$, $p < 0.05$), suggesting that as GDP per capita increases, potato and milk consumption decrease. This may reflect a dietary shift from basic staples as household income increases.

In contrast, GDP per capita positively influences the consumption of vegetables ($\beta = 0.004$, $t = 3.96$, $p < 0.01$), fruits ($\beta = 0.003$, $t = 3.04$, $p < 0.01$), and meat ($\beta = 0.002$, $t = 5.11$, $p < 0.001$). There is also a strong positive relationship between GDP per capita and egg consumption ($\beta = 0.010$, $t = 8.30$, $p < 0.001$). These results align with expected income effects – higher income improves access to more diverse and higher-protein food sources. However, GDP per capita does not significantly impact the consumption of sugar ($\beta = 0.001$, $t = -1.10$).

A significant negative relationship exists between GDP per capita and the prevalence of undernourishment ($\beta = -0.001$, $t = -4.20$, $p < 0.01$), indicating that higher GDP per capita reduces undernourishment.

Higher GDP per capita substantially increases the consumption of vegetables, fruits, meat, and eggs while decreasing potato consumption and the prevalence of undernourishment.

Inflation. Inflation shows no significant impact on most food security indicators. However, it weakly interacts with political stability to reduce the consumption of vegetables and meat, highlighting the fragility of food systems under economic pressure. Inflation also does not significantly influence the prevalence of undernourishment ($\beta = 0.08$, $t = 0.12$).

Inflation does not significantly impact the consumption of basic food products or the prevalence of undernourishment in Kyrgyzstan.

Income Inequality. Income inequality, as measured by the Gini coefficient, shows a significant negative impact on oil consumption ($\beta = -0.218$, $p < 0.05$). However, income inequality does not significantly impact the consumption of potatoes ($\beta = -0.100$, $t = -0.20$), vegetables ($\beta = 0.255$, $t = 0.54$), fruits ($\beta = -0.005$, $t = -0.$), sugar ($\beta = 0.200$, $t = 0.82$), eggs ($\beta = 1.203$, $t = 1.91$). The prevalence of undernourishment is also not significantly influenced by income inequality ($\beta = 0.100$, $t = 0.74$).

Higher income inequality reduces oil consumption but does not significantly impact the consumption of other food products or the prevalence of undernourishment.

Environmental Factors. The average temperature (Tave), rainy season, and dry season variables do not display strong direct effects, though temperature has a

negative impact on fruit consumption ($\beta = -5.639$, $t = -2.10$), likely linked to climate-sensitive fruit crops. The dry season is positively associated with vegetable oil consumption ($\beta = 0.058$, $p < 0.05$), possibly due to changes in food preservation and preparation during less agriculturally productive months.

In conclusion, the analysis reveals that economic, political, and environmental factors all play significant roles in shaping food security in Kyrgyzstan. Among the factors examined, economic growth stands out as the most consistent and statistically robust determinant. A higher GDP per capita is significantly associated with reduced undernourishment and increased consumption of a wide range of food products, especially vegetables, fruits, meat, eggs, and vegetable oil. It indicates that as income levels rise, households are better able to afford both caloric sufficiency and dietary diversity. However, the negative association between GDP and the consumption of basic staples like potatoes and milk suggests a shift in consumer preferences as purchasing power increases.

Political stability contributes to lowering undernourishment rates but does not significantly impact the consumption of most food products. In contrast, corruption control significantly reduces oil consumption and, to some extent, impacts the consumption of other foods.

Specifically, the interaction between control of corruption and GDP per capita significantly reduces undernourishment, underscoring that economic growth alone is not sufficient for improving food security outcomes – it must be complemented by effective governance. This finding reinforces the importance of institutional context in development outcomes: when corruption is controlled and public institutions function efficiently, the benefits of economic growth are more equitably distributed, including in areas such as food access and nutrition.

Similarly, the interaction between political stability and inflation negatively affects the consumption of vegetables and meat, implying that macroeconomic volatility (like rising prices) can erode the advantages of political stability. In fragile or developing economies, inflation can disproportionately harm lower-income households by raising the real cost of food, even when overall governance appears stable. Thus, economic policy stability is as critical as political order in safeguarding food access.

Overall, these findings underscore the importance of fostering economic growth, improving governance to reduce corruption, and managing environmental conditions to enhance food security. Policies aimed at these goals are critical to achieving sustainable nutritional outcomes in Kyrgyzstan. More detailed discussions on these policies and their implications will be addressed in the next section.

4. DISCUSSION

The study examines the impact of economic, political, and environmental factors on food security, using food consumption patterns and the prevalence of undernourishment as key indicators. The findings highlight the complex interaction between these factors, shedding light on the determinants of food security in Kyrgyzstan.

Socio-economic determinants. GDP per capita significantly influences food consumption patterns, with a noticeable shift toward higher-quality food items as income levels increase. The positive coefficients for vegetable, fruit, meat, and egg consumption indicate that as GDP increases, households diversify their diets to include more nutrient-rich foods. This trend aligns with other studies that higher income enables consumers to transition from staple-based diets toward more balanced and protein-rich diets (Duisenbekova et al., 2024; Erokhin et al., 2021; Jia et al., 2023; Rathu Manannalage et al., 2023). Conversely, GDP negatively correlates with potato consumption, suggesting a declining reliance on staple foods as households can afford a wider range of food items.

Furthermore, GDP per capita is negatively associated with PoU, indicating that economic growth plays a crucial role in reducing undernourishment (Mulyo et al., 2023). This finding underscores the importance of economic expansion in enhancing food accessibility and affordability. However, the effect of GDP on certain food categories, such as milk and vegetable oil, appears insignificant, implying that some essential food items may be less sensitive to income changes.

Accordingly, inflation demonstrates a statistically significant positive effect on vegetable consumption, suggesting that during inflationary periods, households may shift their consumption preferences toward more affordable plant-based diets. However, its negative, although statistically insignificant, association with fruit and meat consumption implies that price increases could reduce the affordability of these higher-cost items. The lack of a significant relationship between inflation and PoU suggests that short-term inflationary pressures may not directly impact on overall food insecurity but could still influence dietary choices.

In turn income inequality, as measured by the GINI coefficient, negatively affects meat consumption, suggesting that disparities in income distribution limit access to protein-rich foods for lower-income households. This aligns with prior research indicating that inequality exacerbates food insecurity by restricting the purchasing power of economically disadvantaged groups (Duisenbekova et al., 2024).

The insignificant effect of GINI on PoU indicates that while inequality influences dietary diversity, its direct impact on overall food security requires further investigation. However, the negative association with oil consumption suggests that essential cooking ingredients may become less accessible in highly unequal societies, which could have implications for food preparation and dietary quality.

The results indicate that economic factors, particularly GDP growth and income distribution, play a crucial role in shaping food consumption patterns and food security. While rising income enables dietary diversification and reduces undernourishment, income inequality remains a barrier to accessing high-quality foods. Policymakers should adopt a holistic approach that promotes inclusive economic growth, reduces inequality, and stabilizes food prices to enhance food security in the long term.

Political determinants. Political stability does not show strong statistically significant relationships with most food consumption variables, suggesting that its direct impact on food choices may be limited in the short term. However, a positive association is observed with egg consumption, indicating that more stable political conditions could improve access to protein-rich foods. This finding aligns with the idea that political stability can facilitate smoother food supply chains and better distribution systems, contributing to improved access to nutritional foods (Mulyo et al., 2023). Conversely, the negative but insignificant relationship between political stability and sugar consumption may suggest that stable governance promotes healthier dietary patterns by reducing dependency on sugary foods.

The positive coefficient of political stability on PoU, though statistically insignificant, suggests that food insecurity might not always improve under stable political conditions. This counterintuitive result could be attributed to the persistence of structural challenges such as income inequality, agricultural inefficiencies, or market disruptions that political stability alone cannot immediately resolve.

In contrast to POLST, the CC demonstrates stronger and more statistically significant associations with food security indicators. The positive and significant relationship between fruit and egg consumption and corruption control highlights that better governance in the form of reduced corruption can facilitate the effective allocation of resources and improve the availability of food. For instance, more transparent and efficient agricultural policies can lead to better access to fruits and proteins (Abdullah et al., 2022; Mulyo et al., 2023). The significant negative relationship between CC and PoU further suggests that controlling corruption helps reduce food insecurity, as it allows for more equitable distribution of food resources and improved agricultural productivity.

Environmental determinants. The rainy days have a notable effect on several food consumption categories, with significant negative associations observed for vegetable and egg consumption. A significant negative coefficient for vegetables suggests that rainy periods may hinder the availability or affordability of vegetables, due to soil erosion and disruptions in transportation or agriculture during wet conditions (Harris et al., 2022; Luo et al., 2019; Poudel & Kotani, 2013). Similarly, the negative and significant association with egg consumption

aligns with the idea that rainy periods may impact poultry farming, leading to reduced supply and increased prices of eggs, thus affecting consumption.

The negative association with meat consumption, though significant, is somewhat less pronounced, indicating that rainy conditions may have a marginal impact on meat consumption, possibly due to decreased agricultural output or supply chain disruptions. On the other hand, sugar consumption and milk consumption remain largely unaffected by rainy periods, suggesting that these products may not be as vulnerable to weather-related disruptions, or that supply chains for dairy and sugar products are more resilient to changes in weather patterns.

During the dry period, the results show limited significant effects on food consumption, with few variables showing notable relationships. For example, there is a slight negative association between milk consumption, although it is not statistically significant. The absence of significant relationships in the dry period implies that food consumption patterns might not be as directly affected by dry conditions compared to rainy conditions. However, these findings may reflect longer-term trends that are not immediately apparent in the short-term data.

The results for PoU are intriguing. While the rainy variable shows a small positive association, it is not statistically significant, suggesting that rainy periods may not have an immediate or direct impact on food insecurity across the sample. This could be due to other mitigating factors, such as government interventions or the availability of food aid during adverse weather events.

The dry period has an almost negligible impact on PoU, with a small negative coefficient, which further supports the idea that weather-related food insecurity may not be as significant in the short term. However, long-term consequences, such as droughts affecting crop yields and food availability, could contribute to increased food insecurity (WFP, 2023). Therefore, while immediate effects may not be apparent, the cumulative impact of prolonged dry periods could lead to more persistent food security challenges.

Overall, food security in Kyrgyzstan is influenced by a combination of economic, social, and environmental factors. While economic growth plays a fundamental role in improving dietary diversity and reducing undernourishment, addressing income inequality and enhancing climate resilience are equally crucial. A holistic policy approach that integrates economic, social, and environmental strategies will be essential in ensuring long-term food security for the population.

4.1 Food Security and Food Safety Challenges in Kyrgyzstan.

Kyrgyzstan faces significant challenges in ensuring food security, primarily due to economic inaccessibility, physical unavailability, and inadequate food safety systems. Economic barriers stem from low GDP per capita and persistent income inequality, which limit the ability of many households to access diverse and nutritious foods. High food prices driven by inflation further exacerbate this issue,

forcing families to prioritize quantity over quality. Protein-rich foods, such as meat, milk, and eggs, remain out of reach for a substantial portion of the population, highlighting the urgent need for policies targeting income inequality and poverty alleviation.

Environmental factors, such as unpredictable rainfall and extended dry periods, exacerbate food security challenges by negatively impacting agricultural productivity. Local farmers, heavily reliant on rain-fed agriculture, struggle to maintain stable crop yields, making the food supply vulnerable to climate variability. These disruptions particularly affect vulnerable groups that depend on local agriculture for both income and sustenance, further widening the food security gap.

Food safety, a cornerstone of food security, presents another significant issue. Contamination incidents, such as dioxins, mad cow disease, and the use of genetically modified organisms (GMOs), underscore the need for robust food safety systems. International frameworks, such as the WTO's agreements on Sanitary and Phytosanitary Measures and the Codex Alimentarius Commission standards, provide a basis for food safety legislation globally (FAO-WHO, 2024; Uddin & Uddin, 2024). These frameworks emphasize a "farm-to-table" approach, involving all stakeholders in ensuring safety throughout the supply chain. However, Kyrgyzstan has struggled to align with these international standards (Bang, 2023; Nyokabi et al., 2023).

The National Committee "Codex Alimentarius," established in Kyrgyzstan in 2003 under the Ministry of Agriculture, has largely been inactive, leaving a critical gap in the national framework for food safety (FAO-WHO, 2019). Laboratories tasked with food safety assessments remain outdated, operating under Soviet-period GOST standards rather than modern methodologies aligned with ISO and Codex standards (Choi, 2016). Most laboratories lack the technical capacity to conduct comprehensive food safety tests, and those outside the capital, Bishkek, are severely limited in scope. For instance, only one laboratory in the country has the capability to test meat and dairy products for antibiotic residues. The absence of a centralized system for laboratory equipment maintenance and repair further undermines the reliability of food safety testing.

The lack of state-level veterinary monitoring systems compounds the problem. Without mechanisms to detect harmful residues in animal-derived products and feed, private producers frequently use unregulated veterinary medicines and feed additives. This unregulated environment weakens public trust in the safety of domestic food products. Moreover, small and medium-sized enterprises (SMEs), which dominate Kyrgyzstan's food production landscape, lack production laboratories and knowledge of international food safety standards such as HACCP and GlobalGAP. This hinders their ability to meet domestic safety requirements or compete in export markets.

Physical inaccessibility of food is driven by the fragmentation of agricultural production, where small-scale farms lack the resources to achieve economies of scale or meet national demand. The resulting production deficits have made Kyrgyzstan heavily reliant on imported food items, exposing the domestic market to external price fluctuations and supply chain disruptions. This dependence not only affects affordability but also undermines the country's food sovereignty.

The structural issues in Kyrgyzstan's food safety infrastructure amplify these challenges. Laboratories are poorly equipped, and many operate with outdated technology and untrained personnel. The absence of centralized veterinary monitoring systems adds to the complexity, allowing unsafe agricultural inputs to enter the food supply chain. Additionally, the limited adoption of international food safety frameworks restricts the competitiveness of Kyrgyz food producers and their access to export markets.

Addressing these multifaceted challenges requires targeted reforms. Investments in agricultural and laboratory infrastructure are essential to improving both food availability and safety. Expanding irrigation systems, promoting climate-smart agriculture, and encouraging the use of modern farming techniques can mitigate the impact of environmental factors on food production. To enhance food safety, Kyrgyzstan must modernize laboratory facilities, adopt international safety standards, and provide training for food producers. Establishing centralized services for laboratory maintenance and repair will also improve the reliability of food safety assessments.

To tackle economic inaccessibility, policies should focus on reducing income inequality through targeted social programs and subsidies for vulnerable households. Supporting SMEs through financial incentives, such as concessional loans and grants for adopting modern technologies, can enhance productivity and competitiveness. Promoting agricultural cooperatives could help small-scale farmers achieve economies of scale and improve their market access.

4.2 Key Agricultural Policy Measures/Directions for Enhancing Food Security in Kyrgyzstan

In the previous chapter, an analysis of food security revealed that the country's food stability index is at a low level. Kyrgyzstan is currently unable to meet the population's needs for basic food products through domestic production alone, leading to a high level of import dependency (Vinokurov et al., 2023).

The low level of food security in Kyrgyzstan is closely tied to the challenges facing the processing industry, which remains underdeveloped. Many essential food products, including bread and bakery items, meat and meat products, sugar, eggs, and vegetable oil require extensive processing. Strengthening the food processing sector is a key solution to improving food security in the country. Investments in modernizing production facilities, enhancing supply chains, and

supporting local food industries can help ensure a stable and sustainable food supply.

Bread and Bakery Products. Bread and bakery products remain a staple in Kyrgyz diets, but the low gluten content of locally grown wheat poses a significant challenge. Farmers and agronomists attribute this issue to natural climatic conditions, insufficient use of fertilizers, and inadequate post-harvest processing methods. As a result, Kyrgyzstan heavily relies on wheat imports from countries such as Kazakhstan, Russia, Belarus, and China, while locally grown wheat is primarily used as livestock feed or exported to neighboring nations like Tajikistan and Afghanistan (International Trade Center, 2023).

In order to address this issue, Kyrgyzstan must focus on developing new wheat varieties suited to local climatic conditions, ensuring higher gluten content and better suitability for bread production. Investments in agricultural research and infrastructure, along with collaboration with international research institutions, can help achieve this goal. Timely and efficient irrigation systems, access to quality seeds, and better fertilizer use are also crucial to improving wheat production.

Sugar. The sugar industry in Kyrgyzstan struggles with high production costs and outdated technologies, making it uncompetitive in both domestic and regional markets. Current inefficiencies in sugar beet cultivation and processing restrict the industry's capacity to meet national demand (Cherikova et al., 2021). While other nations use protectionist policies to support their sugar industries, Kyrgyzstan's membership in the WTO limits its ability to implement similar measures, such as high tariffs or trade barriers.

To address the challenges in sugar production, two main strategies are proposed:

- *State Subsidies for Modern Equipment.* Providing targeted subsidies for the acquisition of advanced processing equipment can improve the efficiency of sugar beet cultivation and processing. Subsidies should focus on leasing arrangements with private companies and directly supporting farmers.
- *Importing Raw Cane Sugar for Processing*. Establishing trade agreements with countries producing raw cane sugar could enable Kyrgyzstan's sugar plants to process these imports, offering the population more affordable sugar compared to importing processed sugar directly.

By modernizing the sugar production process and leveraging international trade agreements, Kyrgyzstan can reduce its reliance on expensive sugar imports and position itself as a competitive regional supplier.

Vegetable Oil. The vegetable oil industry in Kyrgyzstan also faces significant challenges. While oilseed crops such as sunflower and cottonseed are primarily grown in the southern regions, domestic production remains insufficient to meet

national demand. Small-scale production and outdated refining technologies mean that over 90% of the vegetable oil produced in Kyrgyzstan is unrefined. Consequently, the country relies heavily on imports to meet its vegetable oil requirements.(NSC KR, 2023).

To address this issue, several measures are proposed:

- Expanding Cultivation Areas. Increasing the cultivation area for oilseed crops to 90,000 hectares, with yields of 1.5-2.0 tons per hectare, is essential to meeting the population's physiological needs for vegetable oil. This would require enhanced irrigation systems, modern equipment, and high-quality seeds.
- Providing Financial Incentives. Offering concessional loans to farmers cultivating oilseed crops on more than 10 hectares and entrepreneurs involved in oil refining can boost production and processing capacity.
- Modernizing Technology. Attracting foreign investors and agricultural technology providers can help introduce modern equipment and processing techniques. Collaborations with firms such as "NATE" (Switzerland) and "Donetskprodmash" (Ukraine), as well as importing elite seeds from countries like Russia and Kazakhstan, can improve productivity.

Additionally, supporting companies that supply modern equipment and providing information support to producers are key steps to facilitating the adoption of advanced technologies in the food industry.

The summary of the main policy measures/directions for improving food security in Kyrgyzstan is compiled into a single table, the following results are obtained (see Table 8).

Table 8. Main Policy Measures/Directions for Improving Food Security in Kyrgyzstan

Tasks	**Measures/Actions**	**Expected Results**	**Responsible Implementers**
Bread and Bread Products			
Increase the gluten level in wheat	Develop new wheat varieties adapted to Kyrgyzstan's climatic conditions	New wheat variety with a high gluten level	Breeders and scientists (agronomists) of the Kyrgyz National Agrarian University
Obtain high-quality wheat with a high gluten content	Ensure timely irrigation to improve soil and yield under favorable conditions	High-quality wheat	Farmers
Sugar			
Subsidies for the purchase of modern equipment for sugar processing	Help private producers through subsidies to acquire advanced technologies for growing root crops and processing them, rather than providing monetary funds	Competitiveness of private sugar producers in both domestic and foreign markets	Government of the Kyrgyz Republic, Ministry of Agriculture, Food and Melioration (MSHM), Ministry of Economy (ME), Private Leasing Companies

Conclude agreements with countries producing raw cane sugar for supplies to Kyrgyzstan	Process imported raw cane sugar instead of sugar beets	Provide the population of Kyrgyzstan with sugar at more affordable prices compared to imported raw cane sugar	Government of the Kyrgyz Republic, MSHM, ME, private sugar producers
Vegetable Oil			
Stimulate private producers to expand the cultivation area of oilseed crops to 90,000 hectares and increase their yield to 15–20 centners per hectare	Provide loans to farmers fully engaged in growing oilseed crops over 10 hectares, and to entrepreneurs involved in refining vegetable oil	Produce 55,000 tons of vegetable oil annually from domestic production, reducing the need for imported vegetable oil	Government of the Kyrgyz Republic, MSHM, ME, vegetable oil producers
Increase vegetable oil production	Implement a structural program aimed at consolidating vegetable oil enterprises	Emergence of large vegetable oil enterprises	Government of the Kyrgyz Republic, MSHM, ME, cooperatives, associations
Improve technologies for growing oilseed crops and refining vegetable oil	Attract investors with suitable agricultural equipment, modern processing technologies, and know-how for proper planting, crop care, and harvesting	Production of high-quality refined vegetable oil from domestic production	Government of the Kyrgyz Republic, MSHM, ME, centers providing supply and logistics services

Source: Elaborated by author.

4.3 The Role of Government Institutions in Strengthening Food Security

Agriculture is a vital sector of any country's economy, and the state plays a crucial role in ensuring food security. In Kyrgyzstan, the primary challenges to food security are physical and economic inaccessibility, alongside inadequate food safety.

Physical Inaccessibility of Food. There is a low level of self-sufficiency in essential food products. The main reasons for the physical inaccessibility of these food products are:

- Small-scale agricultural production.
- Insufficient production of essential food products.
- A high proportion of imported essential food products.

Economic Inaccessibility of Food. The main reasons for the economic inaccessibility of essential food products in our republic are:

- A high proportion of household expenses are spent on food.
- A high level of poverty among the population.
- Low-income levels.

Food Safety. In Kyrgyzstan, the number of low-quality food products on the domestic market is increasing every year, including those containing GMOs, dioxins, bovine spongiform encephalopathy, and others. This is because the state, due to limited financial resources, cannot guarantee the quality of agricultural products necessary for an active and healthy lifestyle.

The reasons for the increase in low-quality food in the country are:

- Poor technical equipment and incompetence of existing laboratories.
- Lack of production (independent) laboratories for small and medium-sized enterprises.
- Use of pesticides, veterinary drugs, feeds, and feed additives with unknown quality and safety characteristics.
- Absence of state veterinary laboratory monitoring of residues of prohibited and harmful substances in living animals, animal products, and feeds.
- Low production culture, lack of knowledge, and practices in HACCP and GlobalGAP systems.
- Inability to fully certify the safety of food products.
- Lack of international recognition of test results and compliance documents.

In addressing the food security challenges in Kyrgyzstan, it is evident that the country faces significant issues related to the physical and economic inaccessibility of essential food products, as well as food safety. The analysis highlights the need for comprehensive state intervention and support to enhance the overall food security framework.

Economic Inaccessibility: High poverty levels, low incomes, and a large proportion of household expenses spent on food render essential products unaffordable for many. Developing the Halal industry and establishing robust certification systems could enhance local production and export potential.

Physical Inaccessibility: The country faces low self-sufficiency in essential food products due to small-scale agricultural production, insufficient domestic output, and heavy reliance on imports. Consolidating small producers through cooperatives could improve efficiency and reduce dependency on imports.

Food Safety: The domestic market suffers from an increasing presence of low-quality food products due to outdated laboratory equipment, lack of food safety standards like HACCP and GlobalGAP, and insufficient state monitoring of harmful substances. Modernizing laboratories, introducing international safety standards, and improving producer awareness are critical.

Government Role: The state must develop unified food safety policies, incentivize the adoption of international standards, and support rural processing enterprises. By fostering cooperative models, enhancing food safety infrastructure, and encouraging private-sector involvement, Kyrgyzstan can strengthen its food security framework.

4.4 The Role of Climate in Agricultural Productivity

Agriculture in Kyrgyzstan is highly sensitive to climate variations. The country's geographical location exposes it to extreme temperature shifts and irregular

precipitation patterns, both of which directly affect crop yields and livestock productivity. Empirical findings indicate that temperature fluctuations significantly impact fruit production, as high temperatures can stress crops and reduce yields. Conversely, excessively low temperatures shorten the growing season, limiting the availability of key food products. Furthermore, prolonged exposure to cold conditions can affect soil health, reducing fertility and long-term agricultural productivity.

Precipitation plays an equally crucial role in determining agricultural output. The regression analysis suggests that increased rainfall negatively impacts vegetable and egg production, possibly due to excessive moisture leading to soil degradation, crop diseases, and reduced livestock productivity. On the other hand, insufficient rainfall results in droughts, which threaten staple crops such as wheat and potatoes. These findings highlight the necessity for improved water management strategies, including irrigation infrastructure and drought-resistant crop varieties.

Kyrgyzstan experiences significant seasonal variations in agricultural production. Due to its continental climate, the country faces harsh winters and short growing seasons, making year-round food production challenging. The seasonality of agricultural output leads to periods of surplus and shortage, affecting food availability and price stability. Perishable goods such as vegetables and fruits are particularly susceptible to seasonal supply fluctuations, resulting in volatile market prices and reduced accessibility for lower-income households.

To mitigate the environmental risks affecting food security in Kyrgyzstan, a multi-faceted approach is necessary. The following policy recommendations address key climate-related challenges:

- Expanding Irrigation Systems.
- Introducing Climate-Smart Agricultural Techniques.
- Providing Financial Incentives and Credit Access.
- Encouraging Crop Diversification.
- Developing Storage and Processing Infrastructure.

Effective food security strategies require collaboration between government institutions and the private sector. The government must take an active role in policy formulation, infrastructure investment, and research and development. At the same time, private sector involvement is essential for scaling up technological innovations and expanding food production capacities.

Public-private partnerships (PPPs) can be instrumental in implementing large-scale agricultural projects. Encouraging foreign direct investment (FDI) in the agricultural sector can bring in expertise, capital, and advanced technologies to improve productivity. Additionally, fostering agricultural cooperatives can help small-scale farmers access markets and financial resources more efficiently.

Moreover, investing in agricultural education and training programs will equip farmers with the knowledge and skills needed to adapt to changing environmental conditions. Extension services should focus on disseminating best practices in sustainable agriculture, water conservation, and pest management.

In conclusion, environmental factors play a crucial role in shaping food security outcomes in Kyrgyzstan. Temperature fluctuations, precipitation variability, and seasonal constraints pose significant challenges to agricultural productivity and food availability. Drawing on global best practices, Kyrgyzstan can enhance its food security framework by implementing climate-resilient policies, improving infrastructure, and supporting farmers through financial and technical assistance.

A comprehensive approach that includes expanding irrigation systems, promoting climate-smart agriculture, and investing in storage and processing facilities is essential for long-term food security. Collaboration between government institutions, private sector stakeholders, and international organizations will be key to building a resilient agricultural sector capable of withstanding environmental challenges. By adopting a strategic, evidence-based approach, Kyrgyzstan can work towards a more sustainable and secure food system, ensuring that its population has access to nutritious and affordable food despite the uncertainties posed by climate change.

5. CONCLUSIONS AND RECOMMENDATIONS

Ensuring food security in Kyrgyzstan requires a multifaceted approach that integrates economic, political, and environmental considerations. The findings of this research highlight the interconnectedness of these factors and their collective impact on food availability, affordability, and safety.

The research demonstrates that economic growth, measured by GDP per capita, positively impacts food security, enabling households to afford more diverse diets. However, income inequality limits access to protein-rich foods for lower-income households, emphasizing the need for targeted assistance programs. Inflation further exacerbates food insecurity by raising food prices and reducing nutritional diversity.

Political governance plays a nuanced role. While political stability supports policy implementation and food distribution, its impact on consumption patterns is limited. Control of corruption shows mixed results, benefitting fruit and egg consumption but not significantly reducing undernourishment.

The study reveals that environmental factors such as temperature fluctuations and precipitation patterns significantly influence agricultural production and food security. Higher temperatures increase vegetable consumption, but excessive rainfall reduces the availability of protein-rich foods like meat and eggs. Addressing these challenges requires climate-resilient agricultural practices and infrastructure.

To overcome these challenges, the research suggests several policy recommendations:

- Expand irrigation systems and adopt climate-smart agricultural practices to mitigate environmental risks.
- Provide financial incentives, such as concessional loans and subsidies, to modernize agriculture and food production.
- Strengthen food processing and storage infrastructure to reduce post-harvest losses and ensure year-round food availability.
- Develop targeted programs to reduce income inequality and improve food affordability.
- Modernize food safety standards and laboratory infrastructure, aligning with international benchmarks like HACCP and GlobalGAP.

Sector-specific recommendations include improving wheat quality for *bread and bakery* production, supporting the *sugar* industry through subsidies and trade agreements, and increasing *vegetable oil* production with targeted loans and technology investments.

The outcomes of the research provide a comprehensive understanding of the factors influencing food security in Kyrgyzstan. These results offer valuable

insights into the relationships between economic, political, and environmental variables and their impact on food security. Table 9 summarizes the results of the tested hypotheses, highlighting key findings of food security in Kyrgyzstan.

Table 9. Research hypotheses results.

Hypothesis	Statement	Result	Key Findings.
H1	Economic variables such as GDP per capita, inflation, and income inequalities significantly affect both the prevalence of undernourishment and per capita food consumption in Kyrgyzstan.		
H1a	Higher GDP per capita improves food security by increasing purchasing power and reducing reliance on subsistence agriculture.	Accepted	A rise in GDP per capita significantly reduces undernourishment and increases consumption of vegetables, fruits, meat, eggs, and oil. Suggests improved access to a more diverse, nutritious diet.
H1b	Income inequality worsens food insecurity by limiting access to nutritious food for lower-income households.	Partially Accepted	Income inequality negatively affects access to meat and high-protein foods, but its impact on other food groups and undernourishment is less significant.
H1c	Inflation negatively affects food security by reducing real incomes and raising the cost of essential food items.	Rejected	Inflation was not statistically significant in most models. Its influence appears weak, possibly offset by informal coping mechanisms or government price supports.
H2	Environmental changes, including variations in temperature and precipitation, have a significant impact on food availability, consumption patterns, and undernourishment in Kyrgyzstan.		
H2a	Rising temperatures lower agricultural yields, particularly for staple crops.	Partially Accepted	Higher average temperatures are significantly associated with reduced fruit consumption, indicating climate stress.
H2b	Unpredictable rainfall patterns lead to water shortages and droughts, reducing crop and livestock productivity.	Partially Accepted	Rainfall variables are mostly insignificant, but dry season positively correlates with oil consumption, possibly reflecting seasonal coping or storage behavior.
H3	Political stability and governance quality are crucial to ensuring food security in Kyrgyzstan.		
H3a	Higher political stability demonstrates better food security outcomes due to efficient policy implementation and resource allocation.	Rejected	Political stability does not show a statistically significant impact on most food consumption variables, suggesting that other governance factors may be more influential.
H3b	Corruption weakens food security by misdirecting resources away from vital agricultural and nutrition programs.	Partially Accepted	Control of corruption is positively associated with fruit consumption and moderates the impact of GDP on undernourishment, but broader effects on food access are limited.
H4	Economic, environmental, and political factors interact in shaping food security outcomes in Kyrgyzstan, both in terms of undernourishment and food consumption.		
H4a	The effect of inflation on food security is stronger in politically stable environments.	Accepted	Inflation significantly interacts with political stability to reduce vegetable and meat consumption, suggesting that macroeconomic pressures can undermine the benefits of political stability.
H4b	The effect of GDP on food security is stronger when corruption is better controlled.	Accepted	The interaction between GDP and corruption control significantly reduces undernourishment, confirming that governance enhances the effectiveness of economic growth for food security.

Source: Elaborated by author.

Limitations

This research work offers valuable insights into the factors influencing food security in Kyrgyzstan but comes with some limitations.

Data availability. The analysis relies on aggregated national macroeconomic data, which may hide regional disparities and local dynamics of food security.

Focus on quantitative analysis. While the research primarily employed quantitative methods to identify relationships between variables, it does not include other qualitative approaches such as interviews with farmers, policymakers, and other stakeholders. It could provide a richer, more nuanced understanding of the underlying factors and challenges.

Additional environmental factors. Temperature and precipitation are considered in the research. However, other environmental factors, like soil health, land degradation, and biodiversity are missing.

Geographic factor. The research primarily examines the food security of the Kyrgyz Republic within the national context, missing comparative regional insights.

Further Research Directions

This research can be further expanded by conducting a comparative cross-sectional analysis with other neighboring countries in the Central Asian region. Such an analysis would provide a comprehensive understanding of food security trends across the region, identifying shared challenges and unique circumstances faced by each country. For example, the geographic diversity of Central Asia, ranging from Kyrgyzstan's mountainous terrain to the arid deserts of Kazakhstan and Turkmenistan, offers a rich backdrop to explore the interplay of environmental, economic, and political factors influencing food security.

Comparative analysis can also highlight best practices and policy successes that may be adaptable to Kyrgyzstan. For instance, Kazakhstan's large-scale mechanized farming systems or Uzbekistan's irrigation advancements could provide valuable insights into Kyrgyz agricultural policies. Furthermore, understanding how these countries address regional trade barriers and integrate global market access could inform Kyrgyzstan's strategy to reduce its dependency on food imports.

6. NEW SCIENTIFIC RESULTS

This section presents new scientific findings from the study, offering a comprehensive understanding of how economic, political, and environmental factors influence food security in Kyrgyzstan. By examining key variables such as GDP per capita, inflation, income inequality, political stability, corruption control, and climatic conditions, the analysis provides empirical insights into food consumption patterns and the prevalence of undernourishment in Kyrgyzstan.

While the broader ideas behind some of the hypotheses might be considered "common knowledge" in general terms, the application provided for Kyrgyzstan gives them a degree of novelty/new contribution, particularly for local studies and further international cooperation.

Based on the analysis and findings detailed in the thesis, the following can be considered the key novel scientific results:

1. The thesis uncovers a dual role of GDP per capita in influencing food security. While we can say that economic growth generally improves access to diverse and nutritious foods, the benefits are not evenly distributed. Policies must prioritize low-income groups to ensure their inclusion in economic progress.
2. The findings demonstrate that income inequality significantly impacts access to protein-rich foods, which underscores the need for targeted food assistance programs. This suggests that economic disparity directly affects the dietary choices and nutritional outcomes of vulnerable populations.
3. Governance quality, especially corruption control, is a critical factor influencing food consumption patterns and overall food security. The thesis highlights the importance of transparency and governance reforms to improve accessibility to nutritious foods.
4. The thesis establishes the significant impact of environmental variables on agricultural productivity and dietary patterns. For example, higher average temperatures were linked to increased vegetable consumption, while excessive rainfall negatively impacted the consumption of protein-rich foods like meat and eggs.
5. The thesis develops a conceptual approach addressing the dimensions of food security. This framework is tailored to Kyrgyzstan's unique socio-economic and climatic conditions and provides actionable feasible policy insights.

7. SUMMARY

This study comprehensively examines the critical factors influencing food security in Kyrgyzstan, focusing on economic, political, and environmental determinants. By analyzing these interconnected factors, the research provides valuable insights into the challenges affecting food availability, accessibility, and stability while proposing actionable policy recommendations to address these issues. The findings underscore the complexity of food security in Kyrgyzstan, shaped by structural, institutional, and environmental dynamics.

Economic factors play a pivotal role in food security. GDP per capita positively impacts food accessibility and dietary diversity, enabling households to afford a wider range of nutritious foods, including vegetables, fruits, meat, and eggs. However, the benefits of economic growth are unevenly distributed. Income inequality restricts lower-income households' access to protein-rich and diverse diets, emphasizing the need for targeted food assistance programs and policies to address economic disparities. Inflation exacerbates food insecurity by driving up food prices, reducing real incomes, and forcing households to compromise on nutritional quality. Addressing poverty, income inequality, and inflation is essential to ensuring broader access to affordable, nutritious food.

Political governance plays a nuanced role in food security. While political stability enhances policy implementation and improves food distribution efficiency, it does not significantly affect the consumption of most food categories. Governance quality, particularly in controlling corruption, emerges as a critical factor. Although corruption control positively influences the consumption of certain foods, such as fruits and eggs, its impact on overall food security and undernourishment remains limited. These findings highlight the importance of transparency and governance reforms to direct resources effectively toward agricultural and nutrition programs.

Environmental factors, such as temperature fluctuations and precipitation patterns, significantly impact agricultural productivity and dietary patterns. Rising temperatures are linked to increased vegetable consumption, reflecting certain crops' adaptability to warmer conditions. However, excessive rainfall negatively affects the production and consumption of protein-rich foods like meat and eggs, demonstrating the vulnerability of agriculture to unpredictable weather patterns. The number of dry days also influences food choices, such as increased oil consumption during water-scarce periods. These findings underscore the need for climate-resilient agricultural practices and infrastructure to mitigate environmental challenges and their effects on food security.

Structural challenges further complicate Kyrgyzstan's food security. Small-scale agricultural production limits efficiency and competitiveness, while reliance on food imports increases vulnerability to global market fluctuations and price volatility. Key staples, such as wheat and vegetable oil, are predominantly

imported, leaving the domestic market sensitive to external shocks. The lack of sufficient food processing and storage infrastructure results in post-harvest losses and reduces overall food availability. Additionally, outdated food safety regulations and insufficient laboratory capacities hinder the production and distribution of high-quality, safe food products, posing public health risks and limiting market access for local producers.

To address these multifaceted challenges, the study proposes several policy recommendations. Expanding irrigation systems and promoting climate-smart agricultural practices, such as agroforestry, crop rotation, and drought-resistant crops, can enhance productivity and sustainability. Providing financial incentives, including concessional loans and subsidies, can enable farmers to adopt modern agricultural technologies, improving their productivity and income. Strengthening food processing and storage infrastructure through investments in cold storage facilities and processing plants can reduce post-harvest losses and ensure the year-round availability of seasonal food products, improving physical and economic accessibility.

Economic policies should focus on reducing income inequality and improving food affordability. Targeted social protection programs, such as food assistance and cash transfer schemes, can alleviate the impact of economic disparities on vulnerable populations. Regulating food prices through buffer stock policies and strategic reserves can stabilize markets and protect consumers from price spikes. Promoting agricultural cooperatives can help small-scale farmers access markets, financing, and modern farming techniques, enhancing their competitiveness and income levels.

Coordinated efforts are essential to address Kyrgyzstan's food security challenges. Government intervention is crucial in developing and implementing unified policies that integrate economic, political, and environmental strategies. Encouraging private sector participation, fostering public-private partnerships, and supporting community-driven initiatives can amplify the impact of these efforts. Regional cooperation with neighboring Central Asian countries can provide opportunities for knowledge sharing, joint ventures, and coordinated responses to common challenges.

In conclusion, Kyrgyzstan's food security is shaped by the interplay of economic growth, political governance, and environmental sustainability. Addressing these challenges requires a holistic approach that integrates targeted policies, agricultural innovation, and institutional reforms. By fostering collaboration among government institutions, private enterprises, and international organizations, Kyrgyzstan can build a resilient food system that ensures stable, affordable, and nutritious food for its population. This study lays the foundation for future research and policy development, contributing to sustainable food security in Kyrgyzstan.

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