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Enhancing Food Security in Central Asia and the Caucasus: A SWOT Analysis of Agro-Industrial Potential

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ABSTRACT

This study aims to assess the level of food security in the Caucasus and Central Asia (CCA). Given this region's socioeconomic and environmental challenges, ensuring food security is crucial for achieving its sustainable development. To achieve the goal set in the study, the authors use qualitative research and mathematical methods to process the results. Based on theoretical generalization, comparison, and structural and logical analysis, the study determines the reflection of the concept of food security in official documents and scientific literature, the differences and similarities in approaches to food security in the CCA, the levels of self-sufficiency in basic agro-industrial products, and the ratios of actual consumption of basic foodstuffs per person and accepted consumption norms in the countries of the region. The production, resource, and export potential of the agro-industrial complexes of CCA countries is analyzed through SWOT analysis. The article concludes that at present, the CCA ensures its food security with its production and imports from neighboring countries. This study contributes to the field by offering a structured assessment framework for regional agro-industrial planning and providing policymakers with a data-driven basis for enhancing food security resilience in Central Asia.

1. INTRODUCTION

At present, the food crisis is a major risk that threatens the global economy. The risks faced by the world's food markets are aggravated via the Russian-Ukrainian conflict's trade restrictions in food, fuel, with fertilizers, which caused a sharp rise in input prices, changes in transportation routes, and commodity supply chain disruption.

The focus of this research on food security in the Caucasus and Central Asia (CCA) is critical due to several interconnected socioeconomic and environmental factors that directly impact the sustainability of the region's development. First, food security is a cornerstone of sustainable development, as outlined in the United Nations' Sustainable Development Goals (SDGs), particularly SDG 2: Zero Hunger [1]. Ensuring access to safe, nutritious, and sufficient food is essential for the well-being of populations and the stability of economies [2, 3].

The CCA, with its diverse agricultural systems and varying levels of economic development, faces unique challenges in achieving food security [4]. These include inefficient use of water resources, energy-intensive agricultural practices, and a heavy reliance on imports for key agricultural inputs. These challenges are exacerbated by geopolitical tensions, climate change, and environmental degradation, which threaten the region's ability to maintain a stable food supply. Therefore, evaluating the food security situation in the region is crucial for understanding how these factors affect the ability to achieve sustainable and resilient agricultural systems [5-7].

This research focus is justified by the region's strategic

importance as an agricultural producer. CCA countries possess significant untapped potential in agricultural production and export capacity, but this potential can only be realized through sustainable practices. By addressing inefficiencies in resource use and improving local agricultural productivity, the region can contribute to its food security and global food supply chains.

Proceeding from the fact that CCA countries are chosen as the object for this study, the purpose of the article is to assess the level of food security of the CCA, and the strengths, weaknesses, opportunities, and threats to the realization of production, resource, and export potential of the agro-industrial complexes (AIC) in CCA countries.

Despite growing scholarly interest in food security within the Caucasus and Central Asia (CCA), several critical gaps persist in the literature that hinder the development of effective agro-industrial strategies for the region. Existing research has shown that most studies are focused on analyzing the situation rather than providing a solution, and further experiments should be utilized to provide more effective strategies. Recent studies are often focused on the agricultural spectrum of food security, neglecting the role consumer behavior plays in sustainability [8].

Most research articles focus mainly on the broad assessments of food security, emphasizing trade balances, import dependence reduction, agricultural output, and policy frameworks. However, there is limited integration of qualitative and quantitative analysis that comprehensively evaluates food security across multiple dimensions (i.e., availability, access, utilization, and stability) within the diverse socioeconomic and environmental landscapes of CCA countries.

While studies frequently highlight Central Asia's reliance on food imports, few examine the self-sufficiency of internal agro-industrial products, nor do they provide a comparative analysis of actual versus recommended food consumption per capita across different nations. This gap makes it difficult to assess whether existing policies, trade regulations, and production capacities align with the nutritional needs of the population. Furthermore, the role of agro-industrial complexes in enhancing food security remains underexplored, with literature focusing more on the agro and less on the industrial spectrum [9].

This study aims to bridge these gaps by combining theoretical generalization, comparative analysis, and mathematical modeling to assess the extent to which the CCA's agro-industrial sector can meet food security demands, both through domestic production and strategic imports. By doing so, it contributes valuable insights into policy coherence, agricultural planning, and sustainable development in the region.

In the introduction of this paper the relevance of the study is stated. Further, in a literary review section, approaches to the concept of food security in global practice and the region are examined. The research results include the analysis of food security in the CCA, the ratio of actual indicators, and adopted consumption standards and SWOT analysis of the production, resource, and export potential of the AIC in CCA countries.

2. LITERATURE REVIEW

In the 1994 Human Development Report under the UN Development Programme (UNDP), food security is interpreted as "the availability of basic foodstuffs, which implies sufficient quantity and free access, as well as sufficient purchasing power of the population" [10]. Therefore, the official documents proclaim food security as an objective necessity for the development of mankind in the context of world civilizational development and the globalization of the economic space.

Here we should point out the gradual recognition of the social component of this notion, as described in the 2001 report of the Food and Agriculture Organization (FAO) "The State of Food Insecurity in the World". Here, food security is defined as "a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" [11]. This aspect has given rise to a dual approach to forming food security, which allows for concerted agricultural development while increasing the ability to access food for the poor. This approach is considered in the scientific discourse as a platform for asserting the foundations of sustainable development.

In the evolution of official concepts of food security, the content of this concept has been naturally expanding toward the assertion of the foundations of healthy human life and sustainable development of society. This aspect has become a platform for the formalization of the food security problem in almost all international agreements on the regulation of important components of human activity. The fight against chronic hunger is defined as one of the Global Sustainable Development Goals (SDGs) adopted by the UN General Assembly. The SDGs stipulate that by 2030 all countries should focus on a) overcoming all forms of poverty, b) combating inequality, and c) eliminating the negative manifestations of climate change. The issue of food security is not confined to a single country, as almost all countries, irrespective of their level of political and socioeconomic development, address it.

Food security in Central Asia is influenced by climate change, water scarcity, and political upheaval. The region is dependent on irrigated agriculture, particularly in Uzbekistan, Kazakhstan, and Turkmenistan, which produce water-intensive crops such as cotton and wheat. Additional aggravating factors include glacier melt and shifting rainfall patterns which threaten long-term sustainability. Kazakhstan, which is the largest grain producer in Central Asia, is a key contributor to food supply in the region and there are inequities in terms of access to food. Economic shocks, such as price volatility and trade restrictions further increase food insecurity. Regional cooperation, irrigation efficiency, and crop and income diversification are the best opportunities for ensuring food security in this geopolitically relevant region [12].

Through an analysis of scientific economic studies on food security, we identified three existing concepts of food security, the definitions of which can be classified based on three characteristics: the state of the system, the mechanism of provision, and the level of access (Table 1).

On the contrary, Hao et al. [13] suggest a different and more tailored approach to providing food security in CCA countries. In their study, they recommended after close study of the water-energy and food security levels that Kazakhstan must prioritize food distribution and supply; Kyrgyzstan and Tajikistan should augment energy and food production while enhancing the efficiency of water and food utilization; Turkmenistan ought to expand water resources and food production, as well as improve the efficiency of water and

energy supply; Uzbekistan should increase available resources and optimize the management of water, energy, and food.

In the first concept, the decisive role in ensuring food security is attributed to the state of the system: social relations, the economy, or the food market. The latter two approaches are united by the fact that the defining content of food security is the understanding of the essence of food security as a process rather than as a state. In addition, van Berkum [14] suggests that for roles attributed to state systems in ensuring food security, that aside from strengthening regional food trade and market integration, measures should be taken to enhancing social safety nets to support vulnerable populations [15].

In this context, ensuring food security with the development of the AIC is a priority for the CCA, also the CCA in the framework for this study includes Armenia, Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, with Uzbekistan.

In the past few decades, CCA countries have achieved a high level of food self-sufficiency [16-19]. However, for several product categories, equipment, and special items, considerable import dependence persists [20]. Sun and Zhang [21] using empirical data suggest that import dependence and trade openness can be beneficial to food security in the CCA providing that it does not exceed certain thresholds. Their conclusion on the other hand doesn't negate the importance of self sufficiency but contradicts the idea of market independence. The domestic market of CCA countries is supplied with a considerable amount of high-tech equipment used in crop and livestock production [22]. In the current geopolitical environment, food security challenges are fundamental for CCA countries.

Table 1. The essence of food security based on different characteristics

Characteristic	Defining Feature of the Concept	Definition
State of the system	State of public relations	Food security is a state of development of social relations marked by a set of legal, socio-political, economic, scientific, technical, organizational, informational, and other measures aimed at ensuring that the population has physical and economic access to food that is safe for life and health and sufficient for preventing and overcoming food emergencies
	State of the economy	A state of the economy, provided with appropriate resources, capacity, and guarantees, under which, regardless of internal and external threats, the state (society) retains a continuous ability to ensure the economic and physical accessibility of vital foodstuffs for the entire population in the quantity, quality, and range sufficient for the expanded reproduction of each person under normal conditions and minimally necessary to maintain health and performance in food emergencies
		A state of the economy, in which the sustainable functioning of the agricultural sector ensures the physical and economic accessibility of food, sufficient and balanced nutrition for all segments of the population in the required volume, range, and quality at the level of rational norms, thereby ensuring the highest level of physical and mental health and social development
	State of the food market	The condition of the food market within an individual country, a regional bloc, or globally
		A set of governmental tools and policies aimed at managing the food market to ensure both physical and economic access to sufficient food for maintaining an active and healthy lifestyle
		An overview or assessment of the food market's status at the national, regional, or global level
Provision mechanism	Self-sufficiency	The availability of a sufficient quantity of food products in the country's food market to maintain a healthy lifestyle; the availability of these products for all segments of the population
		Provision of food security by domestic, national forces to supply food to citizens at a medically appropriate level
	State guarantees	The ability of the state to guarantee and meet the food needs of the population under any circumstances at the scientifically justified consumption level and according to its solvent demand
		The ability of the state to provide an adequate level of food consumption for the population by utilizing all the production, financial resources, political opportunities, and other factors available in the state together with the agroeconomic potential
		The ability to meet the needs of the population in food under limited financial and ecological opportunities of the state according to scientifically-grounded norms, individual characteristics of a person, their solvency, and price levels
	Realization of agricultural potential	Provision with domestic agricultural and food products through a strategy of agrarian protectionism
	Sustainable development	The ability to provide the maximum amount of people with sufficient nutrition at any time without compromising future food security
Level of access	Physical access	Ensuring that people have access to food in the amounts needed for an active and healthy life
	Physical and economic access	Guaranteed and permanent physical and economic availability of safe food products to all citizens according to individual consumer preferences required to maintain their active and healthy lives
	Physical, economic, and social access	Access to sufficient food for an active and healthy lifestyle for all people at any time including the availability of nutritious and safe food and ensuring that food can be purchased without the need for emergency food aid
	Physical, economic, and social access to environmentally safe products	Guaranteeing that everyone can access adequate, safe, and culturally suitable nutritious food, produced in an environmentally responsible manner, while upholding human dignity
		Every individual is entitled to safe, nutritious, and personally suitable food, supported by a sustainable food system that promotes health and ensures equal access for all

Based on sources: [25-41]

Currently, the CCA countries should guarantee food security. They should optimize output, resource application, and external sales from the AIC. This potential is shaped by several factors, including a) the historical specialization of several CCA countries in agricultural production [23]; b) the previously formed production base to provide food security; and c) the underutilized AIC potential of several Central Asian countries, which is currently limited by inefficient water use and poor logistics at the regional level [24].

As seen from Table 1, the chief indices of food security status in the CCA include:

-Self-sufficiency regarding fundamental artificial intelligence products represents one aspect. It is assessed through a division of internal output to internal utilization.

-The proportion concerning the quantity of fundamental food items each individual genuinely ingests relative to the adoption of consumption benchmarks by countries (consistent with eating customs as well as AIC's skill when it comes to ensuring the demanded provision), yet characteristically assigned to physiological norm degrees.

Thus, the article aims to answer the following research questions:

(1) What is the level of self-sufficiency in AIC products in CCA countries?

(2) What is the ratio of actual consumption of basic food products per person to accepted consumption standards in CCA countries?

(3) What are the strengths, weaknesses, opportunities, and threats of realizing the productive, resource, and export potential of CCA countries' AICs?

Amidst this concepts, there exist underlying issues that inadvertently pose a hindrance to food security in CCA countries. The potential and grave impact of global warming cannot be overlooked and studies have forecast that there will be a continuous increase in temperature and precipitation levels Considering this, the development of AIC's should work in tandem with measures directed at mitigating food insecurity due to climatic conditions.

3. METHODS

A qualitative-quantitative approach was used as the basis for this study. The following research methods were chosen to achieve the research goal:

-Theoretical summarization to determine the theoretical foundations of food security,

-The method of comparison to conduct a comparative analysis of the concepts of food security in CCA countries,

-Structural-logical analysis in determining the level of self-sufficiency in basic AIC products and the ratio of factual consumption of basic food products per person to the consumption standards adopted in CCA countries;

-SWOT analysis to analyze the production, resource, and export potential of the AIC in CCA countries.

Analytical and statistical data were selected from the information provided by the Eurasian Development Bank (EDB), national statistical offices, FAO, and the Interstate Statistical Committee of the CIS. International documents and scientific sources were selected using the international databases Web of Science and Scopus based on the keywords "food security", "agricultural sector", "agro-industrial complex", and "regional security" in Russian and English with the publication date limited to no more than 10 years ago.

4. RESULTS

4.1 Approaches to the concept of food security in the CCA

To analyze the state of food security in the CCA, it is first essential to identify the approaches to the concept of food security in the region, which need to be considered.

The concepts of food security adopted in CCA countries at the national level are similar, despite occasional differences in definitions and objectives. However, the degree of institutionalization and policy enforcement varies across countries, revealing a gap between conceptual alignment and practical implementation. For instance, while food self-sufficiency is a common goal, the extent of its operationalization through coordinated programs remains uneven.

1) All concepts of food security contain the fundamental condition of access to food for the population (economic and physical), which aligns with the most popular definition introduced by the Declaration of the World Summit on Food Security [42];

2) All CCA countries use some variation of the concept of food independence, which assumes about 80-90% self-sufficiency in basic types of agricultural products that can be produced on a mass scale given the country's agro-climatic conditions;

3) The conditions for ensuring food security are defined as the development of the domestic AIC, the development and use of food reserves, and targeted social aid for low-income population groups to improve the economic accessibility of food.

The comparative analysis of food security concepts in CCA countries is provided in Table 2.

Table 2. The concepts of food security in CCA countries

No.	Country	The Concept of Food Security
1	Azerbaijan	Ensuring demand for food products important for the health and livelihood of the country's population [43]
2	Armenia	Providing enough safe and good-quality food that fits the culture and traditions of society, is available to everyone at all times, and supports a healthy and stable life. A key goal of the country's food policy is to produce enough food on its own [44]
3	Kazakhstan	Food security is regarded as a component of economic security. It refers to a condition in which the state is capable of providing the population with both physical and economic access to safe, high-quality food in quantities sufficient to meet physiological consumption standards and support demographic growth. Although food independence is not explicitly included in the definition of national food security, it is acknowledged as a key factor in ensuring economic security [45]. Food independence is considered lacking when the annual production of essential food items falls below 80% of the population's annual requirements based on physiological consumption norms [46]
4	Kyrgyzstan	Assumes the provision of the country's food independence (80%) along with the physical and economic accessibility of food products for the population according to the established minimum consumption norms [47]

5	Tajikistan	The ability of the state to guarantee satisfaction of the need for food at a level that ensures the normal livelihood of the population, which requires the physical and economic accessibility of food to the population in the appropriate quantity and assortment [48]. It is planned to reach 70% self-sufficiency in food by 2030 [49]
6	Uzbekistan	A state of the economy in which the country independently ensures its food security (no less than 80% of the population's annual need for food according to physiological norms) and the population is guaranteed constant physical and economic access to a sufficient quantity of safe and high-quality food that satisfies nutritional needs and preferences for a healthy and active lifestyle [50]

Therefore, it can be concluded that the priority direction in the food security policy in CCA countries is to ensure the physical accessibility of food while reducing the risks associated with the imports of food and material resources and equipment for the AIC. Several CCA countries prioritize the economic accessibility and quality of food products.

4.2 Analysis of food security in the CCA

Analyzing the production and consumption of foodstuffs from the basic market basket for food security based on the data provided by national statistics agencies, FAO, and the Interstate Statistical Committee of CIS, we found that the majority of CCA countries have resolved the problem of the physical availability of basic food products predominantly through domestic production. Self-sufficiency in food products in 2021 exceeded 80-95% for most types of food, indicating that CCA countries have achieved food independence. Nevertheless, this aggregate figure masks important national disparities and vulnerabilities. For example, despite high self-sufficiency ratios in bread and vegetables, countries such as Armenia and Tajikistan still fall short in meeting recommended dietary needs for meat and dairy products.

Data from national statistics agencies, FAO, and the Interstate Statistical Committee of CIS show that most CCA countries (except for Kazakhstan) have low self-sufficiency in vegetable oils. Even though the demand for vegetable oils is largely met by supply from Belarus and Russia (oilseeds that cannot be produced on a large scale in most CCA countries due to less favorable natural and climatic conditions), the share of CCA countries in this segment can be increased [51].

At the level of individual countries, low self-sufficiency is observed for the following agricultural products:

-Azerbaijan: grain, potatoes, sugar, vegetable oils;

-Armenia: grain, meat, sugar, vegetable oils;

-Kazakhstan: sugar, fruits, and berries;

-Kyrgyzstan, Tajikistan, and Uzbekistan: vegetable oils, grain, and sugar.

The high variability of self-sufficiency in individual types of food among CCA countries is natural and owes to their natural-climatic conditions and cultural traditions [52].

The ratio of factual per capita consumption of basic food products and the adopted consumption standards is analyzed in Table 3.

According to the FAO, in terms of energy value, the average diets of CCA countries (except for Kyrgyzstan and Tajikistan) are generally sufficient and exceed 2,800 kcal/day, which corresponds to the upper limit of the state of food security and is comparable to developed countries (more than 3,000 kcal/day).

Table 3 shows that for some foodstuffs, the average per capita consumption remains below the norms accepted in CCA countries. This underconsumption could be attributed not only to production shortages but also to economic barriers such as low purchasing power, especially in rural and mountainous areas, which merits further micro-level investigation. For some categories – primarily for bread products and vegetables – the factual average per capita consumption significantly exceeds the normative ones in several countries.

Table 3. Factual and normative average per capita consumption of basic foodstuffs in CCA in 2021, kg per person per year

	Azerbaijan	Armenia	Kazakhstan	Kyrgyzstan	Tajikistan	Uzbekistan
Bread and other refined grain products	139.5 (125)	157.1 (130)	99.2 (109)	156.4 (115)	165.8 (145)	186.2 (–)
Potatoes	73 (88)	60.6 (91)	107.4 (100)	99.7 (99)	42.9 (91)	96.0 (–)
Vegetables and melons	117.3 (100)	170.6 (110)	230.6 (149)	159.4 (114)	227.3 (164)	276.7 (–)
Fruits and berries	87.7 (75)	92.5 (73)	48.7 (132)	26.2 (124)	71.8 (122.4)	102.5 (–)
Meat and meat products (converted into meat equivalent)	64.5 (45)	59.6 (37)	78.7 (78.4)	40.1 (61)	18.6 (41)	48.2 (–)
Fish and fish products	14.5 (12.0)	4.4 (11.0)	15.1 (14.0)	1.4 (9.1)	ND (8.4)	3.0 (–)
Dairy products (converted into milk equivalent)	270.3 (305)	245.1 (312)	247.0 (301)	204.8 (200)	81.1 (114)	303.0 (–)
Eggs (pcs. per year)	169.6 (155)	229.6 (183)	228.7 (265)	91.3 (183)	77.1 (180)	200.2 (–)
Sugar	30.4 (16.0)	24.9 (18.0)	26.5 (17.0)	11.1 (26)	16.7 (19.2)	19.3 (–)
Vegetable oil	11.6 (7.3)	10.5 (7.3)	21.1 (12.0)	7.5 (9.1)	15.9 (16.6)	10 (–)

Note: Table 3 provides factual and (in brackets) normative consumption rates; consumption standards in Uzbekistan have not been determined.
Source: EDB based on the data provided by state authorities.

Table 4. SWOT analysis of the potential of the AIC in CCA countries

Strengths	Weaknesses
historical specialization of several CCA countries on agricultural production;	inefficient water use;
the production base created to ensure food security;	high energy intensity and water intensity;
	low efficiency of logistics at the regional level;

self-sufficiency in basic AIC products	lack of interconnected regional transport infrastructure; small-scale production dependence of the AIC on the imports of investment and intermediate goods
Opportunities	Threats
increased domestic consumption, improved economic and physical accessibility of food; increased agricultural exports; expansion of mutual trade and cooperation; comprehensive development of a unified transportation system of CCA countries; improvement of logistics in the southern and eastern directions; development of major players in the food market both at the national and regional level; stimulation of cooperation among small farms; improvement of the efficiency of water-energy complex management; state support for the development of the technological base of the AIC; the establishment of a favorable regulatory environment; reinforcement of financial infrastructure to support AIC activities	significant differences between countries in terms of both food production and consumption; transportation and logistics limitations; critically inadequate water supply, water scarcity; growing environmental problems; internal competition between producers

4.3. SWOT analysis of the potential of the AIC in CCA countries

The results describing the state of the AIC in CCA countries served as a basis for SWOT analysis of the potential of CCA countries' AICs (Table 4).

5. DISCUSSION

The AIC is of assessed importance to the socioeconomic growth of the CCA since it greatly improves agricultural output as a portion of GDP throughout all countries within the region (from 4.76% within Azerbaijan to 23.47% within Uzbekistan) so greatly represents a source of revenue to a large segment of the population.

Our findings demonstrate that domestic production of basic food products does not cover the internal needs of CCA countries, which forces them to import foodstuffs. High dependence on agri-food imports makes these countries vulnerable to price fluctuations in external markets and affects the level of export revenues. However, the situation varies from country to country.

Kazakhstan as one of the world's largest grain exporters faced the problem of having no access to external grain markets, primarily in Europe, the Middle East, and North Africa: pre-conflict costs of transportation to these regions for Ukraine and Russia were immeasurably lower than Kazakhstan's. As a result, the country has become the world's leading supplier of flour to Central Asia [27]. Although virtually all countries in the region are developing their grain programs, they are not effective enough. Except for Kazakhstan, the countries in this region have no natural and climatic advantages and no historical experience in grain production. Their grain is always more expensive and lower in quality and, therefore, cannot compete.

In Uzbekistan, cotton has traditionally been a competitor in food crop production. Its profitability in the world market is much higher than that of grain. Under free market conditions, grain production is unlikely to develop in the country in volumes sufficient for domestic consumption [20].

Today, in most cases, governments are trying to increase the productivity of individual large enterprises created at the expense of budgetary investments or subsidized by the state. The effects of such projects are often compelling, allowing a critical mass of such enterprises to be quickly created to satisfy domestic demand or exports.

Thus, the development of the AIC and participation in regional trade have contributed to solving the food security problem in the CCA.

Significant progress in food production has been noted in Kazakhstan (for all product groups except sugar), which is now a net exporter in terms of energy value and an active participant in international trade [23].

Uzbekistan has increased its food production, but due to rapid population growth, this progress is not sufficient to fully cover the country’s internal demand. Consequently, net food imports, measured by energy value, have risen [40].

The key trend that has contributed to a favorable level of food security in the CCA is the growth of cereal crop production in Kazakhstan and especially Russia (the main importer of cereal products to CCA countries). This is due to the fact that wheat is one of the most important staple foods. Around 70% of wheat consumption is food-related, and it also is a component of many food products. Kazakhstan (together with Russia) has entered the world's top 10 in terms of grain production and exports.

For most other food categories, the situation is not so clear-cut. The CCA has a slight production surplus in vegetables and melons, a balance in potatoes, meat, milk, and eggs, and a need for imports in vegetable oils, also covered by Russia.

The analysis of production, consumption, and import/export of food products in the CCA also indicates inter-state production specialization, determined both by natural and climatic conditions and by the existing needs of several CCA countries for some categories of food products. Trade relations between CCA countries are a necessary condition for resolving the intra-regional problem of food security.

Thus, mutual trade between CCA countries has been steadily growing and the volume of mutual exports of food products has increased significantly over the last two decades. The predominant share of food supply to the CCA domestic market is provided by Kazakhstan, which is the key food producer in the region. Kazakhstan is the leading importer in the CCA market. Uzbekistan also acts as a major importer.

In the three decades after the collapse of the USSR, the CCA has overcome the challenges of ensuring intra-regional food

security (including through the growth of mutual trade) and increased the production of basic food products.

Considering the agricultural potential of the CCA, low crop yields and livestock productivity indicate that the AIC of CCA countries has significant potential, subject to technological advances in production. Rising temperatures in Central Asian countries may lead to a decrease in river runoff and create risks for the AIC and food security in the region.

The product structure of the resource potential of CCA countries differs significantly due to the specialization of the agricultural sector. In Kazakhstan, the main contribution is and will be made by the production of cereals; in Uzbekistan, Azerbaijan, and Armenia – by vegetables, melons, and fruits; in Kyrgyzstan – by dairy products and fruits; in Tajikistan – by vegetables and melons.

Researchers believe that given the significant potential of its AIC, the CCA is characterized by moderate expectations regarding the increase in domestic consumption in the long term. This trend results from multidirectional demographic trends and the population's diet, which is already sufficient in energy value [22].

Ensuring food security is a priority in the agroindustrial policy of CCA countries. SWOT analysis of the potential of the AIC in CCA countries suggests that increasing agrarian exports is a task that will enable better realization of the existing resource potential of CCA countries (without compromising food security).

However, the CCA is still distinguished by significant differences between countries in food production and consumption. During 2021, the proportion of domiciles whose consumer spendings were under the price of sustenance equaled 65–70% within Armenia and 70–75% throughout Kazakhstan plus Kyrgyzstan. Consumption standards existed at an even diminished level in Kyrgyzstan as in Armenia.

Augmenting reciprocal commerce and collaboration represents another vital element toward guaranteeing the food security of CCA countries. This permits one to construct partnerships, first, also to concentrate efforts not on achieving food independence but on augmenting the economic and physical accessibility of food, second, which includes expanding supplies from neighboring countries.

The impeding element to achieve the AIC potential of the region involves deficits regarding transport with logistics. Deficient logistics alongside storage systems throughout CCA countries precipitate losses including 40% of domestic agricultural products. Regional logistics systems still exist at a comparatively immature stratum. Approximately 70% of comestibles able to be cultivated within CCA nations are imported. This transpires due to commerce beyond the vicinity. Removing such constraints requires a connected transport infrastructure including roads, railroads, seaports, distribution centers, agro-logistics facilities, etc. Increasing importance is attached to the integrated development of a unified Eurasian transportation framework, which should rely on modern digital technologies, making it possible to improve the accuracy of planning and safety of products and reduce delivery times.

The most promising external markets for CCA countries are China, India, Southeast Asia (Vietnam), the Middle East (Saudi Arabia, Iran), and North Africa (Egypt). The potential import capacity for food imports to these countries exceeds the possible export volumes of CCA countries, which indicates additional opportunities to increase supplies to foreign markets. To access these markets, CCA countries need to significantly improve logistics in the southern and eastern directions.

An advisable step in realizing the potential of the AIC is the development of major players in the food market at the national and regional levels, which should include participants from all the stages of the food production and export chain. This will make it possible to increase the productivity and competitiveness of food products produced in CCA countries in foreign markets. The participation of major players will make it easier to build a network of logistics centers and fill the AIC with efficient transport facilities.

However, the emergence of large and efficient market players in CCA countries is challenging and may take time. It is necessary to develop cooperation between small farms, which can be achieved through the creation of special institutions to counteract the problem of small-scale commodity production, for example, through the formation of an effective system of purchasing agricultural products and a network of service and procurement centers (SPC).

The main source of structural limitations for CCA countries is water scarcity, which will only increase in the future, limiting the potential for agricultural land expansion. The resolution of the food security problem is closely connected with improving the efficiency of water and energy sector management and water-saving technologies.

The economies of CCA countries are highly energy- and water-intensive, including agriculture. The socioeconomic development of Central Asian countries in the Aral Sea basin has long been affected by the depletion of water resources, which determines the predominant vector of interstate relations. Water scarcity has largely resulted from poorly organized water use and the poor condition of water infrastructure. Critically insufficient water availability, uneven distribution of water resources among the countries, and growing environmental problems in the CCA demonstrate the need to coordinate activities based on common interests.

The high dependence of CCA countries' AICs on investment and intermediate goods imports could be another challenge for preserving the region's food security. To address the issue in the long term, it is necessary to develop the technological base of the AIC with state support in the development of agricultural science, domestic breeding and genetics, agricultural engineering, and the production of fertilizers, veterinary drugs, and fodder additives.

A separate set of steps should focus on improving rules and policies: encouraging local demand to avoid overproduction (through food purchases, support for low-income groups, etc.) and removing trade barriers within Central Asia (like in transport, taxes, and technical rules). Competition among local producers in meat, vegetable, and fruit markets may increase. Countries with large markets, such as Kazakhstan and Uzbekistan, should ease import rules and develop farming sectors with strong export potential. Another important step is to strengthen financial support for agriculture, including using local currencies for trade and creating a shared system for export insurance.

6. CONCLUSIONS

The CCA generally provides food security with domestic production and imports from neighboring countries. In 2021, self-sufficiency in most food products exceeded 80-95%, defined as food independence. The cooperation of CCA

countries plays a critical role in solving the problem of inter-regional food security. CCA countries have great potential to intensify agricultural production and increase land and livestock productivity. The key challenge in realizing their production, resource, and export potential lies in the fact that a major part of this potential is concentrated in regions marked by challenging agroclimatic conditions or strict infrastructural limitations in selling agrarian products on domestic and export markets. The solution to the existing problems hindering the full realization of the AIC potential of CCA countries includes increasing domestic consumption, improving economic and physical accessibility of food, increasing agricultural exports, expanding mutual trade and cooperation, developing a unified transportation system, improving logistics in the southern and eastern directions, developing major players in the food market at the national and regional levels, stimulating of cooperation among small farms, improving the efficiency of water-energy complex management, state support for the AIC technological base, establishing a favorable regulatory environment, and reinforcing financial infrastructure to support AIC activities.

Among the study limitations, we should note the limitations of food security indicators, preventing us from fully generalizing the conclusions. Also, for this study, one area was addressed when tackling food security and further research should focus on other underlying factors that play important roles. Another limitation is the cooperation of CCA countries, for this to be fully actualized there is a need for policy reforms to foster ease in transportation of goods and homogeneity in food prices.

Another potential limitation of this study lies in its reliance on qualitative methods and theoretical generalizations, which may limit the objectivity and replicability of the findings. Further research should implement practical data such as surveys and field assessments to fully capture the realities of food insecurity, especially among vulnerable populations. Furthermore, the study focuses predominantly on national-level indicators like self-sufficiency ratios and consumption norms, which may mask significant subnational disparities in food access and nutritional outcomes. Further research is recommended to understand the food security levels among subsistent farmers and underdeveloped areas of CCA.

Another limitation is that this study does not account for dynamic factors such as climate variability, political instability, pandemics or global market fluctuations, all of which could substantially impact regional food security in the near future. These limitations suggest the need for a more comprehensive, mixed-methods approach in future studies to better inform policy and sustainable development strategies.

A prospect for further research is the analysis of food security in terms of the economic accessibility of food products for the population of CCA countries.

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