HUNGARIAN UNIVERSITY OF AGRICULTURE AND LIFE SCIENCES

Hungarian University of Agriculture and Life Sciences

Key Driving Forces of Food Security in Kyrgyzstan

DOI: 10.54598/006550

Doctoral (Ph.D.) dissertation

by

Stalbek Bopushev

Gödöllő, Hungary

2025

Hungarian University of Agriculture and Life Sciences

Name of Doctoral School: Doctoral School of Economic and Regional Sciences

Discipline: Economic and Regional Sciences

Head of Doctoral School: Prof. Dr. Bujdosó, Zoltán, Ph.D.
Economic and Regional Sciences, MATE, Hungary

Supervisors: Professor Emeritus Dr. Fehér, István, Ph.D.
Institute of Agricultural and Food Economics, MATE, Hungary

Prof. Dr. Bozsik, Norbert, Ph.D.
Economic and Regional Sciences, MATE, Hungary
Institute of Agricultural and Food Economics, MATE, Hungary

.....	.....
Approval of the Head of Doctoral School	**Approval of the Supervisor(s)**

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ADB	Asian Development Bank
CBD KR	Centralized Database of Legal Information of the Kyrgyz Republic
CFS	Committee on World Food Security
CPE	Centrally Planned Economy
EAEU	Eurasian Economic Union
FAO	Food and Agriculture Organization
FSN	Food Security and Nutrition
GDP	Gross Domestic Product
Global GAP	Global Good Agricultural Practices
GMO	A genetically modified organism
HACCP	Hazard Analysis and Critical Control Points
IFPRI	International Food Policy Research Institute
ISO	International Organization for Standardization
KGS	Kyrgyz Som (national currency)
LLC	Limited Liability Company
NSC KR	National Statistical Committee of the Kyrgyz Republic
PoU	Prevalence of Undernourishment
UNICEF	United Nations International Children's Emergency Fund
USD	US Dollars
VAT	A value-added tax
WB	World Bank
WB CCKP	World Bank Climate Change Knowledge Portal
WFP	World Food Program
WHO	World Health Organization

1. INTRODUCTION

1.1 Background

Food security is a critical issue being discussed and researched by policymakers and researchers worldwide. As a main factor of economic and social stability, food security is becoming one of the most significant global challenges of the 21st century (WFP, 2021). Its importance is underscored by the prevalence of malnutrition, lack of food, problems in the agricultural sector, and the consequences of climate change (IFPRI, 2019). Global initiatives such as the United Nations' Sustainable Development Goals (SDG 2: Zero Hunger) underscore the urgency of addressing food insecurity (UN, 2015). Despite concerted efforts by international organizations, such as the Food and Agriculture Organization (FAO), the World Food Programme (WFP), and the International Food Policy Research Institute (IFPRI), achieving comprehensive food security remains a challenge for many developing nations (FAO, 2023b; IFPRI, 2019; WFP, 2021).

Food security encompasses four key dimensions: availability, access, utilization, and stability (FAO, 2006). Globally, each of these dimensions faces unique challenges. Climate change has emerged as a predominant factor, causing unpredictable weather patterns, extreme events, and disruptions in agricultural production (IPCC, 2022). Additionally, the COVID-19 pandemic highlighted the fragility of global supply chains, with millions of people pushed into hunger due to lockdowns, unemployment, and restricted trade (FAO, 2023b). Geographical conflicts further exacerbate food insecurity, as seen in recent disruptions in grain supplies caused by conflicts in major agricultural-exporting regions (WFP, 2021).

Economic factors, such as inflation and fluctuating food prices, disproportionately impact low-income households (World Bank, 2024a). These households typically spend a significant portion of their income on food, leaving them vulnerable to economic shocks. According to the FAO (2023b), global food prices increased sharply in the past decade, and volatility in commodity markets continues to pose risks to food accessibility in developing countries like Kyrgyzstan.

Kyrgyzstan, a landlocked, mountainous country in Central Asia, has long grappled with food security challenges. Its transition from a centrally planned economy to a market economy in the 1990s marked a significant shift in its agricultural and food systems (World Bank, 2001). This transition brought economic liberalization but also led to a decline in state support for agriculture, such as subsidies,

infrastructure development, and access to modern farming techniques (ADB, 2014). Consequently, agricultural productivity dropped, and rural communities, heavily reliant on farming, faced increased vulnerabilities (World Bank, 2024a).

Between 1990 and 1995, Kyrgyzstan experienced a dramatic 40% reduction in GDP, with adverse effects on food production and distribution (World Bank, 2001). The decline in agricultural productivity further strained food availability. Additionally, privatization and land reforms, while intended to enhance efficiency, often resulted in fragmented landholdings, limiting economies of scale and investment in modern technologies (ADB, 2014). Even decades later, the agricultural sector in Kyrgyzstan remains underdeveloped, characterized by low yields, limited mechanization, and insufficient access to fertilizers and high-quality seeds (FAO, 2023a).

A striking feature of Kyrgyzstan's food security landscape is the disparity between rural and urban areas (NSC KR, 2023b). Rural regions, which house 63% of the population, are more vulnerable to food insecurity due to limited access to markets, infrastructure, and social services (Serova & Yanbykh, 2023). High poverty rates in rural areas exacerbate malnutrition and limit the ability of households to withstand economic shocks (NSC KR, 2023c).

While urban centers like Bishkek have better access to markets and imported goods, this reliance on imports creates a different set of vulnerabilities. According to the National Statistical Committee of the Kyrgyz Republic (NSC KR), over 15% of the country's food supply is imported (NSC KR, 2023b). This dependency on imports, especially for staple foods like wheat and oil, exposes Kyrgyzstan to global market fluctuations and geographical pressures. Moreover, rural communities are often more affected by these price hikes, as they lack the purchasing power of their urban counterparts (World Bank, 2024a).

Kyrgyzstan's geography presents a unique set of challenges and opportunities for food security. With over 90% of its territory covered by mountains, agricultural activities are largely constrained to the fertile valleys and lower-altitude regions (ADB, 2014). This topographical limitation makes the country heavily reliant on small-scale farming and pastoralism, which are highly sensitive to environmental changes.

Climate change has compounded these vulnerabilities, leading to more frequent and severe weather events such as droughts, floods, and extreme winters (IPCC, 2022). For instance, in 2012, a harsh winter severely affected livestock, a primary livelihood source for rural families (Conti et al., 2018).

Such events not only reduce agricultural productivity but also increase the economic burden on farming households, pushing them into deeper cycles of poverty and food insecurity (WFP, 2023b).

Water resources, while abundant due to glacial melt and high-altitude rivers, are unevenly distributed (ADB, 2014). Irrigation infrastructure is often outdated, leading to inefficient water use and limiting agricultural potential. Furthermore, cross-border water-sharing issues with neighboring countries add a layer of complexity to managing these resources effectively (World Bank, 2021).

Malnutrition remains a pressing concern in Kyrgyzstan, reflecting both undernutrition and overnutrition challenges (WFP, 2023a). According to the WFP, stunted growth in children under five has been a persistent issue in rural areas. Poor dietary diversity and limited access to micronutrient-rich foods contribute to essential vitamin and mineral deficiencies. At the same time, urban areas are witnessing a rise in overweight and obesity rates, driven by the consumption of inexpensive energy-dense foods high in fat and salt (NSC KR, 2023d).

International organizations have played a pivotal role in addressing Kyrgyzstan's food security challenges. Since joining the WFP in 2011, Kyrgyzstan has received significant support in improving food distribution systems, developing nutrition programs, and building resilience to climate-related shocks (WFP, 2023a). UNICEF has also worked to combat malnutrition through initiatives like salt iodization and flour fortification (FAO et al., 2024).

Despite these challenges, there have been some positive trends in the food security landscape of Kyrgyzstan. Increased government focus on rural development and agricultural modernization has stabilized food availability to some extent. For example, investment in smallholder farming, efforts to promote local food production, and regional cooperation through the Eurasian Economic Union (EAEU) have provided new opportunities for growth (ADB, 2014). However, the country remains highly vulnerable to external shocks, underscoring the need for integrated strategies that address the economic, environmental, and political dimensions of food security.

1.2 Significance of the Study

The ongoing food insecurity in Kyrgyzstan is not only a humanitarian issue but also a significant barrier to sustainable development and economic stability. Despite its agricultural potential and reform efforts, Kyrgyzstan faces critical challenges in food security due to economic inequalities,

environmental vulnerabilities, and political instabilities. The complexity of food insecurity demands integrated and sustained policy interventions.

Food insecurity in Kyrgyzstan is evident in various forms, including malnutrition, inadequate access to nutritious food, and susceptibility to external shocks. According to the WFP, approximately 33% of the population lives in poverty, with an additional 7% at risk (WFP, 2023a). This highlights the country's struggle to provide consistent and equitable food access across its regions.

Economic factors significantly exacerbate food insecurity. Over 60% of household income in Kyrgyzstan is spent on food, leaving limited funds for essentials like healthcare, education, and savings (WFP, 2023a). High poverty rates, especially in rural areas, restrict households' ability to afford diverse and nutritious diets. Inflation and fluctuating food prices further exacerbate this issue, making it difficult for vulnerable populations to cope with sudden price hikes or economic shocks.

The agricultural sector, which contributes approximately 12% of Kyrgyzstan's GDP and employs about 25% of its workforce (WFP, 2023a), plays a crucial role in the country's food security. However, it remains underdeveloped due to insufficient investment, inadequate infrastructure, and limited access to modern technologies. These structural weaknesses are further exacerbated by climate change, which disrupts agricultural productivity through irregular precipitation, rising temperatures, and extreme weather events. Severe droughts, such as those experienced in 2008, 2012, and 2021, have resulted in crop losses of up to 30% in staples like wheat and barley (WFP, 2023a).

Socio-political factors compound these economic and environmental challenges. The transition to a market economy in the 1990s disrupted agricultural systems, reducing state support for farmers and weakening rural resilience. While entry into the EAEU introduced new trade opportunities, it also exposed domestic farmers to increased competition from imports, limiting their market share (FAO, 2023a). Additionally, political instability and weak policy implementation capacity hinder the effective resolution of food security issues.

This study 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.

1.3 Research Objectives

The primary aim of this study is to examine the interplay 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.

1.4 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 (PoU) and the per capita consumption levels of nine basic food products (potato, vegetable, fruit, meat, milk, sugar, egg, vegetable oil, and bread). While PoU captures caloric adequacy and long-term trends in nutritional deprivation, the consumption of basic food products reflects the population's dietary access, diversity, and affordability, which are the basic dimensions of food security. These nine key food products are consistent with the Law on Food Security of the Kyrgyz Republic (CBD KR, 2023).

The following research questions will guide the study:

- 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?

1.5 Hypotheses

Understanding food security in Kyrgyzstan involves analyzing how economic, environmental, and political factors affect both caloric adequacy (PoU) and dietary diversity (food consumption). 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 consumption 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 security is stronger when corruption is better controlled.

2. LITERATURE REVIEW

2.1 Overview of Food Security Concepts

Ensuring food security has been a fundamental concern throughout human history. As noted by the renowned American scientist Abraham Maslow in his "Hierarchy of Needs Theory," the physiological need to satisfy hunger and thirst forms the foundation of human existence. According to Maslow, meeting these primary needs is essential for individuals to focus on higher-level aspirations (Maslow, 1943). Consequently, food security is not only vital for individual well-being but also a cornerstone of societal stability.

Historically, scholars have recognized the critical importance of food production to food security. Aristotle emphasized the role of specialized agricultural labor in ensuring a reliable food supply, a principle echoed by 18th-century physiocrats who highlighted land and nature as primary sources of wealth (Serrano & Mazat, 2013). They argued that agricultural productivity underpins economic and political stability, identifying wealth as the goods necessary for human life and their annual reproduction.

Thomas Malthus advanced the discourse by systematically addressing the challenges of food security. His theory of diminishing returns to land posited that population growth could outstrip the means of subsistence, sparking debates that persist today. Contemporary neo-Malthusians argue that high birth rates in less developed countries, coupled with low mortality rates facilitated by external medical aid, exacerbate food insecurity. They advocate for prioritizing population control measures alongside other forms of assistance (Ehrlich, 1968).

Despite the historical and contemporary significance of food security, no universally accepted definition exists within economic science. Instead, interpretations vary based on differing priorities and contexts. Aristotle's early focus on food supply emphasized the essential role of agricultural labor, while Malthus introduced the interdependence between population growth and subsistence resources (Malthus, 1868).

Over time, this conceptual framework has been refined by researchers. For example, in 1990, Conway and Barber defined food security as ensuring all individuals have access to sufficient food for an active and healthy life (Conway & Barbier, 2013). Similarly, Russian researchers like Y. Khromov and E. Serova emphasized both food availability and accessibility. Khromov focused on the complete

provisioning of food, while Serova highlighted the accessibility of food sufficient to maintain a normal standard of living (Khromov, 1996; Serova, 1999). Kazakh scholars, including Zhanbekova, Burdukov, and Saetgaliev, have adopted similar perspectives, linking food security to the ability to meet citizens' food needs in line with physiological norms and ensuring a stable food supply (Burdukov & Saetgaliev, 1999; Zhanbekova, 2003).

Building on earlier foundations, subsequent research has broadened the concept of food security by introducing new criteria. One prominent area of discussion revolves around the source of food supply – whether it should depend primarily on domestic production or include imports (Porkka et al., 2017). This debate gained significance as some developed countries, benefiting from their economic strength and specialization in international production, began prioritizing food imports funded by high revenues from other economic sectors (Smith & Glauber, 2020). As a result, the definition of food security expanded to distinguish between self-sufficiency – reliance on domestic production – and import dependence (Clapp, 2017). However, recent crises like the war in Ukraine and COVID-19 have exposed the fragility of global food systems, renewing interest in domestic resilience, food self-sufficiency, and regional supply chains (Ben Hassen & El Bilali, 2022; Laborde et al., 2022).

In recent years, ensuring universal access to adequate nutrition, regardless of geographic location, has become one of humanity's most critical challenges. Consequently, new dimensions of food security have emerged, including economic, physical, and social accessibility. These dimensions provide a comprehensive perspective on food availability, highlighting its multifaceted nature (CFS, 2012).

The Green Revolution marked a significant turning point in global food production, driving a substantial increase in agricultural output (Otsuka & Sugihara, 2022). However, it became evident that food shortages and malnutrition were less about declines in food production and more about disparities in purchasing power among vulnerable population groups. This realization led to an expanded understanding of food security, incorporating not only physical but also economic access to food. In 1983, the Committee on World Food Security (CFS) formally recognized this broader perspective, defining food security as a condition where "all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs" (CFS, 2012).

- Physical availability: Physical availability ensures that food is available across all regions of a country at any time, in sufficient quantity and variety. This dimension addresses geographic disparities in food availability, ensuring that even remote areas have reliable access to food products (WFP, 2009).

- Economic accessibility: This dimension emphasizes the necessity for individuals to have sufficient income to purchase the food they need. Even if a country produces or imports adequate food to meet national requirements, certain population segments may face food insecurity due to insufficient income.
- Social accessibility: Social accessibility refers to equitable access to food for all populations, regardless of their cultural or religious backgrounds. This concept was integrated into the FAO's definition of food security and affirmed in the Declaration of the World Summit on Food Security in 2009 (CFS, 2012).

Another crucial dimension of food security is food safety. While efforts to increase agricultural productivity and profitability have successfully expanded food availability, they have sometimes compromised food quality. The emphasis on maximizing yields has raised significant concerns about the health risks associated with modern food production practices. Changes in food consumption trends, agricultural techniques, and increasingly globalized supply chains have further exacerbated the issue, enabling the spread of foodborne pathogens across borders. Contaminated food-carrying diseases such as Salmonella, Listeria, and Vibrio cholerae have emerged as a major public health threat, presenting substantial challenges to food safety worldwide (Beke & Fehér, 2018).

The concept of food safety gained traction in the mid-1990s, largely due to the initiatives led by UNICEF and the World Health Organization (WHO). These efforts highlighted the importance of food consumption at both household and individual levels, stressing the need for balanced nutrition that includes adequate proteins, calories, vitamins, and minerals for all members of a household at all times (CFS, 2014). The World Food Summit of 1996 further broadened the understanding of food security, defining it as a condition where "all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life." This comprehensive perspective laid the foundation for identifying four key dimensions of food security: availability, access, utilization, and stability (CFS, 2009).

In the 2000s, the combination of the concepts of "food security" and "food safety" resulted in a new, integrated framework known as Food Security and Nutrition (FSN). Although food security and food safety pursue interconnected goals, they approach the issue from different angles: food security focuses on availability and access, while food safety emphasizes quality and health outcomes. The FSN framework, which has been central to international policy discussions and institutional reports by organizations such as the Committee on World Food Security (CFS) and the Food and Agriculture

Organization (FAO) since 2009, underscores the need for coordinated action at multiple levels—global, national, and household or individual (CFS, 2009).

Food security can be effectively analyzed across three hierarchical levels: the global (international), national (domestic), and household or individual levels (Maxwell, 1996). Each level presents distinct challenges and requires targeted strategies to ensure food security for all populations (Figure 1).

- Global Level (International): Focuses on international cooperation, trade policies, and global efforts to address food shortages and distribution disparities.
- National Level (Domestic): Involves policies and actions to ensure a stable food supply and equitable distribution within a country.
- Household or Individual Level: Examines the ability of households and individuals to access and utilize sufficient, nutritious food based on their unique circumstances.

Each hierarchical level of food security requires distinct criteria tailored to its unique challenges and objectives. The problems and priorities at each level differ fundamentally, necessitating customized approaches to effectively address food security.

At the global or international level, the primary objective is to ensure the production of sufficient food to meet the nutritional needs of the planet's entire population. This includes not only maintaining an adequate level of food production but also establishing robust reserve stocks to sustain the global population during natural disasters, pandemics, or other catastrophic events. Such reserves are critical for mitigating crises and preventing large-scale food shortages.

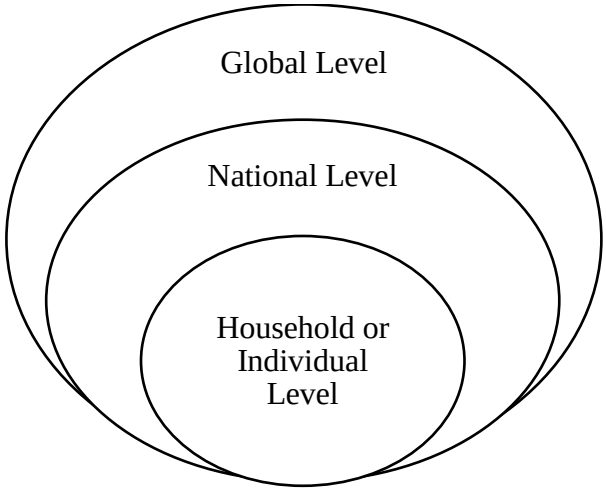

Figure 1. Hierarchy of food security levels

Source: Author's illustration

At the national level, key criteria for food security include ensuring an adequate food supply for the population, maintaining emergency insurance stockpiles, and making food economically affordable for all citizens. Policymakers must focus on stabilizing national food production, improving agricultural infrastructure, and implementing effective food distribution systems to achieve these goals.

At the household or individual level, the emphasis shifts to physical and economic access to food, as well as ensuring the quality and safety of the food consumed. Food safety, in particular, serves as a cornerstone of food security at this level, directly influencing public health and well-being. It is also intricately linked to income levels, as households with limited financial resources often struggle to access nutritious and safe food.

To assess a country's food security, several factors must be considered, including historical, cultural, national, and religious traditions, the nutritional status of the population, prevalent diseases, migration trends, climatic conditions, economic potential, and the level of scientific and technological development.

Despite these national distinctions, the FAO has developed universal indicators that account for variations in food security levels and shortages among countries. These indicators form the basis for the annual report, "The State of Food Security and Nutrition in the World," by the CFS. Key global assessment indicators include:

- The volume of global grain reserves, expressed as the ratio of world grain reserves to global consumption.
- The ratio of supply from exporting countries to total global grain demand.
- Average annual export prices for different types of grain.
- Grain reserves in exporting countries as a percentage of domestic consumption, categorized by type and purpose of use.
- Trends in global grain production dynamics, tracking changes over time.
- Changes in grain production trends within grain-importing countries.

For less-developed countries, the FAO proposes additional specific measures to better capture their unique challenges:

- Net per capita income, calculated using the World Bank's Atlas method, to assess individuals' economic capacity to access food.

- Food import reliance, measured as the volume of imported foods (in calories across various categories) exceeding exports over a three-year period. This metric focuses on essential food products, including cereals, legumes, oilseeds and oils (excluding wood oils), meat, and dairy products.

In conclusion, the modern understanding of food security should reflect a system of economic and industrial relations that ensures food meets essential criteria such as availability, accessibility, and quality. High-quality nutrition must be guaranteed for each individual, regardless of their income, place of residence, nationality, or race. This holistic perspective highlights the critical role of equitable access to nutritious food in addressing food security challenges globally.

2.2 Background of Food Security in Kyrgyzstan

2.2.1 Historical Context of Food Security in Kyrgyzstan

Situated in Central Asia, Kyrgyzstan is characterized by its mountainous terrain and landlocked status. The country is bordered by China, Kazakhstan, Uzbekistan, and Tajikistan. These geographical features render the country highly susceptible to the adverse effects of climate change, including heightened risks of droughts, landslides, mudslides, floods, and river erosion. Approximately 63% of its population lives in rural areas, and a significant share of the labor force is employed in agriculture (WFP, 2023a).

Figure 2. The map of Kyrgyzstan

Source: United Nations Geospatial, (United Nation, 2025)

Economically, Kyrgyzstan is classified as a lower-middle-income country by the World Bank. As of recent data, its GDP per capita is around 1,300 USD, with agriculture contributing 12% of GDP (WFP, 2023a). While this marks a decline from the sector's peak contribution of over 40% in the 1990s, agriculture remains a crucial pillar of the economy, especially in terms of employment and food security. Inflation has historically been volatile, and income inequality continues to influence food access and rural development.

Politically, Kyrgyzstan has undergone multiple constitutional reforms and leadership changes since its independence in 1991 (Ivanov, 2022). Issues of corruption and political instability have periodically disrupted economic and institutional development. The World Bank's Worldwide Governance Indicators reflect relatively low scores for control of corruption and political stability, both of which affect agricultural policy effectiveness (World Bank, 2024b).

Agriculture continues to serve as a primary source of employment, food supply, and income for rural households. It also underpins related sectors such as food processing, textiles, and light industry. As such, the development of agriculture is directly linked to national food security, economic growth, and poverty reduction.

During the Soviet period, Kyrgyzstan's food security was maintained through a centralized economic planning system, ensuring consistent physical and economic access to food for the population. However, the collapse of the Soviet Union marked a turning point, as the dismantling of the collective agricultural structure and the transition to a market economy introduced systematic challenges (Spoor, 1999). These reforms disrupted established food production and distribution mechanisms, significantly affecting food security across the nation.

To fully understand the factors behind the fluctuations in food security within Kyrgyzstan's agricultural economy, it is essential to examine the historical trajectory of its development. According to Musaeva (2008), the evolution of the agrarian economy of Kyrgyzstan can be divided into three distinct periods.

The three periods of development of Kyrgyzstan's agrarian economy:

1. *The destruction of the old economic system and the formation of a new economic mechanism (Mid-1990s – 1994)*. This period marked the dismantling of the centralized, collective farming system and the initial steps toward private ownership. In 1991, efforts began to transition land ownership from collective to private hands. Approximately 5% of arable land was distributed

to 2000 individual farmers (Delehanty & Rasmussen, 1995; Mogilevskii et al., 2017). Despite these efforts, the process of land distribution and ownership was marked by significant regulatory ambiguity.

In 1992, collective farms were reorganized into joint-stock companies, agricultural cooperatives, and farmers' associations. However, these structural reforms were only partially successful, as a majority of the rural population continued to operate within socialist-style collective farming organizations. By the end of 1994, about 20 thousand small farms had been formed, but only 12 % of the land was cultivated by individual farmers due to unclear land ownership policies (Spoor, 1999).

2. *The formation of market mechanisms (1994 – 2000s).* This period saw the gradual emergence of new business entities and the establishment of market-oriented management mechanisms. The government prioritized key areas for agricultural reform, including:
    - The development of agricultural cooperatives, peasant farms, and agribusiness enterprises;
    - Improvements in water and pasture management; and
    - The social development of rural areas.

    These initiatives sought to create a foundation for a more market-driven agricultural sector. However, the transition was slow, and the rural economy faced persistent challenges, particularly in adapting to competitive market conditions (Swinnen et al., 2011).

3. *The onset of sustainable economic growth and development (2000s onwards).* During this period, Kyrgyzstan began to experience gradual economic stabilization. However, food security remained a pressing issue due to the residual effects of earlier reforms and the loss of agricultural productivity.

The destruction of the centrally planned economy in Kyrgyzstan had profound and far-reaching consequences, leading to a sharp decline in food security. During the initial transition period, a large portion of the population faced hunger and extreme economic hardship (Delehanty & Rasmussen, 1995; Otunchieva et al., 2021; Spoor, 1999; Swinnen et al., 2011). The collapse of the Soviet system left Kyrgyzstan without a clear direction, forcing the country to devise its own development goals and strategies.

The transition from a planned economy to a market economy led to a sharp reduction in subsidies in the mid-90s in the country's overall economy, and in the agriculture sector particularly. In 1990 and

1995, the GDP crashed by 40 percent, from USD 2.67 billion in 1990 to USD 1.66 billion in 1995 (World Bank, 2001). This trend was followed by a further decline till 2000, such a situation had severe implications for food security in Kyrgyzstan. Scholars identified key challenges during the transition period, focusing on political dynamics, economic pressures, and systematic structural changes, while offering directions for future research.

Governance issues and ineffective policies have been central to the challenges facing Kyrgyzstan's agricultural sector. Oruzbaev (2000) attributes the decline in agricultural production to poorly implemented agrarian reforms heavily influenced by foreign specialists. According to Oruzbaev, this external influence led to strategies that were misaligned with local needs and contexts (Oruzbaev, 2000). While this highlights the risks of over-reliance on external expertise, it lacks an exploration of how local stakeholders could have been more effectively integrated into the reform process. Abdymalikov (2007) expands on governance-related challenges by emphasizing systemic corruption, bribery, and irresponsibility within government institutions. These factors, he argues, have obstructed progress in the agricultural sector, highlighting the need for robust governance reforms to ensure accountability and effective implementation(Abdymalikov, 2007). While Abdymalikov's analysis is comprehensive, it would benefit from a quantified assessment of corruption's impact on agricultural productivity. Similarly, Djailov (2010) critiques Kyrgyzstan's agricultural policies as ill-conceived and responsible for the sector's instability. He points to governance failures and the lack of developed marketing systems, which have contributed to weakened food security. Djailov's assessment underscores the need for a complete reevaluation of policy frameworks, yet it does not delve deeply into how political instability or shifting government priorities have influenced policy outcomes. Addressing these dynamics would provide a more nuanced understanding of governance challenges.

Economic challenges have compounded governance issues, creating a difficult environment for agricultural production and food security. Abdymalikov (2007) identifies inflation, resource shortages, low wages, and inadequate market structures as significant impediments to agricultural productivity. These factors, coupled with systemic governance failures, create a multi-faceted barrier to progress. Koichuev (2007) highlights the disconnection between agricultural production and related industries, particularly the light and food sectors. The decline in livestock and agricultural raw materials has disrupted the supply chain, weakening the overall efficiency of the sector. Koichuev's analysis effectively identifies these structural issues but would benefit from exploring their origins and how policy or economic interventions might mitigate them. Musaeva (2008) offers a critical perspective on the shift from state-controlled farms to family-owned peasant farms. She notes that

this transition has resulted in a regression from mechanized to manual agricultural production, significantly impacting productivity and efficiency. Furthermore, Musaeva points to unstable pricing, lack of knowledge about market mechanisms, and insufficient foreign trade practices as key challenges. Atabekov & Zulpukarova (2013) focus on negative economic trends, particularly the declining prices of agricultural products compared with rising costs for agricultural machinery. These pressures, they argue, have constrained farmers' abilities to sustain production and livelihoods. Although this research provides valuable insights into the economic constraints facing rural producers, potential solutions, such as subsidies or investments in affordable agricultural technology, could be considered.

The combination of ineffective reforms, policy missteps, and structural challenges has significantly impacted Kyrgyzstan's agricultural sector and food security. While the government has taken steps to address these issues through legislation and institutional frameworks, many systemic problems remain unsolved. The insights from these scholars underline the need for comprehensive and context-specific solutions to stabilize agricultural production, enhance food security, and improve the livelihoods of rural communities.

However, several gaps remain in the existing literature. First, there is limited consideration of environmental factors, such as climate change, which increasingly impact agricultural production. Second, while many analyses diagnose the challenges, few offer actionable, context-specific solutions. Finally, interdisciplinary approaches that integrate economic, political, and environmental perspectives are largely absent, limiting the comprehensiveness of existing research.

2.2.2 Food Security Strategies in Neighboring Countries During the Post-Soviet Era

The breakdown of the Soviet Union had profound implications for food security across Central Asia, with nations facing a mix of shared challenges and unique responses shaped by their historical, geographic, and socio-political contexts. Further, the study examines how Kyrgyzstan's experiences compare with those of Kazakhstan, Uzbekistan, Tajikistan, and Turkmenistan, highlighting lessons and insights for addressing food security challenges.

Economic factors. The economic upheaval following the Soviet Union's collapse had a profound impact on food security across Central Asia. Kyrgyzstan's economy experienced significant turbulence in the 1990s. GDP per capita (PPP) sharply declined, and inflation skyrocketed to over

1000%, destabilizing food prices and severely affecting household purchasing power (World Bank, 2001). This economic instability widened income inequalities, leaving rural populations particularly vulnerable to food insecurity.

Kazakhstan's experience contrasts sharply with Kyrgyzstan's. Blessed with abundant natural resources, including vast arable land and oil reserves, Kazakhstan implemented policies that supported agricultural modernization and mechanization. For instance, targeted subsidies and investments in agricultural infrastructure, especially grain production, helped stabilize the economy and ensure food security (Petrick & Pomfret, 2016). By the late 1990s, Kazakhstan had become a leading grain exporter in the region. Although inflation initially soared, the country's higher GDP per capita enabled households to better withstand economic shocks (Bobojonov et al., 2015).

However, land reforms in Kazakhstan also created disparities. Wealthier and well-connected farmers benefited disproportionately, while smaller farmers struggled to compete, often excluded from government programs (Bobojonov et al., 2015). This dynamic contrasts sharply with Kyrgyzstan's fragmented privatization, which lacked sufficient regulation and institutional support, leading to inefficiencies and disorganization.

In the case of Uzbekistan, it adopted a cautious approach to economic reform, maintaining state control over key agricultural commodities such as wheat and cotton. This strategy mitigated inflationary pressures and ensured stable food supplies for much of the population (Spoor, 1999). However, this came at the cost of limited market liberalization and inefficiencies within the agricultural sector. Despite these limitations, Uzbekistan's focus on food self-sufficiency helped maintain relatively low levels of undernourishment during the transitional period (Lerman & Sedik, 2009).

The other two countries, Tajikistan and Turkmenistan, by contrast, struggled economically. Tajikistan's GDP per capita plummeted during its civil war (1992-1997), exacerbating food insecurity (Akramov & Shreedhar, 2012). Inflation and unemployment soared, and large portions of the population relied on international food aid (Spoor, 1999). Turkmenistan's authoritarian regime focused on maintaining control over the agricultural sector but prioritized cotton exports over domestic food production, resulting in uneven food distribution and rising rates of undernourishment (Lerman & Sedik, 2018).

Political factors. Governance and political stability played critical roles in shaping food security outcomes across Central Asia. Kyrgyzstan's political environment during the 1990s was marked by frequent leadership changes, weak institutions, and widespread corruption. Control of corruption was particularly poor, with agricultural resources often failing to reach intended beneficiaries (Abdymalikov, 2007). Political instability undermined policy consistency, leaving the agricultural sector disorganized and underfunded. These factors exacerbated food insecurity, particularly in rural areas (Djailov, 2010).

As for Kazakhstan, its political stability under President Nursultan Nazarbayev allowed the government to implement consistent and effective policies. Investments in agricultural infrastructure and a focus on grain production were supported by relatively low levels of corruption (Petrick & Pomfret, 2016). This political environment facilitated efficient resource allocation and better food security outcomes compared to Kyrgyzstan.

At that time, despite stability in Uzbekistan's political system under Islam Karimov, it was characterized by authoritarian rule and high levels of corruption. But despite these governance issues, the centralized control of agriculture ensured the availability of staple foods, albeit at the expense of market efficiency (Spoor, 1999). Political stability allowed Uzbekistan to avoid the severe disruptions experienced by Kyrgyzstan and Tajikistan.

As for Tajikistan, the political instability during the civil war in the country devastated food security. The conflict displaced large portions of the population, disrupted agricultural production, and increased reliance on international food aid (Akramov & Shreedhar, 2012). Turkmenistan, while politically stable, suffered from authoritarian governance that prioritized export crops like cotton over food crops. The lack of accountability and transparency in Turkmenistan's governance further hindered food security improvements (Spoor, 1999).

Environmental factors. Nowadays, approximately five million individuals who reside in Central Asia experience insufficient access to food sources (Peyrouse, 2013). Climate change presents a major risk to food security in Central Asia because of various climate-induced risks affecting agricultural production. These risks include elevated temperatures, changes in precipitation patterns, and shifts in river runoff (Meyers et al., 2012). For instance, Figure 2 illustrates that over the last 33 years, the average surface air temperature in Central Asia has risen by 0.36 - 0.42°C for every ten years (Hu et al., 2014), while the precipitation has risen by 4.63mm per decade (Luo et al., 2019). Additionally, the erosion caused by heavy rainfall events and storms has led to a diminishing supply of suitable

arable land (Christmann et al., 2009). Alterations in the prevalence and severity of pests and diseases further compound these challenges (Meyers et al., 2012). Furthermore, the competition for dwindling water resources among agricultural, industrial, and human consumption sectors causes a critical concern (Hanjra & Qureshi, 2010). As temperatures become more extreme, crops are increasingly vulnerable to reaching sensitivity thresholds, which adversely impact their growth and yield (Lioubimtseva & Henebry, 2012). The dependence of the region on agriculture makes it a key example of how climate change can destroy food systems and economies.

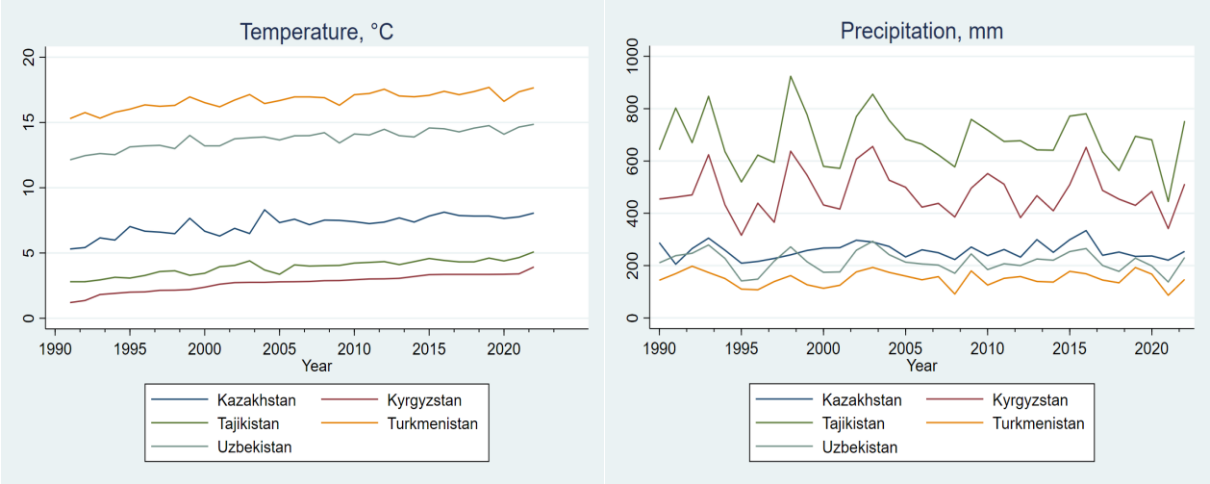

Figure 3. Annual Average Temperature and Precipitation

Source: Author's illustration using data from the WB CCKP

Kyrgyzstan's mountainous terrain and limited arable land have always posed challenges for agriculture. In addition, annual average temperatures in the post-Soviet period showed a slight warming trend, while precipitation patterns became more erratic, leading to reduced agricultural yields. Water resource management, critical for irrigation, was hampered by inadequate infrastructure and governance, further exacerbating food security challenges (ADB, 2014).

As regards Kazakhstan, its vast steppes provide a significant advantage for grain production, but the country also faces environmental challenges such as soil degradation and water scarcity. Effective water management policies and investments in irrigation infrastructure helped mitigate these issues. Despite occasional droughts, Kazakhstan's favorable environmental conditions and effective resource management supported its agricultural success (Bobojonov & Aw-Hassan, 2014).

Three others, Uzbekistan, Turkmenistan, and Tajikistan, face severe water-related challenges due to their reliance on the Amu Darya and Syr Darya rivers. Overuse of these water resources for irrigation

has contributed to the Aral Sea's depletion, causing environmental and health crises (Bobojonov & Aw-Hassan, 2014; Loodin, 2020). These environmental issues directly impact agricultural productivity and food security. Uzbekistan's policies to maintain wheat self-sufficiency mitigated some of these effects, while Turkmenistan's focus on export crops exacerbated food security challenges.

For instance, in Tajikistan, limited arable land and the impacts of climate change, such as increased droughts, further hindered agricultural productivity (Bobojonov & Aw-Hassan, 2014). Kyrgyzstan's environmental challenges, though less severe than those of its southern neighbors, remain significant due to the country's dependence on water-intensive crops and insufficient infrastructure to manage climate variability.

Comparative Food Security Outcomes. Kazakhstan emerges as a relative success story in terms of food security during the post-Soviet period. Its resource wealth, stable governance, and investments in agricultural modernization provided a solid foundation for addressing food security challenges (Petrick & Pomfret, 2016). By contrast, Kyrgyzstan's fragmented reforms, political instability, and environmental challenges left it particularly vulnerable. The prevalence of undernourishment remained higher in Kyrgyzstan compared to Kazakhstan, reflecting the stark differences in their economic and governance contexts (Abdymalikov, 2007; ADB, 2014; FAO, 2019).

Uzbekistan's cautious reform strategy and focus on food self-sufficiency helped maintain relatively stable food security. However, inefficiencies and governance issues limited the effectiveness of these policies (Spoor, 1999). Tajikistan and Turkmenistan faced unique challenges, with Tajikistan's civil war causing widespread food insecurity and Turkmenistan's governance model prioritizing export crops over domestic needs (Akramov & Shreedhar, 2012; Spoor, 1999).

The collapse of the Soviet Union created significant food security challenges for Central Asia, with each country's response shaped by its unique economic, political, and environmental contexts. Kyrgyzstan's struggles underscore the importance of stable governance, targeted economic policies, and effective environmental management in achieving food security. Kazakhstan's relative success highlights the benefits of resource wealth and consistent policy implementation, while Uzbekistan demonstrates the trade-offs of state-controlled agriculture. Tajikistan and Turkmenistan, by contrast, illustrate the detrimental impacts of conflict and authoritarian governance on food security.

2.2.3 Current State of Food Security in Kyrgyzstan

Kyrgyzstan is currently in the third phase of its agricultural development. This phase emphasizes sustainable economic growth and the consolidation of agricultural reforms. Over the past three decades, the country has faced significant challenges in achieving food security due to the socio-economic transformations associated with its transition to a market-oriented economy. The formal recognition of food security as a national priority came with the adoption of the Law on Food Security on August 4, 2008. This law identified food security as an integral component of national security, crucial for ensuring societal stability and long-term development (CBD KR, 2023).

The Law on Food Security established a legal foundation for achieving food security in Kyrgyzstan, setting out goals to ensure the availability, accessibility, and stability of food supplies.

Food security is ensured through the implementation of the following measures (CBD KR, 2023):

- Ensuring the safety and quality of food products and raw materials in compliance with established standards and regulatory requirements.
- Organizing the prompt procurement, delivery, and distribution of essential food supplies, particularly for socially vulnerable groups, in the event of a food crisis or its potential occurrence.
- Approving a list of essential food products, developed by the authorized public health agency.
- Applying state oversight over the production, storage, and distribution of food products across all organizations, regardless of their legal or ownership structure.

Central to this framework is the identification of nine basic food products as benchmarks for assessing the country's food security status. These include bread and bakery products, meat and meat products, vegetables and melons, vegetable oil, potatoes, milk and dairy products, fruits and berries, sugar, and eggs. The selection of these products reflects Kyrgyzstan's cultural and climatic characteristics, as well as the dietary habits of its population (CBD KR, 2009).

To facilitate the implementation of food security policies, the Regulation on the Food Security Council of the Kyrgyz Republic was adopted on October 8, 2007. This regulation established an institutional framework for overseeing food security, emphasizing the importance of coordinated efforts among government bodies, local authorities, and international organizations. The council is tasked with monitoring food availability, managing strategic food reserves, and responding to crises such as natural disasters or market disruptions.

According to the Law on Food Security, Kyrgyzstan's food security is deemed adequate when the country maintains reserves sufficient to meet the 90-day needs of socially vulnerable segments of the population. These groups include individuals whose consumer spending falls below the poverty line, encompassing approximately 22,4 % of the population (NSC KR, 2023d). For example, maintaining sufficient reserves of wheat grain to cover the needs of these groups is a critical government responsibility. The financing of these reserves is supported through state budget allocations and other legal funding mechanisms, forming a crucial safety net for the country's food security system (CBD KR, 2023).

The reserves, managed as part of the national material reserve system, are essential for mitigating the risks associated with food shortages. They play a vital role in stabilizing food prices during crises and ensuring the availability of essential food items for the most vulnerable populations. This mechanism reflects an important aspect of Kyrgyzstan's commitment to addressing food insecurity, although challenges remain in the efficient management and replenishment of these reserves.

The Food Security and Nutrition Program of Kyrgyzstan for 2015 – 2017 introduced new approaches to managing food security (FSN Forum, 2016). The inclusion of the term "nutrition" in the program's title highlights its focus on improving the quality of nutrition and public health, as well as aligning with the internationally recognized concept of food security.

Considering the specific characteristics of the country's agricultural sector, its reliance on external markets, and global best practices, the program is built around four key objectives:

- Ensuring the availability of food within the country.
- Assuring physical and economic access to food.
- Enhancing the quality, diversity, and caloric value of nutrition.
- Strengthening control and oversight over food safety.

Agricultural production in Kyrgyzstan reflects a mix of growth and decline across the key food categories, underscoring the sector's uneven development and its challenges in achieving self-sufficiency. Table 1 highlights recent trends in the production of critical agricultural products during 2022, compared to the average production for the period 2018-2022.

Grain production showed overall growth, with output peaking at 1,867.3 thousand tons in 2022, surpassing the five-year average. Wheat production demonstrated stability, fluctuating around 600 thousand tons annually, but remained below its 2020 peak of 629.1 thousand tons. Barley production

experienced significant variability, with a sharp decline in 2021 to 274.1 thousand tons due to unfavorable conditions but rebounded strongly in 2022 to 539.6 thousand tons (NSC KR, 2023a).

Table 1. Indicators of the dynamics of the production of basic food products in Kyrgyzstan

Agricultural products	Production in 2022, tsnd tons	Average production for the period 2018–2022, tsnd tons	Deviation from average production for the period	Dynamics (growth/decrease in the production trend) for the period 2018–2022
Grain (in weight after refinement)	1867.3	1715.06	±2%	growth
Wheat	592.5	600.58	±2%	growth
Barley	539.6	443.8	±3%	decrease
Sugar beet	468.1	559.32	±28%	growth
Potatoes	1275	1342.34	±7%	growth
Vegetables	1163.6	1123.5	±3%	decrease
Fruits and berries	275.5	268.16	±7%	decrease
Meat (in slaughter weight), thsnd tons	248.3	232.24	±5%	decrease
Raw milk, thousand tons	1734.1	1663.7	±5%	decrease
Eggs, mln pc	607.9	565.72	±6%	decrease

Source: Calculated by the author based on data from the National Statistical Committee of the Kyrgyz Republic (NSC KR, 2023a)

Potato production showed a gradual decline over the period, decreasing from 1,446.6 thousand tons in 2018 to 1,275 thousand tons in 2022 as shown in Table 2. This steady drop highlights challenges in maintaining high productivity levels. Conversely, vegetable production increased steadily, reaching 1,163.6 thousand tons in 2022 (NSC KR, 2023a), indicating a positive trajectory supported by favorable conditions and demand.

Fruits and berries saw moderate growth from 251.4 thousand tons in 2018 to 275.5 thousand tons in 2022. Dairy production, including raw milk and eggs, demonstrated consistent improvement. Milk production increased steadily, reaching 1,734.1 thousand tons in 2022, while egg production rose from 533.2 million pieces in 2018 to 607.9 million pieces in 2022, reflecting increased efficiency in livestock management (NSC KR, 2023a).

Table 2. Production of basic food products in Kyrgyzstan

Agricultural products	2018	2019	2020	2021	2022
Grain (in weight after refinement)	1741.5	1781.4	1856	1329.1	1867.3
Wheat	615.9	601.2	629.1	564.2	592.5
Barley	429.3	465.8	510.2	274.1	539.6
Sugar beet	773	741.1	448.8	365.6	468.1
Potatoes	1446.6	1373.8	1327.2	1289.1	1275
Vegetables	1094.9	1113.6	1131.2	1114.2	1163.6
Fruits and berries	251.4	269.5	278	266.4	275.5
Meat (in slaughter weight). thsnd tons	221.3	226.2	230.4	235	248.3
Raw milk. thousand tons	1589.7	1627.8	1668	1698.9	1734.1
Eggs. mln pc	533.2	561.3	562	564.2	607.9

Source: National Statistical Committee of the Kyrgyz Republic (NSC KR, 2023a)

According to Table 2, meat production, measured in slaughter weight, showed a steady upward trend, growing from 221.3 thousand tons in 2018 to 248.3 thousand tons in 2022 (NSC KR, 2023a). This growth signifies gradual improvements in livestock productivity despite challenges like high feed costs and limited access to modern farming techniques.

While certain categories, such as grain, vegetables, milk, and eggs, show a positive trajectory, others, like potatoes and sugar beet, reflect a declining trend. These mixed results underline the sector's vulnerability to systemic challenges, including fluctuating climatic conditions, limited access to modern technology, and inefficiencies in supply chains. Additionally, the country's reliance on food imports, particularly for staples such as bread and meat, exacerbates its vulnerability to global market fluctuations. Import dependency not only undermines food security but also exposes the population to price shocks and supply disruptions. Addressing these vulnerabilities requires a concerted effort to strengthen domestic production and reduce reliance on imports.

Economic accessibility remains a critical barrier to food security in Kyrgyzstan. High poverty rates, coupled with a significant share of household income spent on food, limit the ability of many families to purchase adequate quantities of nutritious food. In 2018, food expenses accounted for 53% of

household budgets, compared to the 20–30% typical in developed countries (NSC KR, 2023c). This high proportion reflects the economic struggles faced by a large segment of the population and highlights the need for targeted interventions to improve affordability.

Undernourishment is a widespread issue, with nearly half the population consuming fewer than 2,100 kcal per day – a level below the recommended minimum for adequate nutrition (NSC KR, 2023a). According to medical studies, a daily calorie intake below 2,100 kcal can lead to various health problems, including anemia, gastrointestinal diseases, and increased vulnerability to infections such as tuberculosis. The Decree of the Government of the Kyrgyz Republic No. 111 sets the average physiological norm for daily calorie intake at 2,981.17 kcal per person, underscoring the gap between recommended and actual consumption levels (CBD KR, 2010).

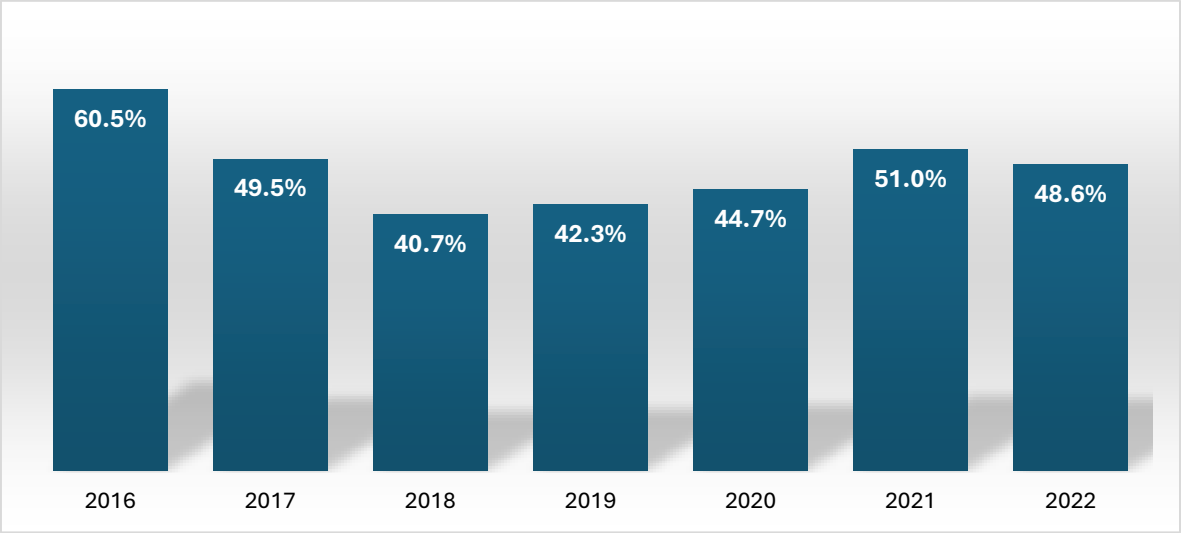

Figure 4. The proportion of the population consuming less than 2100 kcal per day in Kyrgyzstan, %

Source: Women and Men of the Kyrgyz Republic, 2023

The affordability of food is further compounded by rising inflation and stagnant wages. Basic food items such as bread, meat, and dairy products have become increasingly expensive, placing them out of reach for many low-income households. This economic inaccessibility underscores the urgent need for government interventions to stabilize food prices and enhance social safety nets.

It should be noticed that the transition from a centrally planned economy to a market-oriented system disrupted Kyrgyzstan's agricultural sector, leading to systemic inefficiencies and governance challenges. Key issues include the failure of agrarian reforms to effectively transition from collective

to private farming structures, the disconnection between agriculture and food industries, and the lack of knowledge and skills among rural producers in managing market mechanisms (CBD KR, 2023).

In addition to these structural challenges, the agricultural sector suffers from limited government support and inadequate access to modern technology. Small-scale farmers, who make up the majority of agricultural producers, face significant barriers in accessing credit, machinery, and high-quality inputs. These limitations reduce productivity and competitiveness, hindering the sector's ability to meet national food demand.

So, governance issues, including weak institutional frameworks, corruption, and inadequate policy implementation, further exacerbate the challenges facing Kyrgyzstan's food security. Strengthening these frameworks and promoting transparency in resource allocation are critical for improving the effectiveness of food security policies.

As we noticed above, Kyrgyzstan's mountainous terrain and limited arable land pose inherent challenges to agricultural productivity. Climate change has compounded these issues, introducing irregular precipitation patterns, more frequent droughts, and soil degradation. These changes have had a detrimental impact on crop yields and livestock production, increasing the vulnerability of the agricultural sector.

Moreover, water resource management is a particularly pressing issue, as Kyrgyzstan relies heavily on irrigation for agricultural production. Inefficient irrigation systems and poor water management practices have led to significant water losses, reducing the availability of this critical resource. Developing sustainable water management strategies and investing in climate-resilient agricultural practices are essential for mitigating the impacts of climate change and ensuring food security.

To address these challenges, Kyrgyzstan has implemented several initiatives aimed at improving food security. These include policies to increase agricultural production, enhance food storage infrastructure, and expand social safety nets for vulnerable populations. However, significant gaps remain, particularly in addressing economic accessibility and reducing reliance on food imports.

2.3 Consumption of Nine Basic Food Products

In the following discussion, the author briefly analyzes the current state of the nine essential food products, which include bread and bakery products, meat and meat products, vegetables and melons,

vegetable oil, potatoes, milk and dairy products, fruits and berries, sugar, and eggs (CBD KR, 2009). Specifically, the author examines how their consumption differs from production and assesses their accessibility and affordability to better understand the challenges facing Kyrgyzstan's food security.

Bread and bakery products

Bread and bakery products are essential components of Kyrgyzstan's diet. However, the domestic production of wheat often falls short in terms of quality, necessitating significant reliance on imported wheat and wheat flour (Serova & Yanbykh, 2023).

Figure 4 illustrates a fluctuating trend in wheat and wheat flour imports, driven by changes in domestic production, economic conditions, and external market dynamics. Wheat imports surged from 74.34 thousand tons in 2001 to a peak of 449.93 thousand tons in 2014, indicating growing reliance on foreign markets to meet domestic demand. Following this peak, imports declined, reaching a low of 146.96 thousand tons in 2018, before climbing again to 276.70 thousand tons in 2022 (International Trade Center, 2023).

In parallel, wheat flour imports followed a different trajectory. Starting at 2.16 thousand tons in 2001, they grew significantly, reaching a high of 139.30 thousand tons in 2013. However, imports of wheat flour have generally declined in recent years, falling to 30.85 thousand tons in 2022 (International Trade Center, 2023). According to Serova & Yanbykh (2023), the import of flour has decreased due to rising prices in the global market. This was caused by the post-COVID situation and military conflicts around the world.

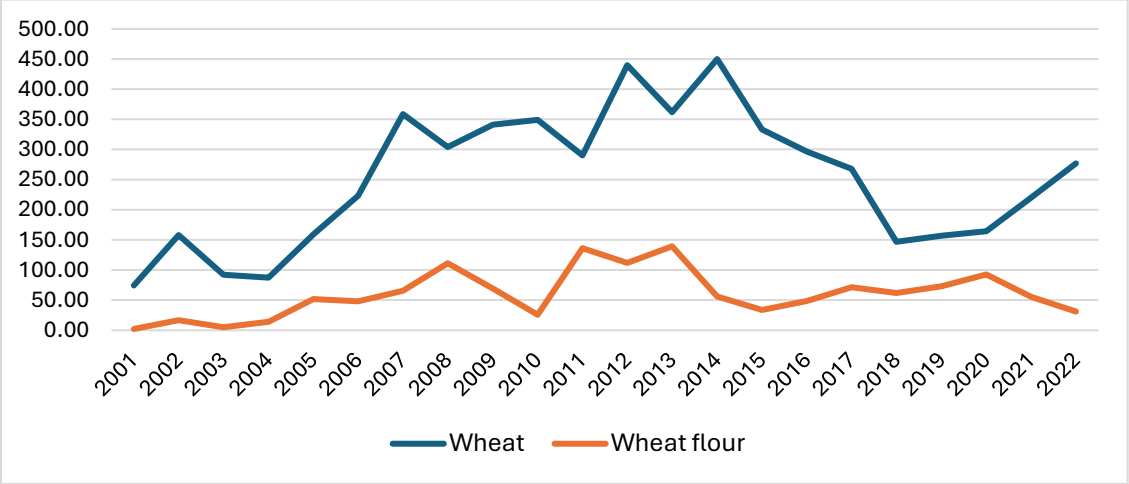

Figure 5. Dynamics of grain imports in Kyrgyzstan, thousand tons

Source: Author's illustration based on data from NSC KR and International Trade Center

To meet its demand for higher-quality wheat, Kyrgyzstan heavily depends on imports, primarily from Kazakhstan, Russia, and the USA (Figure 5). In 2019, Kazakhstan dominated Kyrgyzstan's wheat imports, accounting for 92.2% of the total. By 2022, Kazakhstan's share had decreased significantly to 58.7%, reflecting a diversification of supply sources. During the same period, imports from Russia saw a substantial increase, growing from 3.9% in 2019 to 37.1% in 2022. This growth might be related to the sanctions against Russia by developed countries. Wheat imports from the United States remained relatively stable, rising slightly from 3.8% in 2019 to 4.2% in 2022 (International Trade Center, 2023).

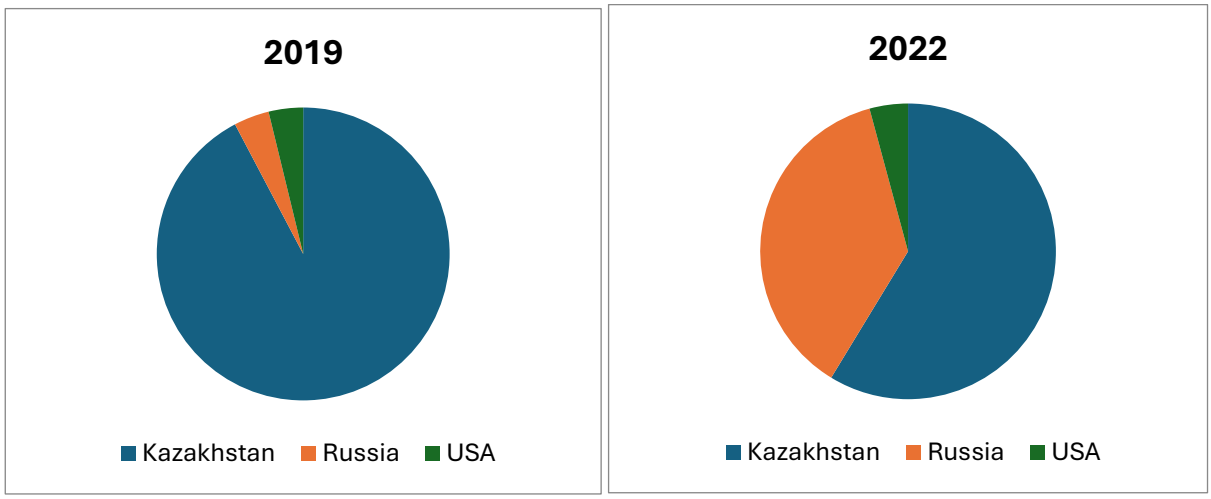

Figure 6. The share of wheat imports by country

Source: International Trade Center database

The reliance on imported wheat exposes Kyrgyzstan to vulnerabilities in global markets. Price volatility and supply chain disruptions have a direct impact on consumer behavior. For example, when international wheat prices rise, many consumers in Kyrgyzstan turn to lower-quality, domestically produced wheat, which is often more affordable but nutritionally inferior.

Moreover, the contrasting trends in wheat and wheat flour imports suggest a shift toward importing raw wheat for domestic processing. While this could indicate improved local milling capabilities, it also underscores the importance of developing robust domestic supply chains to reduce dependence on foreign markets.

Potatoes

The dynamics of potato production and consumption in Kyrgyzstan, as illustrated in Figure 6 and supported by Wengle et al. (2024), reveal significant trends and persistent challenges.

From 1997 to 2001, potato production per capita experienced a noticeable decline, mirroring the broader economic and agricultural disruptions during Kyrgyzstan's transition to a market economy. However, starting in the early 2000s, production began to recover, demonstrating some resilience and adaptation within the agricultural sector. By 2004, potato production per capita peaked at 267.5 kg/y, significantly exceeding the average physiological norm of 98.6 kg/y.

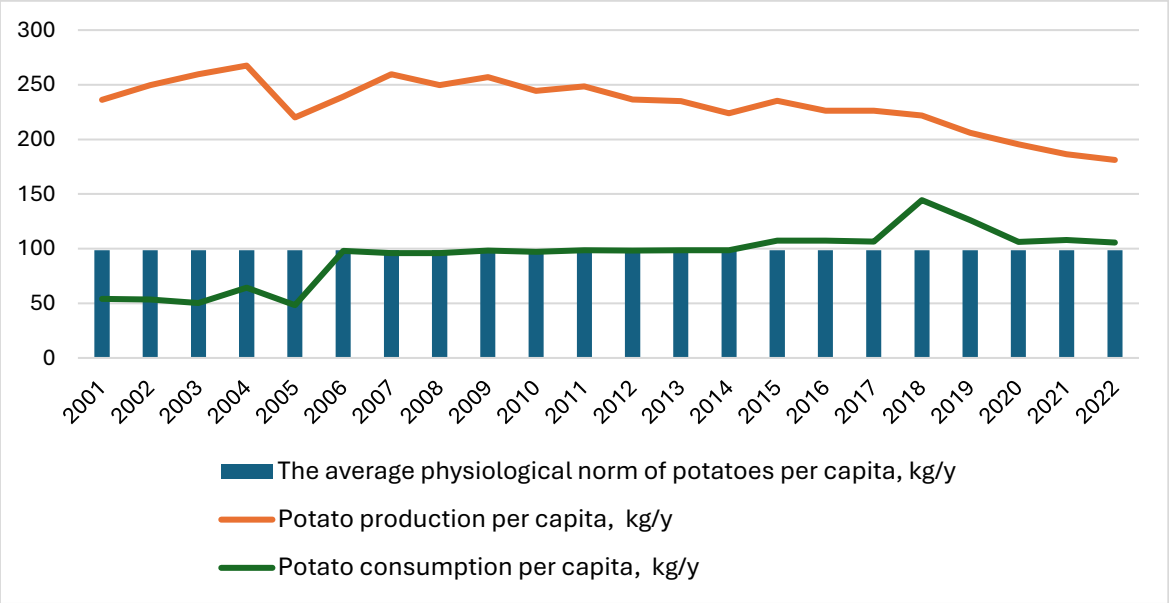

Figure 7. Dynamics of consumption and production of potatoes per capita in Kyrgyzstan

Source: Author's illustration based on data from NSC KR

Despite this recovery, potato consumption remained far below the production levels, with per capita consumption at 54 kg/y in 2001 and fluctuating only slightly in subsequent years. Even as production exceeded consumption, the average consumption consistently fell below the physiological norm necessary for adequate nutrition.

While potato production continued to meet and often surpass the physiological norm throughout the 2000s and early 2010s, consumption trends reveal a persistent gap. For example, in 2015, production was 235.3 kg/y, yet consumption stood at 107.2 kg/y, just above the norm but still much lower than production. By 2022, production had dropped to 181.2 kg/y, while consumption remained at 105.7 kg/y, a slight decline compared to earlier years (NSC KR, 2023a). This disparity between production

and consumption is indicative of structural inefficiencies in the agricultural sector, including low household purchasing power, regional disparities, and post-harvest losses.

Recent years have seen a decline in per capita potato production, particularly from 2019 onward, when production dropped from 206.2 kg/y to 181.2 kg/y in 2022. This trend is partly attributed to reduced agricultural productivity and shifts in land use patterns.

Simultaneously, potato consumption has shown only marginal changes, remaining below both the physiological norm and production levels. According to Wengle et al. (2024), this stagnation in consumption reflects deeper socioeconomic challenges such as insufficient investment in agricultural value chains, economic barriers limiting consumer access to affordable produce, and policy gaps in addressing regional imbalances and market inefficiencies.

From Figure 6, it is noticed that despite Kyrgyzstan's historical success in meeting the physiological norm for potato production, consumption trends highlight significant issues in affordability, accessibility, and distribution.

Vegetables and melons

The production and consumption of vegetables and melons in Kyrgyzstan have demonstrated a positive and consistent growth trend, particularly since 2009. Both of them have not only increased but, in recent years, have surpassed the average physiological norm of 114.3 kg per capita per year, signaling significant progress in the accessibility and availability of these essential food products (Figure 7). This growth is a testament to the increasing role of small-scale agricultural practices, market development, and improved production methods.

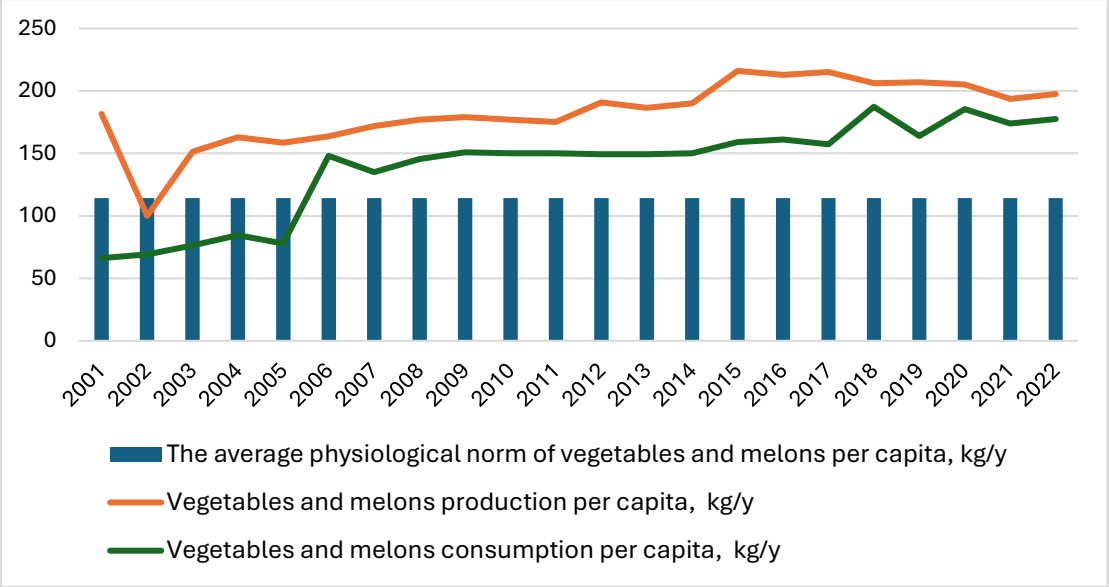

Figure 8. Dynamics of consumption and production of vegetables and melons per capita in Kyrgyzstan

Source: Author's illustration based on data from NSC KR

As can be seen from the table, from 2001 to 2022, the dynamics of vegetable and melon production per capita show a general upward trajectory. In 2001, production was 181.7 kg/y, significantly exceeding the consumption level of 66.2 kg/y, which was far below the physiological norm. By 2022, production had reached 197.5 kg/y, while consumption increased to 177.6 kg/y, showcasing remarkable progress toward meeting dietary requirements (NSC KR, 2024).

Consumption has consistently grown alongside production, particularly since 2015, when both metrics surpassed the average physiological norm. For instance, in 2018, per capita production stood at 206.2 kg/y, and consumption increased dramatically to 187.4 kg/y. By 2022, the gap between production and consumption narrowed further, with consumption reaching its highest recorded level (NSC KR, 2024).

This growth in vegetable and melon production is closely tied to the expansion of family peasant farms. These small-scale farms, predominantly located in rural areas, have been instrumental in increasing production through their adaptability to local climatic conditions and resource availability (Wengle et al., 2024). Many households engage in cultivating vegetables and melons for both subsistence and commercial purposes.

The role of direct sales has also been crucial in this dynamic. Farmers selling their produce directly to consumers through local markets and roadside stalls have minimized the reliance on intermediaries, ensuring better prices for producers and more affordable options for consumers (Vinokurov et al., 2023). These direct transactions have strengthened local economies and improved access to fresh produce for urban and rural populations alike. Vinokurov et al. (2023) highlight the strategic importance of vegetables and melons in the agricultural economy of Kyrgyzstan. The authors note that targeted agricultural policies supporting small-scale farmers have facilitated access to inputs like seeds and fertilizers, contributing to higher yields. In addition, increased production has opened up export opportunities, particularly to neighboring countries, which boosts farmer incomes. Moreover, the adaptability of vegetables and melons to varying climatic conditions has made them a reliable crop even in years of adverse weather.

The steady growth in vegetable and melon production and consumption reflects Kyrgyzstan's progress in addressing food security challenges and improving dietary diversity. However, continued investments in infrastructure, such as cold storage and transportation, along with policies to further promote direct sales and exports, will be essential to sustain this growth and ensure equitable access across the country.

Fruits and berries

The production and consumption of fruits and berries in Kyrgyzstan have consistently fallen short of the average physiological norm of 123.7 kg per capita per year required for adequate nutrition. Over the past two decades, per capita production has averaged around 31 kg per year, while consumption has remained even lower at approximately 26 kg per year. This persistent gap underscores significant barriers to both the physical and economic accessibility of fruits and berries for the majority of the population (Figure 8).

An examination of trends from 2001 to 2022 highlights the following:

- Production peaked at 41.2 kg/y in 2013 – 2014 but has since fluctuated between 38 and 40 kg/y.
- Consumption has generally remained low, with notable dips below 30 kg/y in multiple years. However, 2022 marked a recovery, with consumption reaching 44.6 kg/y, the highest in two decades (NSC KR, 2024).

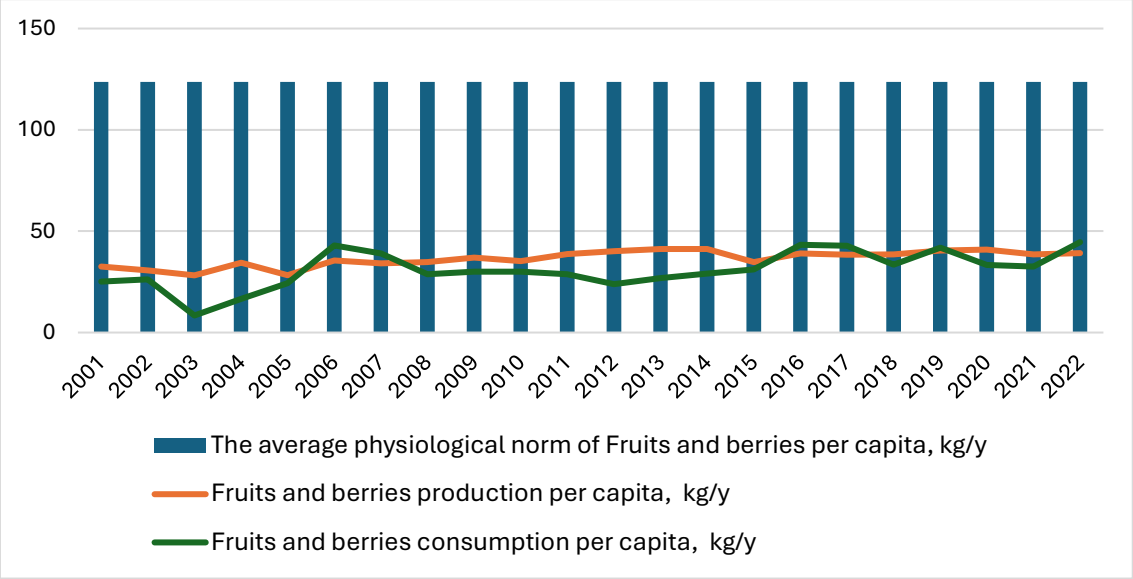

Figure 9. Dynamics of production and consumption of fruits and berries per capita in Kyrgyzstan

Source: Author's illustration based on data from NSC KR

Despite these positive developments in recent years, consumption levels remain far below the physiological norm. High-quality fruits and berries are largely inaccessible to lower-income households due to their relatively high prices, a consequence of limited domestic supply and high import costs.

Interestingly, Kyrgyzstan's export of fruits and berries has grown significantly in recent years, outpacing imports. The country's fertile valleys produce high-quality organic fruits and berries, which are in demand in neighboring markets. For instance, in 2022, 743 tons of fruits were exported to Russia and 212 tons – to Kazakhstan (International Trade Center, 2023). While these exports boost the national economy, they exacerbate domestic shortages, reducing the availability of affordable produce for local consumption.

Vinokurov et al. (2023) emphasize several key points regarding fruits and berries in Kyrgyzstan:

- Policy Gaps: Weak government regulation in managing exports and prioritizing local availability has contributed to the current imbalance.
- Market Access: The rising demand for organic produce from Kyrgyzstan's neighboring countries represents a missed opportunity for leveraging this demand to improve domestic production systems.

- Potential for Growth: Investments in infrastructure, such as cold storage facilities and better transportation networks, could enhance the efficiency of the supply chain, increasing availability for both local and export markets.

Addressing the challenges in fruits and berries production and consumption requires targeted policy interventions to balance export-oriented growth with domestic food security. Initiatives to support small-scale farmers, regulate export levels, and increase domestic production are essential to ensuring equitable access to these vital food products.

Meat and meat products

Meat and meat products are among the least accessible food items in Kyrgyzstan, both economically and physically, despite relatively high levels of domestic production. The paradox of Kyrgyzstan's meat industry lies in the fact that while the country produces high-quality organic meat, much of it is exported to international markets such as Kazakhstan and the UAE, where it fetches higher prices (International Trade Center, 2023). At the same time, local consumers primarily rely on imported meat products, which, although more affordable, are often of lower quality. This duality limits access to nutritious, high-quality protein sources for the domestic population.

A review of meat production and consumption per capita over the past two decades highlights persistent challenges in achieving self-sufficiency. The average physiological norm for meat consumption is 61.3 kg per capita per year, yet actual per capita consumption has historically fallen far below this threshold (CBD KR, 2010). In 2001, production stood at 40.4 kg per capita, while consumption was only 12.8 kg per capita, reflecting severe economic barriers to meat accessibility. Although production has remained relatively stable, averaging 34–35 kg per capita in recent years, consumption has gradually increased, reaching 46.9 kg per capita in 2022 (NSC KR, 2024). However, this figure still remains well below the recommended intake (Figure 9).

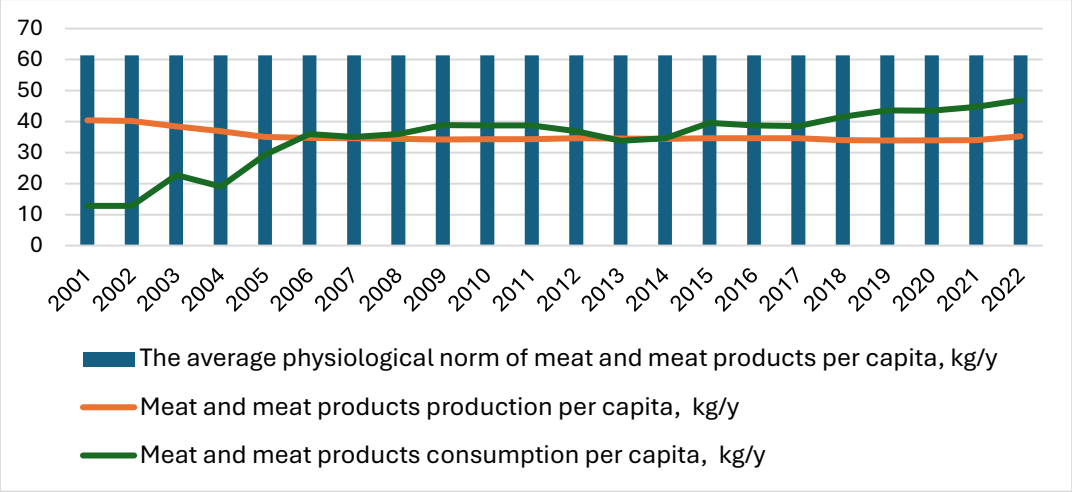

Figure 10. Dynamics of production and consumption of meat and meat products per capita in Kyrgyzstan

Source: Author's illustration based on data from NSC KR

One of the key factors limiting local meat accessibility is the export-oriented strategy of Kyrgyz meat producers. A significant proportion of high-quality organic meat is directed toward international markets, where it commands premium prices. This prioritization of exports, while beneficial for the agricultural sector's economic growth, reduces the availability of quality meat for domestic consumption. According to Tokobaev (2014) , the large-scale export of live cattle further depletes domestic livestock resources. Many farmers find it more profitable to sell cattle to foreign buyers than to supply the local market, exacerbating shortages. This situation is compounded by unregulated cross-border smuggling, the extent of which remains difficult to quantify but is widely acknowledged as a persistent issue. These factors contribute to the country's reliance on imported meat, which is often of inferior quality.

The affordability of meat remains a major concern for Kyrgyz households. The low purchasing power of the population prevents many from accessing sufficient quantities of high-quality meat. While imports help bridge the gap in supply, they do not fully resolve the issue, as prices remain volatile due to global market fluctuations. Rising import costs directly impact domestic prices, making meat even less accessible to lower-income groups.

Milk and dairy products

Milk and dairy products are an essential part of the Kyrgyz diet, providing key nutrients necessary for overall health. As indicated by production data, domestic milk and dairy production levels are

generally sufficient to meet the country's consumption needs. The sector is largely sustained by small-scale dairy farms, which contribute to both local markets and household consumption (Tokobaev, 2014). This strong production capacity ensures the physical availability of dairy products across the country.

According to data from 2001 to 2022, milk and dairy production per capita has consistently exceeded the physiological norm of 200 kg per year (CBD KR, 2010). In 2022, per capita production stood at 246.4 kg, while consumption was recorded at 220.3 kg per capita. Despite this relatively high level of production, consumption levels have not always matched production due to various economic constraints. Between 2001 and 2003, for example, per capita consumption remained significantly low, reaching only 87.4 kg in 2001, despite production exceeding 230 kg per capita (NSC KR, 2024).

Consumption levels improved notably from 2004 onward, increasing to 153.2 kg per capita and further rising to over 200 kg per capita by 2006. However, the gap between production and consumption persists, with some fluctuations in later years. This suggests that while dairy products are widely available, economic accessibility remains a key issue (Figure 10).

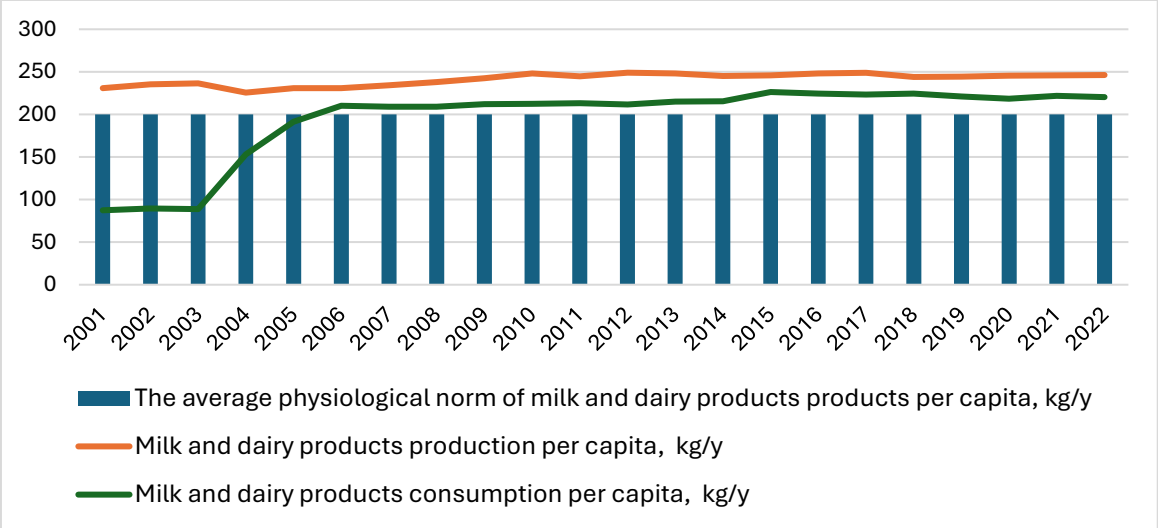

Figure 11. Dynamics of production and consumption of milk and dairy products per capita in Kyrgyzstan

Source: Author's illustration based on data from NSC KR

Although domestic dairy farming ensures a stable supply, affordability challenges prevent many households from incorporating sufficient dairy products into their diets. Factors such as income levels, purchasing power, and inflation influence dairy consumption patterns, particularly among lower-income groups. While production is not a limiting factor, economic accessibility plays a decisive role

in shaping consumer behavior. Vinokurov et al. (2023) emphasize the importance of improving market access, distribution networks, and production efficiency to enhance dairy affordability and availability. Strengthening the infrastructure of dairy supply chains and supporting small-scale dairy farmers can help bridge the gap between production and consumption.

Sugar

The sugar industry in Kyrgyzstan faces significant challenges in terms of both production and accessibility, as illustrated in Figure 11. Over the years, domestic sugar production has steadily declined, while consumption levels remain well below the average physiological norm of 25.6 kg per capita per year (CBD KR, 2010). This production-consumption gap underscores the country's heavy reliance on sugar imports, making affordability a major concern for Kyrgyz consumers.

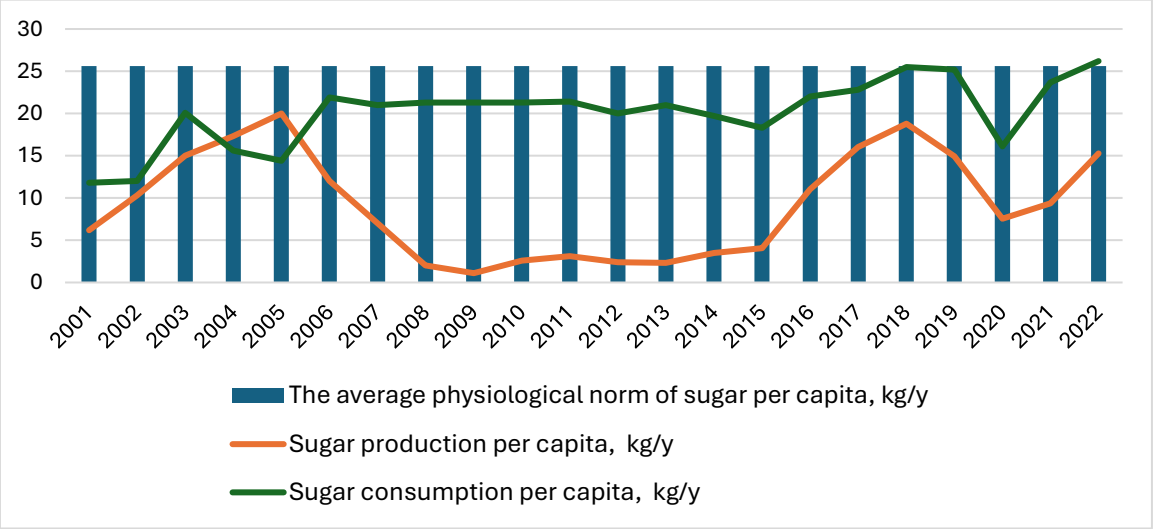

Figure 12. Dynamics of production and consumption of sugar per capita in Kyrgyzstan

Source: Author's illustration based on data from NSC KR

Between 2001 and 2022, sugar production in Kyrgyzstan fluctuated but remained far below the required levels. In 2001, per capita sugar production stood at 6.2 kg, while consumption was 11.8 kg per capita. Production increased slightly in the early 2000s, peaking at 20 kg per capita in 2005, but subsequently declined to only 2 kg per capita by 2008. By 2022, production levels had recovered somewhat to 15.3 kg per capita, yet this remained below the 26.2 kg per capita consumption recorded that year (NSC KR, 2024).

This pattern suggests that while domestic demand for sugar is strong, production is insufficient to meet local needs, forcing the country to import large quantities of sugar to fill the gap.

Kyrgyzstan has lost its competitive edge in the sugar industry, leading to a sharp rise in imports while exports have declined. Historical trade data reveal that between 2004 and 2010, Kyrgyzstan exported more sugar than it imported, demonstrating a period of relative strength in domestic production (International Trade Center, 2023). However, since 2010, exports have collapsed, while imports have surged Figure 12.

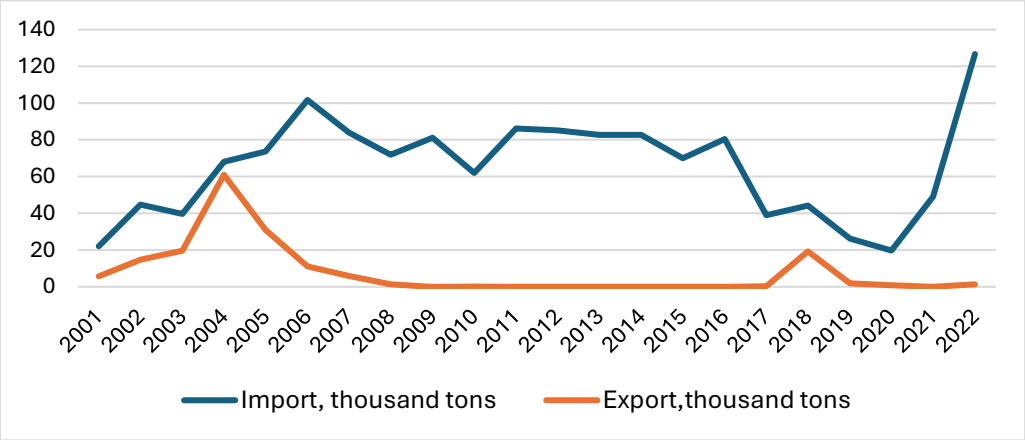

Figure 13. Dynamics of export and import of granulated sugar in Kyrgyzstan

Source: Author's illustration based on data from NSC KR

In 2022, Kyrgyzstan imported 126.7 thousand tons of sugar, a significant increase from only 19.7 thousand tons in 2020. Conversely, exports in 2022 totaled just 1.2 thousand tons, illustrating a clear loss of competitiveness in the global market (International Trade Center, 2023).

Several factors contribute to the declining competitiveness of Kyrgyzstan's sugar industry:

- High Production Costs. Sugar production in Kyrgyzstan is more expensive than in competing countries, making local sugar less competitive in both domestic and international markets.
- Dependence on Imports. The influx of cheap imported sugar from countries like Ukraine, Belarus, Kazakhstan, Russia, and Turkey has undercut local producers, leading to significant financial losses for domestic farmers.

Without strategic interventions, Kyrgyzstan's dependence on sugar imports will continue to increase, further weakening its domestic sugar industry and making sugar even less affordable for local consumers.

Eggs

The egg production sector in Kyrgyzstan faces significant limitations, as illustrated in Figure 13. Despite the country's potential for domestic production, economic and infrastructural challenges continue to hamper growth. Production levels remain well below the average physiological norm of 182.5 eggs per capita per year, indicating a substantial supply deficit.

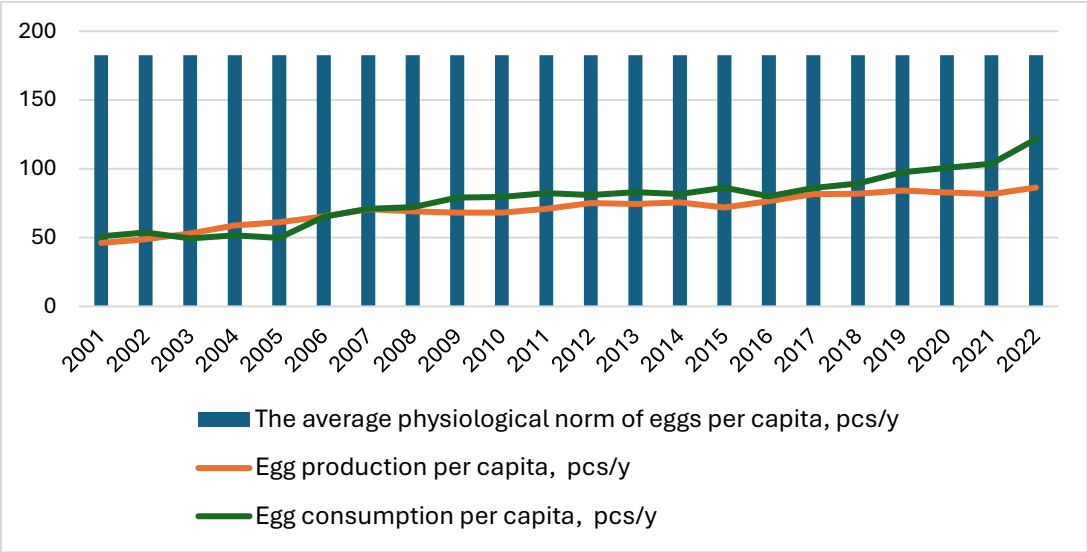

Figure 14. **Dynamics of production and consumption of eggs per capita in Kyrgyzstan**

Source: Author's illustration based on data from NSC KR

Egg production in Kyrgyzstan has shown gradual improvements over the years but still fails to meet domestic demand. In 2001, per capita egg production was only 46.1 eggs, which increased to 86.4 eggs by 2022 (NSC KR, 2024). However, this remains far below the physiological norm, meaning domestic producers cannot fully supply the population's needs.

Despite fluctuations in production, egg consumption in Kyrgyzstan has shown steady growth. In 2001, per capita egg consumption was 51 eggs, rising to 121.6 eggs per capita in 2022 (NSC KR, 2024). However, this is still far below the recommended 182.5 eggs per capita, highlighting limited access and affordability issues.

With domestic production falling short, Kyrgyzstan has become increasingly dependent on egg imports. While imports help fill the gap, they also expose the market to risks, such as price volatility in international markets, affecting affordability and supply chain disruptions, which could cause temporary shortages.

Vegetable oil

The analysis of vegetable oil production and consumption in Kyrgyzstan from 2001 to 2022 reveals a persistent gap between domestic supply and demand. As shown in Figure 14, while the physiological norm for vegetable oil consumption per capita is 9.1 kg per year, domestic production has consistently fallen short of this requirement. Over the observed period, production per capita never exceeded 3.8 kg (in 2009), and by 2022, it had declined to a mere 0.9 kg. In contrast, consumption per capita has demonstrated a steady upward trajectory, increasing from 8.5 kg in 2001 to 17.1 kg in 2022 (NSC KR, 2024). This widening disparity underscores Kyrgyzstan's growing dependence on imported vegetable oil to meet domestic demand.

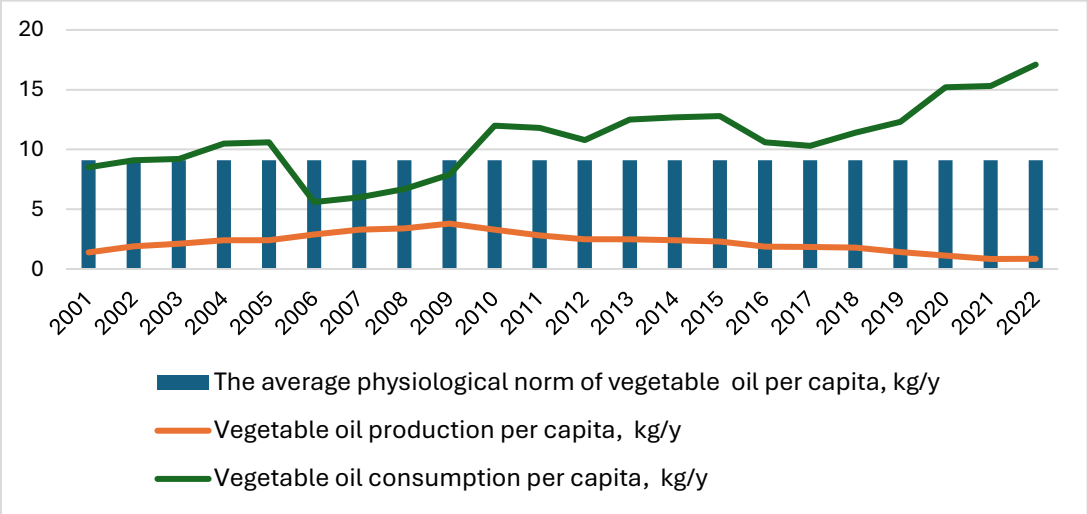

Figure 15. Dynamics of production and consumption of vegetable oil per capita in Kyrgyzstan

Source: Author's illustration based on data from NSC KR

The vegetable oil industry in Kyrgyzstan is shaped by a mix of large enterprises and small-scale producers, with the latter accounting for over 87% of production. Despite the presence of key enterprises such as Doma Ata LLC, Gulam Ata LLC, Elimai LLC, Archa LLC, and Bayas LLC, the sector remains underdeveloped, characterized by low-quality production and limited technical capabilities (Tokobaev, 2014).

A significant concern in the industry is the lack of modernization in processing facilities. Around 90% of vegetable oil produced in Kyrgyzstan is unrefined, limiting its marketability and consumer appeal. The absence of advanced equipment and insufficient investment in modernization prevent the sector from reaching self-sufficiency (Cailov & Bekov, 2023).

Kyrgyzstan is heavily dependent on imports to meet its vegetable oil demand. In 2017, self-sufficiency was only 30%, meaning that most of the country's consumption is covered by imports. The main import sources are Russia, Kazakhstan, and Ukraine (International Trade Center, 2023).

Additionally, due to insufficient local raw material production, many oil-processing plants rely on imported seeds of cotton and sunflowers. The high cost of imported raw materials, which includes transportation fees, VAT (12%), and customs duties, raises the final price of vegetable oil, making it less affordable for consumers.

2.4 Prevalence of Undernourishment

Food security is a crucial priority for governments as it plays a significant role in ensuring political stability and economic development. Any food system comprises the environment, people, institutions, policies, and procedures. Good public policy in managing economic issues can improve food security and lower the number of undernourished people (Ray et al., 2019). However, corruption remains a significant issue in developing countries, severely disrupting various economic activities (Herrera-Cuenca et al., 2021; Jauregui et al., 2021). Uchendu & Abolarin (2015) showed that corruption has a detrimental impact on food security. Nevertheless, the effects of corruption control are still debated in developing countries.

Nowadays, undernourishment remains a significant threat to global food security. Since the COVID-19 pandemic, the prevalence of undernourishment has risen sharply, increasing from 7.9% in 2019 to 9.2% in 2022, which means the number of people facing hunger has increased to 122 million (UN, 2023). Within Asia, Southern Asia faces the highest rates of undernourishment, with a prevalence rate of 15.6%, followed by Western Asia and Southeastern Asia with rates of 10.8% and 5.0%, respectively. In contrast, Central and Eastern Asia depict relatively lower ranges of prevalence of undernourishment, ranging from 3.0% to less than 2.5% (FAO, 2023b).

Central Asia, comprising Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan, has made significant efforts to reduce undernourishment over the past two decades. Before the COVID-19 pandemic, many CA countries faced substantial reductions in the level of the prevalence of undernourishment. For instance, Kazakhstan made significant progress, reducing its prevalence from 6.5% in 2002 to 2.5% by 2019 (Duisenbekova et al., 2024). Tajikistan achieved substantial results as well, with NoUP decreasing from 18.5% in 2013 to 8.6% in 2019, highlighting a concerted effort toward improving

food security during this period (FAOSTAT, 2024). Although progress in Kyrgyzstan and Uzbekistan was more gradual, these countries also saw a slight decline in undernourishment rates, contributing to a positive regional trend in reducing food insecurity (Figure 15) (FAO, 2023a).

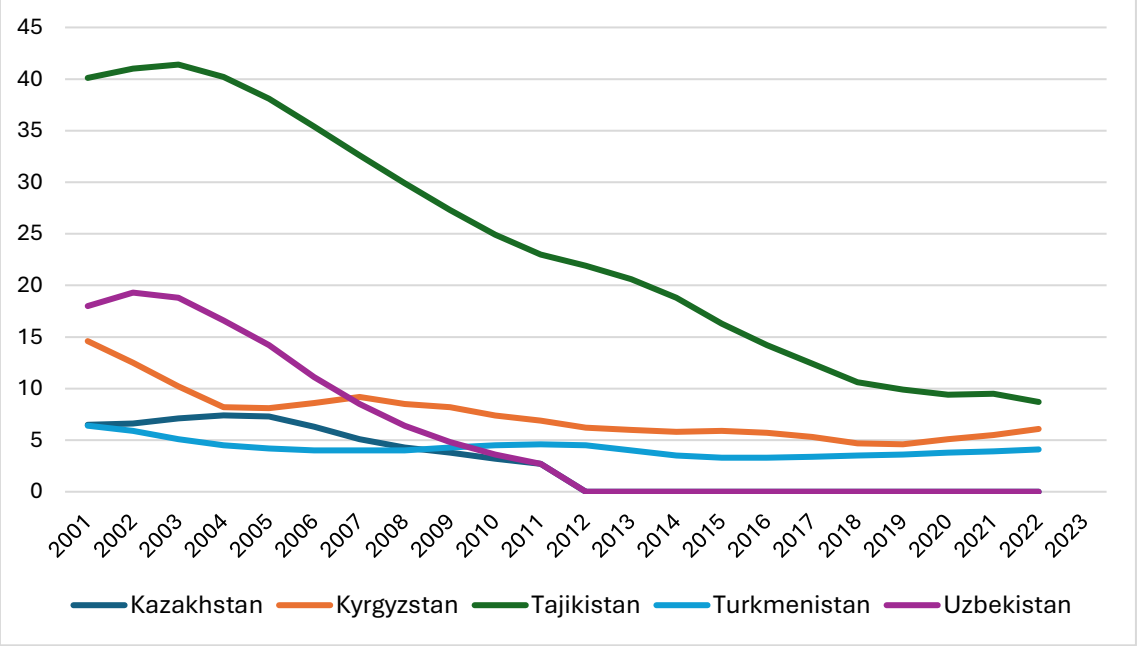

Figure 16. Dynamics of the Prevalence of Undernourishment in Central Asia

Source: FAOSTAT

The COVID-19 pandemic has had a significant impact on Kyrgyzstan's food security (World Bank, 2021). The economic slowdown caused by the pandemic led to increased poverty and unemployment, which in turn affected people's ability to access sufficient food. According to the WFP (2023a), poverty in Kyrgyzstan increased from 20% to 31% between 2019 and 2020. This rise in poverty has contributed to higher rates of undernourishment, as many households struggled to afford nutritious food.

The pandemic also disrupted food supply chains, making it difficult to access basic food products (WFP, 2023a). The closure of borders and restrictions on movement affected the import and distribution of food, leading to shortages and higher prices. This situation was particularly challenging for vulnerable households, which were already facing economic hardships (IMF, 2021).

In response to the crises, the government of Kyrgyzstan implemented several measures to support food security. These included emergency health spending, stepping up food security programs for the

vulnerable, and providing temporary tax deferrals and subsidized loans for small and medium enterprises (IMF, 2021).

Economic slowdowns during the pandemic led to income declines and increased poverty rates, making it even more difficult for low-income households to afford nutritious food. The pandemic underscored the critical role that income and employment play in food security, as reductions in purchasing power quickly translated into reduced food access (Junussova et al., 2024; Rabbi et al., 2021).

In addition to economic factors, income inequality can further degrade food security and nutritional value (Zakaria et al., 2016). Increases in GDP have a positive effect on per capita calorie and nutrient availability, enabling people to purchase food more easily, especially during periods of scarcity (Erokhin et al., 2021).

In conclusion, reducing the prevalence of undernourishment requires holistic strategies that consider economic, political, and environmental factors. Efforts to improve food security must focus on increasing access to food, reducing poverty, promoting trade, and attracting foreign investment. By addressing these challenges collectively, countries can make significant progress in reducing malnutrition and improving the well-being of their populations. However, continued efforts and investments are needed to ensure sustainable and equitable access to food for all.

3. 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, vegetable, 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.

This approach provides a multidimensional view of food security, capturing both the availability and quality of food.

3.1 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. From the data availability perspective, 2001 marks the beginning of more consistent reporting of key macroeconomic, governance, environmental, and food security indicators for Kyrgyzstan by national and international institutions. Earlier years were excluded due to gaps and inconsistencies in data coverage.

Furthermore, this 22-year period captures key socio-economic transformations in the country's post-Soviet development, including major policy reforms, climatic shifts, and structural changes in the economy, particularly in agriculture. It also includes recent global events that significantly influenced food security, such as the financial crisis in 2008 and the COVID-19 pandemic. Thus, the chosen time frame provides a meaningful historical context and sufficient temporal variability to analyze the underlying trends and relationships central to this study.

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.

3.2 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 3.

Table 3. 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 the author

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 (e.g., differencing) to meet the assumptions of the regression model as

illustrated in Table 4 (Gujarati, 2004). The dataset was also examined for any outliers and inconsistencies, and necessary transformations were applied to ensure its suitability for analysis.

Table 4. ADF test results

Variable	Stage	t_stat	p_value
ConsPotato	1st difference	-6.851	0.000
ConsVeg	at level	-3.044	0.031
ConsFruit	1st difference	-6.660	0.000
ConsMeat	1st difference	-5.367	0.000
ConsMilk	at level	-3.975	0.002
ConsSugar	at level	-2.868	0.049
ConsEgg	1st difference	-4.586	0.000
ConsOil	1st difference	-4.356	0.000
ConsBread	at level	-4.804	0.000
PoU	at level	-5.132	0.000
POLST	1st difference	-4.312	0.000
CC	1st difference	-6.436	0.000
GDP	1st difference	-4.550	0.000
INF	at level	-3.130	0.024
FPI	1st difference	-5.479	0.000
GINI	1st difference	-6.753	0.000
Tave	at level	-6.085	0.000
Rainy	at level	-5.136	0.000
Dry	at level	-3.677	0.004

Source: Author's calculation using STATA 16.0 program

3.3 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.

Alternative methodologies such as panel data analysis and structural equation modeling (SEM) were considered. However, panel data analysis typically requires sub-national (regional or household level) variation over time, which was not available in this study due to national-level aggregation of the data. SEM, while powerful for modeling latent variables and complex causal pathways, was not practical here because the variables used were all observed, and the model focused more on explanatory power than on latent construct validation. In this context, multiple regression is both methodologically sound and aligned with research questions and hypotheses (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.
$X_{1,i}, X_{2,i}, X_{3,i}, \ldots, X_{n,i}$ 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, particularly undernourishment and consumption patterns.

The results presented in this study are based on unstandardized regression coefficients. This choice was made to preserve the real-world interpretability of the model outputs, particularly when analyzing the effects of economic and environmental variables that are expressed in their natural units. While standardized coefficients facilitate comparison across variables, unstandardized coefficients allow for more meaningful and policy-relevant interpretation, especially when the primary interest lies in the magnitude and direction of real-world effects.

3.4 Diagnostic Tests

To ensure the validity and reliability of the regression models, several diagnostic tests were conducted(Gujarati, 2004):

- *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.

However, the presence of mild heteroskedasticity and autocorrelation was detected in some models. To address these issues and enhance the robustness of the coefficient estimates, Newey-West heteroskedasticity- and autocorrelation-consistent (HAC) standard errors were employed. This correction adjusts the standard errors without altering the coefficient estimates, making the inferences drawn from the regression results more reliable. This approach is commonly used in macroeconomic and time-series contexts where serial correlation and non-constant variance of errors may exist.

3.5 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 security, such as food consumption patterns and undernourishment. 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.

4. RESULTS

4.1 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 5).

Table 5. 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 across 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 5).

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.

Table 6. 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

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.

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.

4.2 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 7).

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 7. 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 (β = 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 (β = -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 (β = -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 (β = 0.0130, t = 0.12). However, there is a significant positive relationship between inflation and vegetable consumption (β = 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 (β = -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.

Higher income inequality significantly reduces meat consumption, reflecting limited access to protein-rich foods for lower-income households, but does not have a significant impact on the consumption of other food products or the prevalence of undernourishment.

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.

4.3 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 8).

Table 8. 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 ($\beta = 0.257$, $t = 0.92$), fruits ($\beta = 0.0321$, $t = 0.15$), meat ($\beta = 0.122$, $t = 0.81$), milk ($\beta = 0.158$, $t = 0.63$), sugar ($\beta = -0.0871$, $t = -1.33$), eggs ($\beta = 0.532$, $t = 1.11$), and oil ($\beta = -0.00144$, $t = -0.02$) are not significantly affected by political stability. The prevalence of undernourishment (PoU) also shows no significant relationship with political stability ($\beta = 0.0858$, $t = 0.68$), 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.

Corruption Control (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.

4.4 Impact of Environmental Factors on Food Security

The analysis of the 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 9).

Table 9. 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 (β = 0.614, t = 0.50), egg consumption (β = 3.811, t = 0.76), oil consumption (β = 0.0479, t = 0.07), and bread consumption (β = -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 (β = -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 (β = -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 (β = -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 (β = -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 (β = 0.000352, t = 0.00), fruits (β = -0.132, t = -1.63), milk (β = -0.000432, t = -0.00), sugar (β = 0.000781, t = 0.02), oil (β = -0.0366, t = -1.44), or bread (β = 0.754, t = 0.88). The prevalence of undernourishment is also not significantly influenced by the number of rainy days (β = 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 (β = 0.0849, t = 0.58), vegetables (β = 0.0783, t = 0.69), fruits (β = -0.119, t = -0.71), meat (β = -0.0394, t = -0.46), milk (β = -0.114, t = -0.98), sugar (β = 0.0321, t = 0.88), eggs (β = -0.100, t = -0.30), oil (β

= 0.0139, t = 0.62), and bread (β = -0.661, t = -1.23). The prevalence of undernourishment is also not significantly affected by the number of dry days (β = -0.00788, t = -0.13).

The number of dry days does not significantly impact the consumption of basic food products or the prevalence of undernourishment in Kyrgyzstan, indicating that dry conditions alone may not be a critical determinant of food security.

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.

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

This section presents the results of regression models assessing the joint effects 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.

Table 10 displays the regression results and offers a comprehensive understanding of how these diverse factors interact and influence food security.

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.

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.

Table 10. 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

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 (β = -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 examined factors, economic growth stands out as the most consistent and statistically robust determinant. A higher GDP per capita is significantly associated with reduced prevalence of 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. This transition reflects broader patterns observed in middle-income countries, where rising incomes typically result in a move away from cheaper calorie-dense foods toward more protein-rich and diverse diets.

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.

While environmental factors such as average temperature, rainfall, and seasonal conditions do not show widespread statistical significance across all models, their influence should not be dismissed. The negative impact of rising average temperature on fruit consumption, for instance, highlights the climate sensitivity of specific agricultural sub-sectors. Likewise, the increase in vegetable oil consumption during the dry season may indicate behavioral adaptations to seasonal availability or preservation constraints. These patterns suggest that localized or commodity-specific studies might reveal stronger environmental effects not captured at the national level.

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.

5. 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 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 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 vegetable 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. 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, 2023a). 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.

5.1 Food Security and Food Safety Challenges in Kyrgyzstan

In Kyrgyzstan, both economic accessibility and physical affordability of food present main challenges. The analysis indicates that GDP per capita positively influences food consumption, particularly for higher-value items such as meat, milk, and eggs. However, the lower GDP and persistent income inequality limit many people's ability to afford these foods. Additionally, the negative impact of income inequality on food consumption, especially for meat and vegetable oil, highlights how wealth disparities restrict access to nutritious food, even if it's physically available in markets.

Furthermore, weather conditions such as rainfall and dry periods affect agricultural production, further disrupting the availability and affordability of food. This adds another layer to the challenges of ensuring access to food in Kyrgyzstan, particularly for vulnerable groups reliant on local agriculture.

As it was noticed, food safety is another integral aspect of food security, serving as a cornerstone for guaranteeing the quality and safety of agricultural products required for an active and healthy lifestyle. The increasing prevalence of food-related issues, such as contamination with dioxins, outbreaks of diseases like bovine spongiform encephalopathy (mad cow disease), and the use of genetically modified organisms (GMOs), has highlighted the need for robust international approaches to food safety.

Global frameworks, such as the WTO Agreements on Technical Barriers to Trade and the Application of Sanitary and Phytosanitary Measures, along with the internationally recognized standards of the Codex Alimentarius Commission by the FAO and WHO, and the requirements of the World Organization for Animal Health, form the basis of food safety legislation worldwide (FAO-WHO, 2024; Uddin & Uddin, 2024). These frameworks aim to ensure the safety of food products in both domestic and international trade by addressing risks along the entire supply chain.

The "farm-to-table" approach, a comprehensive assessment of food safety risks, underscores the shared responsibility of all stakeholders in the food supply chain – from the use of plant protection products and veterinary medicines, to feed production, storage, transportation, sale, and import/export processes (Bang, 2023; Nyokabi et al., 2023). By emphasizing accountability at every stage, this approach ensures that food safety remains an integral part of the food security system. Moreover, the involvement of competent state authorities is critical in enforcing standards, mitigating risks, and fostering trust in the food system.

In this regard, to implement international standards and recommendations of the FAO/WHO Codex Alimentarius Commission, the National Committee "Codex Alimentarius" was established in Kyrgyzstan in 2003 under the leadership of the Ministry of Agriculture of the Kyrgyz Republic (FAO-WHO, 2019). The committee was tasked with ensuring the safety of food products and raw materials and promoting the principles of healthy nutrition in accordance with FAO/WHO standards and recommendations. However, to date, the committee remains largely inactive.

As a result, the national framework for ensuring food safety lacks dedicated bodies responsible for the systematic assessment, management, and communication of risks related to food safety. The overall condition of laboratories in Kyrgyzstan, tasked with testing food products and raw materials, can be described as unsatisfactory. Most laboratories still operate under GOST (State) standards, many of which have not been updated to align with international methodologies adopted by the Codex Alimentarius and ISO standards. Moreover, the equipment used in these laboratories primarily dates back to the Soviet period, making it both physically and technologically outdated (Choi, 2016).

Additionally, Kyrgyzstan lacks a centralized service infrastructure for the supply and repair of laboratory equipment. Each laboratory independently manages these issues, often resulting in the acquisition of substandard materials and an inability to conduct reliable technical evaluations of food products.

While the most well-equipped food safety laboratories are located in Bishkek, the capital, other regions—particularly Talas, Naryn, and Batken provinces – conduct food safety assessments only on limited parameters. For example, only one laboratory, part of the Republican Center for Veterinary Diagnostics, has the technical capacity to test meat and dairy products for antibiotic residues (Choi, 2016).

Similarly, for GMO testing, only the Department of State Sanitary and Epidemiological Supervision has adopted methodologies for polymerase chain reaction (PCR) testing in this area. Low wages in the sector have resulted in high staff turnover and insufficiently qualified personnel, further reducing the effectiveness of food safety measures.

Kyrgyzstan also lacks a state veterinary monitoring system to detect residual banned and harmful substances in live animals, animal-derived products, and animal feed. Consequently, many private producers use veterinary medicines, feeds, and feed additives with unknown quality and safety profiles, leading to widespread public distrust in the safety and quality of food products in the domestic market.

In turn, the absence of production laboratories in small and medium-sized enterprises (SMEs), combined with a lack of knowledge and practice regarding international food safety systems such as HACCP (Hazard Analysis and Critical Control Point System) and GlobalGAP (Good Agricultural Practices), poses a significant barrier to the competitiveness of Kyrgyz food enterprises. These systems, widely adopted in developed countries, promote the modernization of food production and ensure compliance with international safety standards. The lack of such frameworks hampers the ability of Kyrgyz food producers to enhance the competitiveness of their products or expand into export markets.

The physical inaccessibility of food products is primarily driven by the fragmentation of agricultural production, which is dominated by small-scale farms unable to achieve economies of scale or meet national demand. The insufficient production of key food items exacerbates the reliance on imported food products, increasing vulnerability to external price fluctuations and supply chain disruptions.

The economic inaccessibility of food stems from systemic issues such as widespread poverty, which affects a significant portion of the population. A high proportion of household income is spent on food, leaving limited resources for other essential needs, while low average income levels further restrict access to adequate nutrition.

In terms of food safety, the challenges are multifaceted and deeply structural. Existing laboratories suffer from poor technical equipment, often outdated and inadequate, alongside a lack of skilled personnel. SMEs lack production laboratories entirely, limiting their ability to ensure product safety. Moreover, the use of agricultural inputs like pesticides and veterinary medicines with uncertain safety standards introduces risks to the food supply. The absence of state-level veterinary monitoring for

harmful residues in animal-derived products further undermines public trust in food safety. Finally, the low adoption of international safety standards such as HACCP and GlobalGAP hinders the competitiveness of Kyrgyz food producers and restricts their access to export markets.

Addressing these challenges will require targeted reforms, investments in agricultural and laboratory infrastructure, and the promotion of education and training in food safety standards to build a more secure and reliable food system.

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

In the previous chapter, an analysis of Kyrgyzstan's 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. One of the primary challenges in ensuring the production of bread and bakery products domestically is the low gluten content of wheat grown in Kyrgyzstan. This issue is frequently highlighted by farmers and agronomists. As a result, the population relies heavily on imported wheat, primarily from Kazakhstan, Russia, Belarus, China, and other countries. Locally produced wheat is mainly used as livestock feed, with a portion exported to neighboring countries such as Tajikistan and Afghanistan (International Trade Center, 2023).

The key factors contributing to the low gluten content of wheat in Kyrgyzstan include:

- Natural and climatic conditions during the growing season;
- The use of fertilizers and plant protection products;
- Poor-quality post-harvest grain processing.

Addressing this issue requires the development of a new wheat variety tailored to Kyrgyzstan's climatic conditions, with the goal of improving gluten levels. This task should be undertaken by scientists and agronomists at the Kyrgyz National Agrarian University named after K. I. Skryabin. International experience demonstrates that breeders worldwide strive to adapt new wheat varieties to challenging climatic conditions while simultaneously increasing yields.

For example, researchers of Bashkortostan have developed the seed of a unique wheat variety designed to suit the natural and climatic conditions of their region (Nizaieva et al., 2021; Novokhatin, 2016). The process of creating such a variety, aimed at improving gluten levels and yield, typically takes 10 to 12 years. To accelerate results, they experimented by planting wheat in greenhouses during winter, allowing them to obtain research material at least twice a year. Over seven years, scientists determined the optimal location, temperature, and humidity levels for the new variety, crossing more than ten wheat types to identify the best fit for Bashkortostan.

Similarly, in Kyrgyzstan, efforts should focus on developing wheat varieties that combine higher gluten content with resilience to local climatic challenges. The process can be optimized through investments in agricultural research, infrastructure, and collaboration with international institutions.

In addition to developing new varieties, timely irrigation is essential to improving wheat quality and ensuring higher gluten content. Farmers must adopt better irrigation practices and access modern irrigation infrastructure. Providing farmers with training, access to high-quality seeds, and adequate fertilizers will further support this initiative.

Sugar. The development of the sugar industry in Kyrgyzstan remains limited, with the primary challenge being the high production costs that render it uncompetitive. These high costs are largely attributed to the lack of modern technologies for cultivating sugar beets and outdated equipment for processing (Cherikova et al., 2021). Such inefficiencies restrict the industry's ability to meet domestic demand and compete in regional markets.

Global experience demonstrates that challenges in sugar production are often addressed through protectionist policies, including the regulation of foreign trade, guaranteed pricing, and internal state support for agriculture. However, as a member of the World Trade Organization, Kyrgyzstan faces restrictions on employing tariff and non-tariff barriers, such as high customs duties to protect domestic agriculture. These limitations prevent the country from adopting measures like those successfully implemented in other nations.

Given these constraints, the solution for Kyrgyzstan lies in prioritizing the adoption of modern technologies for both the cultivation and processing of sugar beets. This approach can enhance the competitiveness of the sugar industry by lowering production costs and improving efficiency.

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

- *State Subsidies for Modern Equipment.* Government subsidies could support the acquisition of advanced equipment for sugar processing through leasing arrangements with private companies. While financial resources are often cited as the key to agricultural development, current evidence shows that many private entrepreneurs in Kyrgyzstan fail to achieve the desired results despite receiving loans. To overcome this, targeted subsidies should focus on providing farmers and processors with access to advanced technologies for cultivating and processing sugar beets.

Evidence from countries like Russia underscores the importance of subsidies in revitalizing the sugar industry. During the transformation period (1990–2000), Russia's sugar beet production and processing capacity declined significantly. However, by 1997, subsidies for purchasing modern equipment, elite seeds, and advanced technologies led to a notable recovery. Planting areas increased to 1.5 million hectares, and sugar beet yields rose from 13.1 tons/ha to 25–30 tons/ha, resulting in improved self-sufficiency. Today, Russia produces sugar far exceeding physiological norms (43 kg per capita) and leads the world in sugar beet cultivation area (19.5% of global acreage) (Bezlepkina et al., 2004). This example highlights the potential for similar outcomes in Kyrgyzstan through targeted investments in technology and infrastructure.

- *Importing Raw Cane Sugar for Processing*. A second strategy involves establishing trade agreements with countries that produce raw cane sugar. Kyrgyzstan's existing sugar plants are capable of processing imported cane sugar, which would provide the population with more affordable sugar compared to importing processed sugar directly.

Kazakhstan's approach offers valuable lessons. Over recent years, Kazakhstan has struggled with self-sufficiency in sugar production, with per capita availability of sugar at only 10.1 kg in 2012, compared to a recommended norm of 37 kg per year. To address this, the Eurasian Economic Union (EAEU) granted Kazakhstan a duty-free import quota for raw cane sugar until 2019, on the condition that processed sugar would not be re-exported to Russia or Belarus (Erseitova et al., 2017; Yeginbayeva et al., 2023). This policy has helped Kazakhstan stabilize sugar supplies and reduce prices, with the

added potential for exporting processed sugar to other Central Asian countries, including Kyrgyzstan, Tajikistan, and Uzbekistan.

Adopting a similar approach in Kyrgyzstan could help meet domestic demand for sugar at lower costs while also laying the foundation for eventual exports within the region.

Nowadays the sugar industry in Kyrgyzstan faces significant barriers due to high production costs, outdated technologies, and limited state support. However, by focusing on modernizing the sugar production process and leveraging trade agreements for raw cane sugar imports, the country can reduce its reliance on expensive imports and enhance the competitiveness of its sugar industry. Lessons from countries like Russia and Kazakhstan demonstrate that with targeted subsidies and strategic trade policies, Kyrgyzstan can achieve greater self-sufficiency in sugar production and potentially become a regional supplier of processed sugar.

Vegetable Oil. The main crops used for vegetable oil production in Kyrgyzstan are sunflower, safflower, and cottonseed. The primary production of oilseed crops and cotton is concentrated in the southern regions of the country due to favorable climatic conditions.

According to the National Statistical Committee of the Kyrgyz Republic, there are a total of 893 enterprises engaged in vegetable oil production across the country, including 110 legal entities and 783 individual entrepreneurs (NSC KR, 2023b).

As previously identified, the primary reasons for the insufficient supply of domestically produced vegetable oil are:

- The small-scale nature of oilseed crop production and processing (small enterprises or mini workshops for growing and processing oilseeds).
- Underdeveloped technology for refining vegetable oil (over 90% of the vegetable oil produced in the country is unrefined).

To address the issue of providing the population of Kyrgyzstan with vegetable oil through domestic production, the following mechanisms and instruments are proposed based on this research and literature reviews:

The first and foremost task is to increase the volume of vegetable oil production domestically. This can primarily be achieved by expanding the cultivation areas for oilseed crops. To meet the average physiological requirement per capita (9.1 kg per year), it is necessary to produce 55,000 tons of

vegetable oil annually. Consequently, it is essential to expand the cultivation areas for oilseed crops to 90,000 hectares and increase their yield to 1.5- 2.0 tons per hectare. This will reduce the need for imported vegetable oil by boosting domestic production volumes in Kyrgyzstan.

Global practices demonstrate that such issues can be resolved through government procurement prices, tax and credit incentives, agricultural subsidies, foreign trade regulations, and structural programs. For example, in Japan, to stimulate private agricultural producers and increase the volume of essential food products, the government set procurement prices higher than global market prices. This is why the cost of food products in Japan is among the highest in the world.

In China, monetary subsidies are provided to agricultural crop farmers to encourage them to grow crops. Major forms of subsidies include direct payments to grain producers and subsidies for purchasing high-quality seeds, high-yield crops, superior livestock breeds, large machinery, and modern equipment.

In South Korea, the approach to stimulating agricultural producers and increasing food production is somewhat different. The Korean Agricultural Cooperative and the Agricultural Corporation play a vital role in this direction. One of the main goals of this corporation is to increase farm sizes, improve productivity, and raise agricultural income through economies of scale and land consolidation. The corporation provides economic support and credit incentives to farmers fully engaged in rice production, expanding arable land, and acquiring or leasing farmland. As a result, the average farm size increased from 2.2 hectares to 4.3 hectares.

The experience of successful countries shows that while the objectives are the same, each country develops well-thought-out programs and applies different suitable instruments, taking into account their unique circumstances and opportunities. Each country’s approach is tailored to its unique circumstances and economic capacity. While Japan and China rely on procurement prices and agricultural subsidies, Kyrgyzstan may face financial constraints in implementing similar policies. The South Korean model, with its focus on credit access and farm consolidation, appears more feasible for Kyrgyzstan.

A key step toward boosting vegetable oil production is providing incentives for oilseed crop farmers and entrepreneurs involved in refining vegetable oil. This can be achieved through concessional loans, specifically targeting:

- Farmers cultivating oilseed crops on more than 10 hectares.

- Entrepreneurs engaged in vegetable oil refining.

Currently, the small number of oilseed crop producers and processing entrepreneurs limit productivity and scalability. With the average landholding per farm at just 2.7 hectares, structural programs aimed at consolidating vegetable oil enterprises would help increase efficiency and competitiveness.

The subsequent examples seek to explore potential solutions to this predicament. According to global experience, such issues are addressed through the consolidation of enterprises and farms. Let's look at the experience of New Zealand. In the latter half of the 1970s, New Zealand pursued a strong protectionist policy, particularly aimed at protecting the manufacturing industry. Strict quantitative import restrictions were established, interest rates were controlled, and the exchange rate was fixed. Additionally, the government provided compensation payments to farmers in case of natural disasters. However, by 1985, the New Zealand government abolished almost all agricultural support measures due to increasing government debt (Evans et al., 1996). This led to a decline in farm sector incomes, rising rural unemployment, increasing interest rates, falling prices for key agricultural exports, deteriorating credit availability for farmers, and declining land values.

Despite these challenges, New Zealand farmers managed to overcome the difficult situation. With the help of farmer associations and the establishment of agricultural export boards (which are largely independent of the government and play a significant role in organizing exports), they emerged from the crisis within three years. Producers of various products were united under boards (e.g., New Zealand Dairy Board, Meat and Wool Board, Apple and Pear Marketing Board, Kiwifruit Marketing Board, Raspberry Marketing Board, and Hop Marketing Board), which held export monopolies. They not only managed exports but also issued licenses to other exporters. As a result, farmer incomes began to rise. In the 1990s, employment in agriculture recovered, and by 1995, 65% of farms were organized as partnerships that cultivated 48% of all agricultural land. Agricultural exports grew by 63% from 1985 to 1989 (Evans et al., 1996).

The next task for ensuring the population of Kyrgyzstan has access to domestically produced vegetable oil is improving the technology for growing oilseed crops and refining vegetable oil. There are two main directions for improving these technologies:

- Attracting investors with suitable agricultural equipment, modern processing technologies, and know-how for proper planting, crop care, and harvesting (e.g., John Deere from the USA).

- Assisting domestic producers in acquiring modern technologies from firms like "NATE" from Switzerland and "Donetskprodmash" from Ukraine, and importing elite high-quality seeds, new sunflower varieties from Russia, and safflower from Kazakhstan, as well as well-known American and Dutch seeds "Pioneer" for seed multiplication in seed farms.

Therefore, it is crucial to support companies that provide services to domestic producers in sourcing and delivering modern equipment. Today's practice shows that the most effective tool for facilitating the process of introducing modern technologies into the food industry is information support enterprises for producers.

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 10).

Table 11. 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	Government of the Kyrgyz Republic, MSHM, ME, private sugar producers

		imported raw cane sugar	
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

5.3 The Role of Government Institutions in Strengthening Food Security

Agriculture is a strategically important sector of any country's economy, and therefore the state plays a significant role in ensuring food security. The primary objectives of regulatory bodies in the agricultural economy are to ensure the country's food security. This means promoting the production of a sufficient quantity of essential food products to meet the physical and economic needs of the population.

As noted earlier, the main problems in ensuring food security in Kyrgyzstan are as follows.

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 (the average farm size in the country is 2.7 hectares, including 1.9 hectares of irrigated land).

- 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 genetically modified organisms (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.

The Potential Mechanisms and Instruments for Ensuring Food Security in Kyrgyzstan. The primary and fundamental task of ensuring food security in the country, as previously noted, is to increase the volumes of essential food products to meet the needs of the population, i.e., the physical availability of essential food products. Global practices show that this task is often addressed through direct and indirect state support in many countries.

Direct State Support. This includes income support for agricultural producers (which does not directly impact consumer market prices) through agricultural subsidies (including export subsidies), grants, and direct payments. For instance, subsidies in Switzerland average 80% of the cost of agricultural products, 77% in Norway, 71% in Finland, 66% in Japan, 59% in Sweden, 52% in Austria, 45% in Canada, and 30% in the United States.

Indirect Support Measures. These include government procurement at higher prices, tariff and non-tariff measures. For example, the Japanese government uses restrictive quotas against imports, allowing only products that are not produced domestically, produced in such insignificant quantities that their import does not affect domestic production, or if domestic products can compete with them. A case in point is the effective prohibition on rice imports to Japan. To stimulate farmers and increase agricultural production in the country, government procurement prices for rice are eight times higher than global market prices, beef three times higher, and milk 40% higher.

Challenges for Kyrgyzstan. Kyrgyzstan is unable to effectively implement direct and indirect support measures to protect domestic agricultural producers and thus stimulate them to increase agricultural production volumes. This is due to two main factors: the limited state budget and the country's accession to the WTO as a developed country (rather than a developing one) in 1998. Upon accession, Kyrgyzstan took on significant obligations regarding the regulation of foreign trade in agricultural products, adopted a fairly liberal import tariff regime, and committed to a low level of permitted domestic support for domestic agricultural producers. Only countries that went through the process of tariff classification during the Uruguay Round and joined the WTO have special protective measures for agricultural products. Kyrgyzstan only uses customs duties. According to Kyrgyzstan's commitments to the WTO, the average tariff rate on agricultural products is 9.7%.

WTO Agricultural Agreement. According to this agreement, internal agricultural support includes measures classified into the "green," "amber," and "blue" boxes. The classification criterion is the degree of impact on production and trade.

- **Green Box.** Comprises measures that have no or minimal impact on production and trade. Countries adopting "green box" measures can provide the following internal support: storage of public food reserves for food security purposes, domestic food assistance, compensation payments for natural disasters, structural policy measures, environmental protection programs, income insurance and support, expenditures on education, research, science, plant, animal, and

human disease protection, inspection, information and consulting services, training, marketing, and infrastructure services.

- **Amber Box.** Includes measures such as investment subsidies (without any restrictions), compensations, price support, credit incentives, transportation benefits, subsidies for production inputs (electricity, fuels and lubricants, mineral fertilizers, leasing services, etc.), which influence or distort production and trade.
- **Blue Box**. These measures aim to limit production and are mostly applied in countries facing agricultural overproduction.

In the WTO agreements on agriculture, Kyrgyzstan has minimal internal support within the "green box," as during the period before joining the WTO (1994-1996), state internal agricultural support was less than 5%. It is important to note that it was a political decision to join the WTO quickly. Consequently, the "de minimis" threshold for internal agricultural support in our country is 5%, while for developing countries it is 10%.

Currently, Kyrgyzstan does not implement non-tariff measures (quotas, licenses), does not use export subsidies, and only relies on customs duties within the framework of the "green box." Based on this, it can be concluded that our country cannot increase the volume of essential food products (ensure the physical availability of food) through agricultural subsidies (including export subsidies), grants, direct payments, tariff and non-tariff measures. Kyrgyzstan can provide internal support that does not distort production and trade only within the "green box." Consequently, Kyrgyzstan pursues a modest policy of protectionism.

Consequently, in view of the research findings, it is imperative to augment the supply of essential foodstuffs through alternative means. Undoubtedly, this can be achieved by consolidating small private agricultural producers, as global practices show that large agricultural enterprises are capable of guaranteeing stable food security within controlled timelines.

Current practices indicate that the most effective tool for consolidating small private entrepreneurs is cooperatives for production, processing, supply, marketing, and product sales. Although cooperatives exist in the nation, they are currently ineffective. The inefficiency of cooperatives in Kyrgyzstan is likely due to the negative experiences of a centrally planned economy, the lack of clear objectives in their activities, and the reluctance of farmers to support cooperatives.

Every producer in the country remembers that a cooperative means subordination to a leader who dictates what and how to produce, at what price to sell, etc. The country does not yet have positive experiences with other types of cooperatives. Thus, there must be possible directions for consolidating small agricultural entrepreneurs. First and foremost, it is necessary to adopt a new, modern, based on democratic principles approach to forming cooperatives through consultations and training for private producers, eliminating the old stereotype of subordination to a leader. Before creating cooperatives, producers need to be motivated and stimulated to be able to cooperate. Furthermore, it is necessary to organize the work so that private entrepreneurs find it convenient to deal with cooperatives rather than intermediaries.

For instance, experience from other countries shows that in the USA, for example, in the state of Kansas, several large farmers (each with an average of 500 hectares of arable land) organized a service cooperative called "Farmland." Using farmers' contributions, they hired three employees (for a small fee) who were responsible for informing and providing farmers with everything they needed, such as the latest and most modern technologies for growing crops, supplying seeds and fertilizers. Additionally, they were responsible for organizing veterinary services, repairing agricultural equipment, and delivering products to processing enterprises. The American government is very interested in this and therefore allocates funds to the agricultural experimental station and Kansas State University to develop new technologies. The experimental station and university then provide their developments to farmers free of charge through the "Farmland" cooperative employees.

In turn in European Union countries, the structure of agricultural production organization is somewhat different. In Denmark, cooperatives unite almost all agricultural producers, meaning all farmers are members of cooperative societies. In Denmark, each farmer, with an average landholding of 40 hectares, can belong to one or several cooperatives. Farmers in this country are highly specialized, with individual farmers focusing either on a single branch of agriculture, such as cattle farming, pig farming, poultry farming, or crop farming. Cooperatives perform functions related to the production, processing, and marketing of products in domestic and foreign markets, and they also supply farmers with agricultural machinery, fertilizers, feed, seeds, fuel, and other services. This is why 80% of all agricultural products are processed and sold through cooperative organizations, making cooperatives play a significant role in ensuring the country's food security.

In Sweden, agricultural cooperation among farmers is also widespread, particularly in supply, marketing, and service maintenance. Cooperatives in Sweden are highly specialized; some focus on

fertilizers, others on machinery repair, and so on. Each farmer is simultaneously a member of four or five specialized agricultural cooperative organizations.

In Germany, Italy, Spain, and France, agricultural cooperatives take a slightly different form. In these countries, farmers unite into a cooperative called "Agricultural Enterprises Community" or "Joint Agricultural Enterprise," which involves joint use and ownership of agricultural machinery, pooling production means, and sharing capital based on shares. Additionally, partnerships for joint land cultivation are developing in these countries, where not only land but also labor, livestock, and buildings are communal.

In Southeast Asian countries, cooperatives, known as associations, play a significant role in consolidating small farmers. In many Southeast Asian countries (Taiwan, Thailand, the Philippines, South Korea, Japan, and others), farmers use the well-established Japanese system "One Town, One Product." This movement was developed in 1961 by the small mountainous region of Oyama in Japan to consolidate small farmers and develop the rural area. At that time, due to unfavorable geographical conditions in the mountainous region of Oyama, the landholdings of each farmer were very small, and the income level of each farmer was low. As a result, many young people left the Oyama region (leaving only the elderly) to seek employment in the city. Thanks to the positive results of the Japanese system "One Town, One Product" in Oyama, this movement began to spread to neighboring Asian countries, including Africa and Latin America. In Taiwan, for example, several dozen farmers with landholdings ranging from 0.5 to 1 hectare hire staff who handle processing, organizing supply and procurement, and other services.

As demonstrated, the experience of successful countries shows that government intervention plays a crucial role in uniting farmers. Each country develops its system of integration to unite farmers and applies different suitable instruments, considering all the possibilities and characteristics of the locality.

Regarding Kyrgyzstan, cooperatives exist but are currently not functioning effectively. The inefficiency of cooperatives is attributed to the negative experiences of a centrally planned economy, the lack of clear objectives in their activities, and the reluctance of farmers to support cooperatives. Every producer in the country remembers that a cooperative means subordination to a leader who dictates what and how to produce, at what price to sell, etc.

For Kyrgyzstan, there are several existing directions for consolidating small agricultural entrepreneurs to increase the volume of essential food products.

- Developing an Action Algorithm. There is a need for the management bodies to develop an action algorithm to ensure the most effective path to achieving this goal.
- Adopting a New, Modern Approach. It is necessary to start with a new, modern approach to forming cooperatives, based on mutual trust of members. The stereotype of "subordination to a leader" must be eliminated among our producers.
- Motivating and Stimulating Farmers. Before creating cooperatives, farmers must be motivated and stimulated to establish cooperatives.

The work must be organized so that private entrepreneurs find it convenient and beneficial to deal with cooperatives rather than intermediaries. To achieve this, it is necessary to establish a consultation or research center for the development of Kyrgyzstan's agricultural sector (regardless of the center's name, what matters is its effective functioning) to associate with farmers and assist them in increasing the volume of competitive agricultural products. Highly qualified specialists such as programmers, agronomists, veterinarians, engineers, technologists, economists, marketers, managers, lawyers, experts, and agricultural scientists who know the market laws, can guide production development in the right direction and can provide advice to entrepreneurs facing business development challenges should be invited. Investors, businessmen, wholesale procurement and supply workers, IT companies, and research centers should also be attracted. Salaries for center staff can be funded through farmers' contributions or the state budget. If there are not enough highly qualified agricultural specialists in Kyrgyzstan, retired foreign specialists can be invited through international organizations such as the Japan International Cooperation Agency (JICA) from Japan, South Korea, and others, who are willing to assist businessmen and farmers in developing agriculture in Kyrgyzstan. The experience of Malaysia is noteworthy in this regard. One of the main factors in Malaysia's economic prosperity is attracting highly qualified retired foreign specialists from Japan under the "Malaysia My Second Home" program. The Malaysian government supports all retired specialists from Japan who express their willingness to assist Malaysian businessmen and the economy.

Next, the center needs to organize the work of the departments for integrated production, crediting, processing, supply, consulting, and product sales so that each farmer receives the necessary information and maximum support (from field to consumption) from these departments. The center should perform service functions through its subdivisions, meaning that agricultural producers come

together for joint activities in the production, processing, and sale of certain types of products while maintaining their legal and economic independence. Additionally, the center should only provide services to farmers or enterprises that understand the importance of the center's work as a driving force. Therefore, it is necessary to promote and advertise across Kyrgyzstan the importance and benefits of the center's work for farmers through the media, the Internet, and other means to unite all private producers in the country.

For example, the consulting function includes:

- Providing knowledge in the form of management training on new agricultural production techniques and product processing (consulting should be conducted at the production site, and individual training at each worker's workplace).
- Transferring knowledge and technologies for growing agricultural crops.
- Conducting training and retraining of personnel.
- Jointly combating agricultural pests and infectious animal diseases.
- Researching new varieties of agricultural crops and animal breeds.
- Developing and adapting new technologies considering the natural conditions of Kyrgyzstan.
- Guaranteeing the property rights of private agricultural entrepreneurs, etc.

The supply function of the center comprises:

- Providing equipment.
- Developing technologies.
- Performing pre-sale and warranty service.
- Consulting on the operation of technical equipment.
- Supplying fuel and lubricants, feeds, livestock, seeds, fertilizers, and other resources necessary for agricultural production.
- Searching for and delivering modern equipment, etc.

It should be noted that, in Germany, Denmark, and Belgium, material and technical support and service for farmers' equipment play a significant role in the supply and sales cooperative market. The supply system operates with family dealers consisting of 5-7 people. Agricultural machinery is delivered from the manufacturer to the branch, which then passes the equipment to sub-dealers for subsequent sale.

In the USA and Canada, supply and sales cooperatives also play a crucial role in providing material and technical support to farmers. For example, in the 1990s, over 5,000 such cooperatives operated in the USA. These cooperatives supplied building materials, feeds, fuel and lubricants, mineral fertilizers, seeds, and other goods. In Iowa, Illinois, and Wisconsin, the "Growmark" supply and sales cooperative unites 140 local cooperatives. This union has 340 specialized vehicles for transporting liquid ammonia, 200 trucks, 90 fuel tankers, 90 trade vehicles, and a large central warehouse. American local cooperatives sell production means at retail prices. The markup on the wholesale price is 5–8% for gasoline, 3% for pesticides, and 18–20% for mineral fertilizers.

The sales function should perform the following service functions: studying the local and external consumer markets, assisting producers in selling their products and purchasing the necessary materials through special programs linking small and medium producers with wholesale buyers and processors (based on short-term and long-term contracts and agreements). The center is responsible for the quality of the goods.

Once farmers have united and started working with the center's subdivisions, increased their income, and realized the benefits and importance of working with the center, it is crucial to gradually teach them the stringent requirements of the modern market, namely: compliance with quality standards (local and international), minimizing production costs, delivering large batches, strict requirements for production technology and delivery conditions, etc.

Among the possible directions for solving the second task – ensuring the economic accessibility of food – is, firstly, facilitating the establishment of economic entities in rural areas of Kyrgyzstan. In other words, it is necessary to create and develop processing enterprises in each region of the country, considering the local characteristics (priorities) to ensure effective employment of the working-age population and raise income levels. Recent practices show that the most effective tool for ensuring the economic accessibility of food is the development of agricultural processing enterprises in rural areas. The experience of several countries, such as China, demonstrates that they have improved the living standards of rural residents by creating new jobs in rural areas through the establishment and development of township and village enterprises (farmers' enterprises in rural areas), which have become the main source of income growth for farmers and rural economic development. The activities of township and village enterprises include not only the processing of agricultural products but also production, construction, trade, public catering, and rural services.

Secondly, it is necessary to create favorable conditions for investors: primarily ensuring conditions that guarantee the return on investment, i.e., guaranteeing the protection of investor rights from raiding, crime, etc. This requirement can be achieved either by providing foreign investments with state guarantees or by establishing a special insurance fund to ensure this requirement. The presence of laws or bylaws on investment return guarantees, as shown by global and our own experience, does not provide the required assurance. The experience of successful countries, such as China, indicates that they have improved their people's welfare through direct foreign investments, tax incentives, and the creation of free economic zones. Direct foreign investments have made a significant contribution to the adoption of advanced and modern technologies. The Chinese government attracted foreign investments from countries with modern technologies that benefited the production of competitive processed products.

Regarding possible directions for solving the third task – ensuring food safety – this is, based on international good practices and assessment, one of the main tasks facing the state, requiring substantial financial resources. Ensuring food safety is also one of the important and pressing issues for developing countries in the context of globalization. Without ensuring conditions for assessing the quality of produced products, there is no point in discussing the production of competitive products.

In Kyrgyzstan, laboratories primarily conduct food product tests according to GOST (State) standards, many of which do not align with the testing methods accepted by international standards such as the Codex Alimentarius and ISO 22000. The equipment used in national food safety laboratories is outdated both physically and morally, having been in use since the Soviet era. Consequently, these food safety laboratories cannot test elements such as the quantitative content of melamine, dioxins, hormonal drugs, radionuclide strontium-90, benzopyrene, nitrosamines, and others in food products.

It is important to note that primary production is not inspected. Almost every agricultural producer uses fertilizers, pesticides, veterinary drugs, feeds, and additives with unknown quality and safety characteristics in their production. It is unsurprising that most private entrepreneurs (food enterprises) in the country are unaware of international standards such as the OIE Terrestrial Animal Health Code, Codex Alimentarius, Halal, and the implementation of the HACCP system and GlobalGAP. Additionally, private food enterprises in Kyrgyzstan do not have their laboratories.

As Kyrgyzstan is a member of the WTO, WHO, FAO, and OIE, it is crucial to modernize laboratories by implementing the HACCP system, GlobalGAP, and through the Halal industry. This is because most food products produced in the republic do not meet safety requirements, there is no unified and

structured food safety policy, the national laboratory infrastructure is inadequate, and there is no system of laboratory services for production control.

The primary challenges confronting the Kyrgyz Republic in the field of food safety can be categorized as follows:

- The lack of a unified and structured food safety policy.
- Weak laboratory infrastructure throughout the entire food safety chain.
- Low awareness among business entities about the HACCP system, ISO 22000:2005 standard, Codex Alimentarius, GlobalGAP certification, and Halal.
- Insufficient knowledge among private food enterprises on implementing the HACCP system, ISO 22000:2005 standard, Codex Alimentarius, GlobalGAP certification, and Halal.
- There is a shortage of personnel in the field of food safety.
- Private food entrepreneurs do not have their own laboratories.

The possible mechanisms and tools for solving the aforementioned problems to achieve food safety in Kyrgyzstan.

Solving the First Problem: The state should conduct a unified food safety policy by developing a concept for creating a unified regulatory framework that considers all international system requirements (HACCP, GlobalGAP, Halal).

Solving the Second Problem: The issue of weak laboratory infrastructure can be resolved through the modernization of national laboratories by implementing international systems like HACCP, GlobalGAP, and Halal. The state should stimulate and support the private sector in applying the HACCP system through information dissemination, consultations, and staff training. Additionally, a special subject and department on HACCP systems, GlobalGAP, and Halal standards should be introduced in universities that train specialists in agricultural production, sanitary and veterinary hygiene, and food production technology (KNAU named after K. I. Skryabin, KGTU named after I. Razzakov, etc.). Furthermore, to encourage private producers to apply food safety standards, special shelves should be organized in Kyrgyzstan's trade networks specifically for domestic food producers who have ISO 22000:2005 standard, Codex Alimentarius, GlobalGAP, and Halal certification.

The government should also strengthen control over food quality. Global practices show that such problems are addressed by modernizing food distribution channels, reducing the use of fertilizers and pesticides in crop production, expanding environmentally friendly farming methods, and processing

livestock waste. For instance, South Korea implemented the HACCP system in 1997. By 2003, all livestock slaughter points were brought under control. After three years of preparation, in 2006, the government began regulating the GlobalGAP program and designated 21 institutions as certification agencies. Approximately 3,700 domestic farms participated in this program. The number of agricultural product safety tests increased from 43,000 in 2000 to 66,000 in 2006.

In Kyrgyzstan, as previously noted, primary production is not inspected, resulting in most agricultural producers using fertilizers, pesticides, veterinary drugs, feeds, and additives with unknown quality and safety characteristics. In other countries, such issues are addressed through subsidies and various compensatory payments. For example, to ensure safe food for the population, South Korea introduced subsidies in 1999 to compensate for losses incurred from reduced crop yields due to environmentally friendly farming methods. In 2006, approximately 27,000 domestic farms that produced organic products without chemicals received full payments amounting to $11.9 million. Government support was provided to local authorities to fund environmentally friendly farming practices.

This approach to solving such a problem in our country is not feasible due to state financial limitations. Kyrgyzstan cannot afford to pay subsidies to compensate for losses incurred from reduced crop yields resulting from environmentally friendly farming methods. What is the main way to solve this problem in Kyrgyzstan?

First and foremost, it is necessary to develop the Halal industry in the country. The demand for Halal products in the consumer market is increasing every year in Kyrgyzstan, as is the number of food establishments under the Halal logo. According to the National Statistical Committee of the Kyrgyz Republic, 80% of the population in Kyrgyzstan are Muslims. Today, the Halal industry can guarantee the quality of food products, as all unnatural, harmful, and questionable elements are removed from the production process, allowing the private sector to export Halal products to the international market.

Global experience shows that the main exporter of meat products under the Halal brand is New Zealand, followed by Argentina and Brazil. Since 2010, the "Committee for Halal Standardization and Certification" has been operating in Kyrgyzstan as an independent private center. It is considered the establishment of the "Committee for Halal Standardization and Certification" very promising. This committee is involved in the standardization and certification of food products, helping producers to market and advertise their products under the Halal brand in Kyrgyzstan's consumer market and providing services through developing special programs that connect small and medium-sized producers with wholesale buyers and processors.

Through this committee, small producers can be consolidated by creating an integrated network of Halal products. Many scholars note that domestic producers are left alone with their products, and there is no mechanism for linking them with other sectors such as advertising, trade, and processing. However, it is important that this committee can successfully solve the problem of linking producers with subsequent sectors. With the support of such enterprises, ensuring the population has access to safe food products could become a major tool for developing the entire economy. If the state recognizes the importance of this committee and can at least avoid hindering its development, it can be observed excellent results in the near future.

Therefore, considering all possible mechanisms to ensure the food safety of the population in Kyrgyzstan, it becomes clear that the government needs to support private entrepreneurs in the production and processing of food products by helping them establish their laboratories.

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: The low level of income among the population, coupled with high food expenses and poverty, renders essential food products economically inaccessible for many. The state's limited financial capacity restricts its ability to provide direct subsidies and compensatory payments to farmers. To mitigate these challenges, fostering the development of the Halal industry presents a viable solution, given the increasing demand for Halal products in the domestic market. Establishing a robust Halal certification and standardization framework can enhance the quality and export potential of locally produced Halal products.

Physical Inaccessibility: Small-scale agricultural production, insufficient domestic food production, and a high dependency on food imports contribute to the physical inaccessibility of food. Consolidating small private agricultural producers through the formation of cooperatives and associations can significantly improve production efficiency. Successful models from other countries, such as the "One Town, One Product" movement and cooperative structures in the USA and Europe, demonstrate the benefits of organized collective efforts in agricultural production and processing.

Food Safety: The current state of food safety infrastructure is inadequate, with outdated laboratory equipment and a lack of awareness among producers about international food safety standards.

Modernizing national laboratories and implementing HACCP, GlobalGAP, and Halal systems are crucial steps. Enhancing the technical competence and resources of food safety laboratories, coupled with educational initiatives, can ensure the production of safe and high-quality food products. Additionally, establishing private laboratories and engaging highly qualified specialists will further strengthen the food safety framework.

Government Role: The state must play a pivotal role in coordinating and supporting these efforts. Developing a unified and structured food safety policy, incentivizing the adoption of international standards, and creating favorable conditions for investors are essential. Encouraging the establishment of processing enterprises in rural areas and ensuring the protection of investor rights can stimulate economic growth and improve food security.

In summary, addressing the multifaceted challenges of food security in Kyrgyzstan requires a holistic approach that includes economic, political, and environmental strategies. By supporting private sector initiatives, enhancing food safety infrastructure, and fostering cooperative models, Kyrgyzstan can significantly improve its food security landscape.

5.4 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.

One approach to mitigating seasonal impacts is the development of storage and processing infrastructure. Cold storage facilities and food processing plants can extend the shelf life of agricultural products, ensuring a stable food supply throughout the year. Additionally, government-supported market interventions, such as buffer stock policies, can help stabilize prices and protect consumers from seasonal price spikes.

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*: Improved irrigation infrastructure can help counteract the effects of erratic precipitation patterns. The development of modern irrigation networks would allow farmers to maintain stable crop yields during dry periods, reducing dependence on rainfall.
- *Introducing Climate-Smart Agricultural Techniques*: The adoption of climate-resilient farming practices, such as crop rotation, agroforestry, and precision agriculture, can improve soil health and enhance productivity. Encouraging the use of drought-resistant crop varieties and organic fertilizers can further support sustainable agricultural development.
- *Providing Financial Incentives and Credit Access*: Farmers need access to affordable credit to invest in modern agricultural technologies. Government-backed concessional loans can support small and medium-sized farms in acquiring high-quality seeds, irrigation equipment, and efficient storage facilities. Additionally, microfinance institutions can play a crucial role in providing tailored financial products for smallholder farmers, ensuring they have the necessary capital to invest in resilience-building measures. Establishing risk insurance programs to protect farmers from climate-related losses will further encourage investment in agriculture
- *Encouraging Crop Diversification*: Diversification reduces reliance on climate-sensitive crops and improves overall food security. Promoting alternative crops such as safflower and

drought-resistant grains can enhance agricultural resilience. In addition to supporting research into alternative crop varieties, the government can provide incentives for farmers who diversify their production. Developing market linkages and value chains for diversified crops will further ensure economic viability for farmers transitioning to new agricultural products.

- *Developing Storage and Processing Infrastructure*: Investing in food storage and processing facilities will help extend the availability of seasonal food products, reducing market volatility and ensuring a stable food supply. Expanding cold storage capacity, particularly in rural areas, will prevent post-harvest losses and improve food distribution. Additionally, fostering public-private partnerships for agro-processing industries can add value to agricultural products, improve market access, and create employment opportunities in the food sector.

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.

Climate-related food security challenges disproportionately affect rural communities, where agriculture is the primary source of livelihood. Policies aimed at climate adaptation must consider the socioeconomic dimensions of food security, ensuring that vulnerable populations receive adequate support. Social safety nets, such as food assistance programs and targeted subsidies for low-income farmers, can help mitigate the adverse effects of climate change on food accessibility.

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.

6. 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 study demonstrates that economic growth, measured by GDP per capita, has a significant positive impact on food security. Higher GDP per capita is associated with increased consumption of vegetables, fruits, meat, and eggs, which suggests that rising incomes enable households to diversify their diets. Additionally, the prevalence of undernourishment declines with economic growth, emphasizing the role of income expansion in improving food accessibility.

However, income inequality, as measured by the GINI coefficient, presents a challenge. The negative correlation between income inequality and meat consumption suggests that disparities in wealth distribution limit access to protein-rich foods for lower-income groups. Inflation also affects food security by influencing food prices, leading households to alter their consumption patterns, often at the expense of nutritional diversity.

Political stability does not show a statistically significant impact on most food consumption variables, but it plays an important role in reducing undernourishment. The findings suggest that political stability enhances policy implementation, which contributes to improved food distribution and agricultural productivity. However, the study finds that corruption control has a mixed effect; while it positively influences fruit and egg consumption, it does not significantly impact other food products or the prevalence of undernourishment.

The study reveals that environmental variables such as temperature fluctuations and precipitation patterns significantly influence agricultural production and food security. Higher average temperatures contribute to increased vegetable consumption, whereas excessive rainfall negatively impacts vegetable, meat, and egg production. The number of dry days does not significantly affect most food products but leads to increased oil consumption, likely due to shifts in dietary preferences during periods of water scarcity. Beyond economic, political, and environmental factors, the study identifies several structural challenges impeding food security in Kyrgyzstan.

Ensuring food security in Kyrgyzstan entails addressing the physical availability, economic affordability, and safety of basic food products. These tasks are critical to meet the needs of the population and promote national stability.

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 11 summarizes the results of the tested hypotheses, highlighting key findings of food security in Kyrgyzstan.

Table 12. 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,	Partially Accepted	Rainfall variables are mostly insignificant, but dry season positively correlates with oil consumption,

	reducing crop and livestock productivity.		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

Physical Availability of Food Products. The primary task is to increase the volume of basic food products to ensure their physical availability. World practice shows that this problem can be solved through direct and indirect state support. Direct support measures include agricultural subsidies and direct payments to support the income of agricultural producers without directly affecting consumer market prices. Indirect measures include government procurement at higher prices and tariff and non-tariff measures. However, due to the limited state budget, Kyrgyzstan cannot effectively apply these support measures to stimulate domestic agricultural production. Currently, small private producers dominate the agricultural sector in Kyrgyzstan. To increase production volumes, it is essential to consolidate these small producers into larger entities. Modern practice suggests that cooperatives

focused on production, processing, supply, marketing, and sales are the most effective tools for this purpose. Despite the existence of cooperatives in the republic, their inefficiency is linked to the negative experiences of a centrally planned economy, unclear goals, and farmers' reluctance to support them.

There are several steps that need to be taken:

- Developing an Action Algorithm: Governing bodies must develop an effective action plan to achieve this goal.
- Modern Approach to Cooperative Formation: A new, modern approach to forming cooperatives is needed, eliminating the stereotype of subordination to a leader.
- Engaging and Motivating Farmers: Before creating cooperatives, farmers must be interested and encouraged to join. A consulting or research center for the agricultural sector's development in Kyrgyzstan should be established to unite farmers and help them increase the volume of competitive agricultural products. This center should invite well-qualified specialists, including programmers, agronomists, veterinarians, process engineers, economists, managers, lawyers, experts, and scientists in agriculture. They should know market laws, direct production development, and advise entrepreneurs facing business challenges. Attracting investors, businessmen, and employees of wholesale procurement, supply, IT enterprises, and research centers is also necessary. If local specialists are insufficient, foreign specialists of retirement age can be engaged through international organizations to help develop agriculture in Kyrgyzstan.

Economic Affordability of Food Products. Ensuring the economic affordability of food contributes to forming business entities in rural areas. Developing processing enterprises in each region, considering local priorities, ensures effective employment and raises income levels. Modern practice indicates that developing agricultural processing enterprises in rural areas is the most effective tool for this purpose. This can be achieved through preferential loans, tax benefits, and guarantees of property rights for private rural producers. Attracting and stimulating investors by providing conditions that guarantee a return on investment is also crucial.

Food Safety. Ensuring food safety is a primary task of the government and requires substantial financing. It is a critical and urgent issue for developing countries in the context of globalization. Without conditions for assessing product quality, producing competitive products is pointless. Laboratories in Kyrgyzstan mainly conduct food tests according to state standards, which often do not

align with international standards like Codex Alimentarius and ISO 22000. The equipment in national food safety laboratories is outdated, rendering them unable to test elements such as melamine, dioxins, hormonal preparations, and nitrosamines in food products. As Kyrgyzstan is a member of the WTO, WHO, and FAO, it is necessary to modernize laboratories by implementing HACCP and GlobalGAP systems.

Sector-Specific Policy Recommendations. Addressing food security also needs specific recommendations to achieve self-sufficiency and reduce dependence on imports. In the **bread and bakery sector,** improving wheat quality and increasing gluten content calls for the breading of new wheat varieties adapted to Kyrgyzstan's climatic conditions, alongside timely irrigation practices.

For the **sugar sector,** government support or subsidies are necessary for acquiring modern sugar processing equipment to reduce production costs. Establishing agreements with sugarcane-producing countries can ensure affordable supplies and decrease reliance on imports. In the **vegetable oil sector,** preferential loans should be provided to farmers engaged in cultivating oil seeds on more than 10 hectares and to entrepreneurs processing refined vegetable oil. This will help increase vegetable oil production. For technological improvement in oilseed cultivation and processing, it is necessary to attract investors with appropriate machinery and modern technologies.

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. Moreover, the limited availability of detailed, disaggregated data may affect the precision of the findings.

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 missed.

Geographic factor. The research primarily examines the food security of the Kyrgyz Republic within the national context, but it can be extended with comparative analysis with neighboring countries or at the Central Asian regional level.

Further Research Directions and Suggestions

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 for 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.

This need for strategic adaptation is further underscored by Kyrgyzstan's lack of dedicated research institutions focused on agriculture and food security, a gap that hinders its ability to address systemic challenges effectively. Establishing local agricultural research centers is essential for the following reasons:

- Local centers can conduct detailed analyses tailored to Kyrgyzstan's unique geographical, cultural, and economic context, offering evidence-based recommendations to policymakers.
- These centers can provide real-time data and expert insights to help the government craft responsive and effective food security policies. For instance, they can analyze the impact of subsidies, irrigation projects, or trade agreements on local farmers and consumers.
- Research centers can serve as hubs for disseminating knowledge and best practices. Through extension programs, they can train farmers in climate-smart agriculture, pest management, and efficient resource utilization.

Beyond the national efforts, these research centers can facilitate international cooperation in the Central Asian region. Collaboration across borders in areas such as education, research, and

agricultural innovation could significantly enhance food security. In order to achieve this the following key initiatives should be considered:

- Develop joint degree programs and exchange opportunities for students and researchers in agriculture, food technology, and environmental sciences.
- Establish partnerships with institutions in neighboring countries to conduct collaborative studies on shared challenges such as water resource management, climate resilience, and trade policies.
- Foster cross-border investments and partnerships in agri-businesses, focusing on mechanization, processing, and value chain development.
- Develop a regional framework for monitoring and mitigating risks such as droughts, floods, and pest outbreaks, which have transboundary implications.

In addition to regional collaboration, Kyrgyzstan could benefit from strengthening its partnerships with international organizations and donors. Entities such as the Food and Agriculture Organization (FAO), the World Bank, and the Asian Development Bank can provide technical assistance, funding, and capacity-building support.

By fostering collaboration between local research institutions, the government, and international partners, Kyrgyzstan can create a robust food security framework that ensures the well-being of its population. These efforts must prioritize inclusivity, sustainability, and resilience, addressing both immediate needs and long-term challenges. Establishing Kyrgyzstan as a hub for agricultural research and innovation in Central Asia could contribute not only to national food security but also to regional prosperity.

7. 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.

8. 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 are among the most significant determinants of food security. The study demonstrates that GDP per capita has a pronounced positive impact on food accessibility and dietary diversity. As households experience higher incomes, they are more likely to afford a broader range of nutritious foods, such as vegetables, fruits, meat, and eggs. However, the benefits of economic growth are not equally distributed. Income inequality remains a critical issue, limiting the ability of lower-income households to access protein-rich and diverse diets. This disparity highlights the importance of targeted food assistance programs and policies aimed at reducing economic inequality, which directly affects the nutritional outcomes of vulnerable populations. Furthermore, inflation exacerbates food security concerns by driving up food prices, reducing real incomes, and forcing households to compromise on nutritional quality. These economic challenges illustrate the need for interventions that address both poverty and inflation to ensure broader access to affordable and nutritious food.

Political governance plays a nuanced role in food security. While political stability improves policy implementation and enhances the efficiency of food distribution, it does not significantly impact the consumption patterns of most food categories. The role of governance quality, particularly in corruption control, emerges as a critical factor. Corruption control is found to have mixed effects: it positively influences the consumption of certain food items, such as fruits and eggs, but fails to substantially impact other categories or the overall prevalence of undernourishment. These findings highlight the importance of improving governance and transparency to ensure that resources are directed toward agricultural development and nutrition programs, ultimately enhancing food security outcomes.

Environmental factors also play a pivotal role in shaping food security in Kyrgyzstan. The research reveals that climatic variables such as temperature fluctuations and precipitation patterns have significant implications for agricultural productivity and dietary patterns. Higher average temperatures, for instance, are associated with increased vegetable consumption, reflecting the

adaptability of certain crops to warmer conditions. However, excessive rainfall negatively impacts the production and consumption of protein-rich foods such as meat and eggs, highlighting the vulnerability of agriculture to unpredictable weather patterns. The number of dry days also influences dietary choices, particularly oil consumption, as households adjust their food preferences in response to water scarcity. These findings underscore the need for climate-resilient agricultural practices and infrastructure to mitigate the adverse effects of environmental challenges on food security.

Structural challenges further complicate Kyrgyzstan's food security landscape. Small-scale agricultural production limits the efficiency and competitiveness of the sector, preventing farmers from achieving economies of scale. Additionally, the country's heavy reliance on food imports increases its vulnerability to global market fluctuations and price volatility. Key staples such as wheat and vegetable oil are predominantly imported, making the domestic market highly sensitive to external shocks. The lack of adequate food processing and storage infrastructure further exacerbates the situation, leading to significant post-harvest losses and reducing overall food availability. Outdated food safety regulations and insufficient laboratory capacities also hinder the production and distribution of high-quality, safe food products, posing risks to public health and limiting market access for local producers.

To address these multifaceted challenges, the study proposes a series of policy recommendations. Expanding irrigation systems and promoting climate-smart agricultural practices are crucial steps to enhance agricultural productivity and mitigate environmental risks. Investing in modern irrigation networks can help farmers maintain stable crop yields during dry periods, while climate-resilient farming techniques, such as agroforestry, crop rotation, and the use of drought-resistant crop varieties, can improve sustainability and resilience. Providing financial incentives, such as concessional loans and subsidies, can enable farmers to adopt modern agricultural technologies and improve their productivity. Strengthening food processing and storage infrastructure is another critical area. Investments in cold storage facilities and food processing plants can reduce post-harvest losses and ensure the year-round availability of seasonal food products, enhancing both physical and economic accessibility.

Economic policies must also prioritize reducing income inequality and improving affordability. Targeted social protection programs, such as food assistance and cash transfer schemes, can alleviate the impact of economic disparities on vulnerable populations. Additionally, 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, improving their competitiveness and income levels.

Improving food safety standards is another key recommendation. Modernizing laboratory infrastructure and aligning regulatory frameworks with international standards such as HACCP and GlobalGAP can enhance food safety and quality. Training agricultural producers and food processors in compliance with these standards will not only improve public health but also boost the competitiveness of Kyrgyzstan's food exports. A structured national food safety policy is essential to ensure effective regulatory oversight and enforcement.

The findings of the study highlight the importance of coordinated efforts to address Kyrgyzstan's food security challenges. Government intervention is crucial in developing and implementing unified policies that integrate economic, political, and environmental strategies. Creating favorable conditions for private sector participation, fostering public-private partnerships, and encouraging community-driven initiatives can amplify the impact of these efforts. Regional cooperation with neighboring Central Asian countries can also provide valuable opportunities for knowledge sharing, joint ventures, and coordinated responses to shared challenges.

In conclusion, Kyrgyzstan's food security is shaped by a complex 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 more resilient food system that ensures stable, affordable, and nutritious food for its population. This research work provides a foundation for future research and policy development and implementation, contributing to the broader goal of achieving sustainable food security in Kyrgyzstan.

9. REFERENCES

Abdullah, Qingshi, W., & Akbar, M. (2022). A Spatial Panel Analysis of Food Security and Political Risk in Asian Countries. *Social Indicators Research*, *161*(1), 345–378. https://doi.org/10.1007/s11205-021-02821-5

Abdymalikov, K. (2007). *Economy of Kyrgyzstan (in the Transitional Period)* (Vol. 560p).

ADB. (2014). *The Kyrgyz Republic: Strategic Assessment of the Economy - Promoting Inclusive Growth*. Asian Development Bank. www.adb.org

Akramov, K. T., & Shreedhar, G. (2012). *Economic Development, External Shocks, and Food Security in Tajikistan*.

Atabekov, A. K., & Zulpukarova, T. A. (2013). Agricultural production and food security of Kyrgyzstan in the context of globalization. *Alatoo Academic Studies*, *8*(2).

Bang, T. C. (2023). *A farm-to-table supply chain to address food safety for fresh food in Vietnam*. https://doi.org/10.26686/WGTN.22783304

Beke, J., & Fehér, I. |. (2018). Agricultural and environmental policies. In *Hungarian University of Agriculture and Life Sciences Kosáry Domokos Library and Archives*. http://opac3.godollo.uni-mate.hu/en/record/-/record/KDKL555659

Ben Hassen, T., & El Bilali, H. (2022). Impacts of the Russia-Ukraine War on Global Food Security: Towards More Sustainable and Resilient Food Systems? *Foods 2022, Vol. 11, Page 2301*, *11*(15), 2301. https://doi.org/10.3390/FOODS11152301

Bezlepkina, I., Oskam, A., Lansink, A. O., & Huirne, R. (2004). Development and performance of Russian agricultural enterprises, 1990–2001. *Post-Communist Economies*, *16*(4), 439–457. https://doi.org/10.1080/1463137042000309557

Bobojonov, I., & Aw-Hassan, A. (2014). Impacts of climate change on farm income security in Central Asia: an integrated modeling approach. *Agric Ecosyst Environ*, *188*, 245–255. https://doi.org/10.1016/j.agee.2014.02.033

Bobojonov, I., Teuber, R., Oshakbayev, D., & Glauben, T. (2015). *Agrifood sector transformation and its implications on development of small farmers in Kazakhstan*. https://doi.org/10.22004/AG.ECON.211357

Burdukov, P. T., & Saetgaliev, R. Z. (1999). *Russia in the Global Food Security System*.

Cailov, C., & Bekov, T. (2023). Food Security in Kyrgyzstan: Threats and Mitigations Mechanisms. *Reforma*, *4*(96), 6–11. https://doi.org/10.4060/CB4474RU

CBD KR. (2009, March 3). *Regulation on Monitoring and Food Security Indicators of the Kyrgyz Republic*. Centralized Database of Legal Information of the Kyrgyz Republic. http://cbd.minjust.gov.kg/act/view/ru-ru/59774?cl=ru-ru

CBD KR. (2010). *Decree On Approval of Average Physiological Norms of Consumption of Basic Foodstuffs for the Population of the Kyrgyz Republic*. Centralized Database of Legal Information of the Kyrgyz Republic. http://cbd.minjust.gov.kg/act/view/ru-ru/92065

CBD KR. (2023). *Law of the Kyrgyz Republic on Food Security, #138, August 4, 2008*. The Centralized Database of Legal Information of the Kyrgyz Republic. https://cbd.minjust.gov.kg/202397/edition/1244333/ru

CFS. (2009). *REFORM OF THE COMMITTEE ON WORLD FOOD SECURITY FINAL VERSION*. www.fao.orgW/K6023/e

CFS. (2012). *COMMITTEE ON WORLD FOOD SECURITY*. www.fao.org

CFS. (2014). *Report of the 41st Session of the Committee on World Food Security*. www.fao.org

Cherikova, D., Ermekova, A., Dzhylkychieva, Z., & Koichieva, Z. (2021). *Features of the Formation of Secondary Resources Processing of Sugar Industry in the Kyrgyz Republic*. www.eurasian-scientific-editions.org

Choi, J. (2016). *Competitiveness of the Kyrgyz economy in the wake of accession to the Eurasian Customs Union: Selected issues and opportunities*.

Christmann, S., Martius, C., & Bedoshvili, D. (2009). *Food Security and Climate Change in Central Asia and the Caucasus*. https://www.researchgate.net/publication/235792149

Clapp, J. (2017). Food self-sufficiency: Making sense of it, and when it makes sense. *Food Policy*, *66*, 88–96. https://doi.org/10.1016/J.FOODPOL.2016.12.001

Conti, V., Sitko, N. J., & Ignaciuk, A. (2018). *How do extreme weather events affect livestock herders' welfare? Evidence from Kyrgyzstan*. FAO. www.fao.org/publications

Conway, G. R., & Barbier, E. B. (2013). After the green revolution: Sustainable agriculture for development. *Taylor and Francis Ltd 5*, *9781315066820*, 1–205. https://doi.org/10.4324/9781315066820/GREEN-REVOLUTION-EDWARD-BARBIER-GORDON-CONWAY/ACCESSIBILITY-INFORMATION

Delehanty, J., & Rasmussen, K. (1995). Land Reform and Farm Restructuring in the Kyrgyz Republic. *Post-Soviet Geography*, *36*(9), 565–586. https://doi.org/10.1080/10605851.1995.10641007

Djailov, D. S. (2010). Economic Problems of food market development in conditions of deepening integration processes. *Reforma*.

Duisenbekova, A., Kulisz, M., Danilowska, A., Gola, A., & Ryspekova, M. (2024). Predicting Food Consumption to Reduce the Risk of Food Insecurity in Kazakhstan. *Economies*, *12*(1). https://doi.org/10.3390/economies12010011

Ehrlich, P. R. (1968). *The Population Bomb Revisited*. https://www.researchgate.net/publication/42766072

Erokhin, V., Diao, L., Gao, T., Andrei, J. V., Ivolga, A., & Zong, Y. (2021). The Supply of Calories, Proteins, and Fats in Low-Income Countries: A Four-Decade Retrospective Study.

International Journal of Environmental Research and Public Health 2021, Vol. 18, Page 7356, *18*(14), 7356. https://doi.org/10.3390/IJERPH18147356

Erseitova, A., Muratova, D., Sarikulova, L., Sarikulova, L., Moldobekova, A., Moldasheva, A., & Atasheva, D. (2017). *Sugar beet production in the Republic of Kazakhstan*. *38*(24).

Evans, L., Grimes, A., Wilkinson, B., & Teece, D. (1996). Economic Reform in New Zealand 1984-95: The Pursuit of Efficiency. *Journal of Economic Literature*.

FAO. (2006). *Policy Brief Changing Policy Concepts of Food Security*. http://www.foodsecinfoaction.org/

FAO. (2019). *Food Security and Nutrition Profile of the Kyrgyz Republic*. https://doi.org/10.7%

FAO. (2023a). Europe and Central Asia - Regional Overview of Food Security and Nutrition 2023. In *Europe and Central Asia - Regional Overview of Food Security and Nutrition 2023*. FAO. https://doi.org/10.4060/cc8608en

FAO. (2023b). The State of Food Security and Nutrition in the World 2023. In *The State of Food Security and Nutrition in the World 2023*. FAO; IFAD; UNICEF; WFP; WHO; https://doi.org/10.4060/cc3017en

FAO, IFAD, UNICEF, WFP, & WHO. (2024). The State of Food Security and Nutrition in the World 2024 - Financing to end hunger, food security and malnutrition in all its forms. In *The State of Food Security and Nutrition in the World 2024*. FAO; IFAD; UNICEF; WFP; WHO; https://doi.org/10.4060/cd1254en

FAOSTAT. (2024). *Prevalence of undernourishment*. https://www.fao.org/sustainable-development-goals-data-portal/data/indicators/2.1.1-prevalence-of-undernourishment/en

FAO-WHO. (2019). *Analysis of the legislation of the Kyrgyz Republic for compliance with the requirements of the Alimentarius Code*. https://cdn.who.int/media/docs/default-source/food-safety/codex-trust-fund/project-outputs/ctf2-rep-kyrgyzstan-policyanalysis-element3-ru.pdf?sfvrsn=de986a37_5&download=true

FAO-WHO. (2024). *About Codex | CODEXALIMENTARIUS FAO-WHO*. https://www.fao.org/fao-who-codexalimentarius/about-codex/en/#c453333

Field, A. P. (2009). *Discovering statistics using SPSS : (and sex and drugs and rock "n" roll)*. SAGE Publications.

FSN Forum, F. (2016). *Food security and nutrition programme for Kyrgyzstan in action. How to implement policy in the most efficient way?* www.fao.org/fsnforum/eca/activities/discussions/kyrgyzstanFSNForuminEuropeandCentralAsiawww.fao.org/fsnforum/eca

Gujarati, D. (2004). *Basic Econometrics* (4th edition). The McGraw-Hill Companies.

Hanjra, M. A., & Qureshi, M. E. (2010). Global water crisis and future food security in an era of climate change. *Food Policy*, *35*(5), 365–377. https://doi.org/10.1016/j.foodpol.2010.05.006

Harris, F., Amarnath, G., Joy, E. J., Dangour, A. D., & Green, R. F. (2022). Climate-related hazards and Indian food supply: Assessing the risk using recent historical data. *Global Food Security*, *33*. https://doi.org/10.1016/j.gfs.2022.100625

Herrera-Cuenca, M., Landaeta Jimenez, M., & Sifontes, Y. (2021). Challenges in Food Security, Nutritional, and Social Public Policies for Venezuela: Rethinking the Future. *Frontiers in Sustainable Food Systems*, *5*, 635981. https://doi.org/10.3389/FSUFS.2021.635981/BIBTEX

Hu, Z., Zhang, C., & Tian, H. (2014). *Temperature Changes in Central Asia from 1979 to 2011 Based on Multiple Datasets**. https://doi.org/10.1175/JCLI-D-13

IFPRI. (2019). *2019 Global Food Policy Report*. https://doi.org/https://doi.org/10.2499/9780896293502

IMF. (2021). *Kyrgyz Republic: Country Report*. https://www.imf.org/en/Publications/CR/Issues/2021/07/30/Kyrgyz-Republic-2021-Article-IV-Consultation-Press-Release-and-Staff-Report-463121

International Trade Center. (2023). *Trade Map - List of supplying markets for a product imported by Kyrgyzstan*. https://www.trademap.org/Country_SelProductCountry_TS.aspx?nvpm=1%7c417%7c%7c%7c%7c1101%7c%7c%7c4%7c1%7c1%7c1%7c2%7c1%7c2%7c2%7c1%7c1

IPCC. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability.* https://doi.org/10.1017/9781009325844

Ivanov, Y. (2022). Revolutions in Kyrgyzstan. *Societies and Political Orders in Transition*, 517–547. https://doi.org/10.1007/978-3-030-86468-2_20

Jauregui, A., Heriot, K. C., & Mitchell, D. T. (2021). Corruption and formal-sector entrepreneurship in a middle-income country: spatial analysis of firm births in the Mexican states. *Small Business Economics*, *57*(4), 1957–1972. https://doi.org/10.1007/S11187-020-00388-Y/TABLES/7

Jia, M., Zhen, L., Yang, W., & Wang, S. (2023). Changing Food Consumption Pattern and Influencing Factors in Bangladesh. *Foods 2023, Vol. 12, Page 401*, *12*(2), 401. https://doi.org/10.3390/FOODS12020401

Junussova, M., Mogilevskii, R., Maulsharif, M., Macchioni Giaquinto, A., Mane, E., Enikeeva, Z., Ianova, M., Niiazaliev, B., & Chalbasova, S. (2024). *Gendered impact of the COVID-19 pandemic on food security, agricultural production, income and family relations in rural areas of Kyrgyzstan, Tajikistan and Uzbekistan - Working Paper, 76*. https://doi.org/10.4060/cd0401en

Khromov, Y. (1996). International Food Security and Interests of Russia. *APK: Econolmics, Management*, *2*, 19–22.

Koichuev, T. (2007). *Selected Writings. Economy of Kyrgyzstan at a turning point*.

Laborde, D., Martin, W., & Vos, R. (2022). Impacts of COVID-19 on global poverty and food security: What more do we know now? *Food Security & Poverty*, 30–36. https://doi.org/10.2499/9780896294226

Lerman, Z., & Sedik, D. (2009). Sources of Agricultural Productivity Growth in Central Asia: The Case of Tajikistan and Uzbekistan. In *Policy Studies on Rural Transition* (Vols. 2009–5). https://doi.org/10.22004/ag.econ.54713

Lerman, Z., & Sedik, D. (2018). Transition to smallholder agriculture in Central Asia. *Journal of Agrarian Change*, *18*(4), 904–912. https://doi.org/10.1111/JOAC.12282

Lioubimtseva, E., & Henebry, G. M. (2012). Grain production trends in Russia, Ukraine and Kazakhstan: New opportunities in an increasingly unstable world? *Frontiers of Earth Science*, *6*(2), 157–166. https://doi.org/10.1007/s11707-012-0318-y

Loodin, N. (2020). Aral Sea: an environmental disaster in twentieth century in Central Asia. *Modeling Earth Systems and Environment*, *6*(4), 2495–2503. https://doi.org/10.1007/S40808-020-00837-3/FIGURES/3

Luo, M., Liu, T., Meng, F., Duan, Y., Bao, A., Frankl, A., & De Maeyer, P. (2019). Spatiotemporal characteristics of future changes in precipitation and temperature in Central Asia. *International Journal of Climatology*, *39*(3), 1571–1588. https://doi.org/10.1002/joc.5901

Malthus, Th. (1868). *An Essay on the Principle of Population*. https://ecocrisis.wordpress.com/1-2/suprapopulatia/malthus/

Maslow, A. H. (1943). A THEORY OF HUMAN MOTIVATION. *Psychological Review*, *50(4)*, 370–396. https://psycnet.apa.org/doi/10.1037/h0054346

Maxwell, S. (1996). Food security: a post-modern perspective. In *Food Policy* (Vol. 21, Issue 2).

Meyers, W. H., Ziolkowska, J. R., Tothova, M., & Goychuk, K. (2012). *FAO Regional Office for Europe and Central Asia Policy Studies on Rural Transition No Issues Affecting the Future of Agriculture and Food Security for Europe and Central Asia*.

Mogilevskii, R., Abdrazakova, N., Bolotbekova, A., Chalbasova, S., Dzhumaeva, S., & Tilekeyev, K. (2017). *The outcomes of 25 years of agricultural reforms in Kyrgyzstan*. http://www.iamo.de

Mulyo, J. H., Prasada, I. Y., & Nugroho, A. D. (2023). Impact of political and security stability on food security in developing countries: Case of Africa, Asia, Latin America and the Caribbean. *Agricultural Economics (Czech Republic)*, *69*(9), 375–384. https://doi.org/10.17221/142/2023-AGRICECON

Musaeva, D. A. (2008). *Theory and practice of the economy in transition*. Ilim.

Nizaieva, A., Akchurin, R., Biktimirov, R., Musin, R., & Malyshev, L. (2021). Realizing productive capacity of crested wheatgrass varieties in the southern forest-steppe of the Bashkortostan Republic. *E3S Web of Conferences*, *282*, 02009. https://doi.org/10.1051/E3SCONF/202128202009

Novokhatin, V. V. (2016). *THE THEORETICAL JUSTIFICATION OF INTENSIVE GENETIC POTENTIAL OF THE VARIETIES OF SOFT WHEAT*. https://doi.org/10.15389/agrobiology.2016.5.627rus

NSC KR. (2023a). *Food Security and Poverty Information Bulletin Kyrgyz Republic*. www.stat.gov.kg

NSC KR. (2023b). *Kyrgyzstan in figures*.

NSC KR. (2023c). *Poverty Level in the Kyrgyz Republic 2022*.

NSC KR. (2023d). *Standards of living of the population of the Kyrgyz Republic*. Национальный стат. ком-т Кыргызской Республики.

NSC KR. (2024). *Food Security and Poverty Information Bulletin Kyrgyz 2023*. www.stat.

Nyokabi, N. S., Phelan, L., Gemechu, G., Berg, S., Lindahl, J. F., Mihret, A., Wood, J. L. N., & Moore, H. L. (2023). From farm to table: exploring food handling and hygiene practices of meat and milk value chain actors in Ethiopia. *BMC Public Health*, *23*(1), 1–17. https://doi.org/10.1186/S12889-023-15824-3/FIGURES/5

Oruzbaev, A. (2000). *Deepening agrarian reform and problems of agribusiness development.*

Otsuka, K., & Sugihara, K. (2022). *Correction to: Paths to the Emerging State in Asia and Africa*. C1–C1. https://doi.org/10.1007/978-981-13-3131-2_13

Otunchieva, A., Borbodoev, J., & Ploeger, A. (2021). The transformation of food culture on the case of Kyrgyz nomads—A historical overview. *Sustainability (Switzerland)*, *13*(15). https://doi.org/10.3390/su13158371

Petrick, M., & Pomfret, R. (2016). *Agricultural policies in Kazakhstan*. http://www.iamo.de

Peyrouse, S. (2013). *Food Security in Central Asia*.

Porkka, M., Guillaume, J. H. A., Siebert, S., Schaphoff, S., & Kummu, M. (2017). The use of food imports to overcome local limits to growth. *Earth's Future*, *5*(4), 393–407. https://doi.org/10.1002/2016EF000477

Poudel, S., & Kotani, K. (2013). Climatic impacts on crop yield and its variability in Nepal: do they vary across seasons and altitudes? *Climatic Change*, *116*(2), 327–355. https://doi.org/10.1007/s10584-012-0491-8

Rabbi, M. F., Oláh, J., Popp, J., Máté, D., & Kovács, S. (2021). Food security and the covid-19 crisis from a consumer buying behaviour perspective—the case of bangladesh. *Foods*, *10*(12). https://doi.org/10.3390/foods10123073

Rathu Manannalage, K. M. L., Chai, A., & Ratnasiri, S. (2023). Eating to live or living to eat? Exploring the link between calorie satiation, Bennett's law, and the evolution of food preferences. *Journal of Evolutionary Economics*, *33*(4), 1197–1236. https://doi.org/10.1007/S00191-023-00828-4/TABLES/11

Ray, D. K., West, P. C., Clark, M., Gerber, J. S., Prishchepov, A. V., & Chatterjee, S. (2019). Climate change has likely already affected global food production. *PLOS ONE*, *14*(5), e0217148. https://doi.org/10.1371/JOURNAL.PONE.0217148

Serova, E., & Yanbykh, R. (2023). The food price situation in Central Asia. *Studies in Agricultural Economics*, *125*(2), 69–76. https://doi.org/10.7896/j.2549

Serova, E. V. (1999). *Agricultural Economics*.

Serrano, F., & Mazat, N. (2013). *Munich Personal RePEc Archive Quesnay and the analysis of the surplus in an agrarian capitalist economy*.

Smith, V. H., & Glauber, J. W. (2020). Trade, policy, and food security. *Agricultural Economics*, *51*(1), 159–171. https://doi.org/10.1111/AGEC.12547

Spoor, M. (1999). *AGRARIAN TRANSITION IN FORMER SOVIET CENTRAL ASIA: A COMPARATIVE STUDY OF KAZAKHSTAN, KYRGYZSRTAN AND UZBEKISTAN*.

Swinnen, J., Van Herck, K., & Sneyers, A. (2011). *The Kyrgyz Republic Opportunities and challenges to agricultural growth COUNTRY HIGHLIGHTS*.

Tokobaev, N. (2014). Problems of ensuring food security in Kyrgyzstan in transition economy. *Alatoo Academic Studies*, *9*, 137–145.

Uchendu, F. N., & Abolarin, T. O. (2015). Corrupt practices negatively influenced food security and live expectancy in developing countries. *PAMJ. 2015; 20:110*, *20*(110). https://doi.org/10.11604/PAMJ.2015.20.110.5311

Uddin, M., & Uddin, M. S. (2024). Non-Tariff Barriers on Technical, Sanitary and Phytosanitary Measures: An Overview Under WTO Laws. *International Journal of Global Community*, *7*(2-July), 105–122. https://journal.riksawan.com/index.php/IJGC-RI/article/view/228

UN. (2015). *Transforming our world: the 2030 Agenda for Sustainable Development*.

UN. (2023). *The-Sustainable-Development-Goals-Report-2023*.

United Nation. (2025). *Kyrgyzstan | Geospatial, location data for a better world*. https://www.un.org/geospatial/content/kyrgyzstan

Vinokurov, E., Ahunbaev, A., Chuyev, S., Usmanov, N., Zaboev, A., Malakhov, A., Pereboev, V., Ksenofontov, M., Polzikov, D., Potapenko, V., & Shalimov, V. (2023). *Food Security and Agro-Industrial Potential of the Eurasian Region*. https://papers.ssrn.com/abstract=4425508

Wengle, S. A., Musabaeva, S., & Greenwood-Sánchez, D. (2024). Second Bread: Potato Cultivation and Food Security in Kyrgyzstan. *Journal of Development Studies*. https://doi.org/10.1080/00220388.2024.2374075

WFP. (2009). *Emergency Food Security Assessment Handbook second edition*. www.wfp.org

WFP. (2021). *Annual Performance Report for 2020*.

WFP. (2023a). *Kyrgyz Republic: Annual Country Report 2023*.

WFP. (2023b). *Price Monitoring for Food Security in the Kyrgyz Republic*.

World Bank. (2001). *Kyrgyz Republic: Review of Social Policy and Expenditures*.

World Bank. (2021). *Kyrgyz Republic: General Water Security Assessment*.

World Bank. (2024a). *Global Economic Prospects, June 2024*. https://doi.org/doi:10.1596/978-1-4648-2058-8

World Bank. (2024b). *World Development Indicators | DataBank*. https://databank.worldbank.org/source/world-development-indicators

Yeginbayeva, A., Karipova, A., Petrovcikova, K., & Issayeva, B. (2023). The formation of a mechanism to improve the competitiveness of the sugar industry in the Republic of Kazakhstan. *Scientific Horizons, 27*(1), 162–171. https://doi.org/10.48077/SCIHOR1.2024.162

Zakaria, M., Junyang, X., & Fida, B. A. (2016). *Trade Openness, Malnourishment and Income Inequality in South Asia*.

Zhanbekova, Z. H. (2003). Internal and External Threats to Food Security in Kazakhstan. *Vestnik KAZNU, 3*, 23–27.