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## FOOD SECURITY IN CHINA AND IN THE CENTRAL ASIAN COUNTRIES

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## ABOUT ARTICLE

**Key words:** food security, comprehensive evaluation, obstacle factors, China, five Central Asian countries, global warming, extreme climate

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**Abstract:** The current and potential impacts of global warming have generated widespread concerns about food security among all sectors of society. China's food security has attracted global attention as the various drivers of its instability and uncertainty have intensified. This study developed a new framework for food security evaluation in China by analyzing its availability, distribution, utilization, vulnerability, sustainability, and regulation. The main obstacles initially entailed grain distribution but then spread to vulnerability- and sustainability-related issues. Moreover, Central Asian countries located deep in the interior of Asia with fragile ecological environments and lower agricultural technology are particularly more prone to severe threats from climate change.

## XITOIY VA MARKAZIY OSIYO MAMLAKATLARIDA OZIYQ-OVQAT XAVFSIZLIGI

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## MAQOLA HAQIDA

**Kalit so'zlar:** oziq-ovqat xavfsizligi, har tomonlama baholash, to'siq omillari, Xitoy, Markaziy Osiyoning beshta davlati, global isish, ekstremal iqlim

**Annotatsiya:** Global isishning hozirgi va potentsial ta'siri jamiyatning barcha tarmoqlarida oziq-ovqat xavfsizligi bo'yicha keng tarqalgan xavotirlarni keltirib chiqardi. Xitoyning oziq-ovqat xavfsizligi butun dunyo e'tiborini tortdi, chunki uning beqarorligi va noaniqligining turli omillari kuchaygan. Ushbu tadqiqot Xitoyda

oziq-ovqat xavfsizligini baholash uchun uning mavjudligi, taqsimlanishi, ishlatilishi, zaifligi, barqarorligi va tartibga solinishini tahlil qilish orqali yangi asosni ishlab chiqdi. Asosiy to'siqlar dastlab don tarqatish bilan bog'liq edi, ammo keyinchalik zaiflik va barqarorlik bilan bog'liq muammolarga tarqaldi. Bundan tashqari, Osiyoning ichki qismida joylashgan, ekologik muhiti zaif va qishloq xo'jaligi texnologiyasi past bo'lgan Markaziy Osiyo mamlakatlari iqlim o'zgarishidan kelib chiqadigan jiddiy tahdidlarga ko'proq moyil.

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## ПРОДОВОЛЬСТВЕННАЯ БЕЗОПАСНОСТЬ В КИТАЕ И СТРАНАХ ЦЕНТРАЛЬНОЙ АЗИИ

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### О СТАТЬЕ

**Ключевые слова:** продовольственная безопасность, комплексная оценка, факторы препятствий, Китай, пять стран Центральной Азии, глобальное потепление, экстремальный климат.

**Аннотация:** Текущие и потенциальные последствия глобального потепления вызвали широко распространенную обеспокоенность по поводу продовольственной безопасности во всех секторах общества. Продовольственная безопасность Китая привлекла внимание всего мира, поскольку усилились различные факторы его нестабильности и неопределенности. В этом исследовании была разработана новая основа для оценки продовольственной безопасности в Китае путем анализа ее доступности, распределения, использования, уязвимости, устойчивости и регулирования. Основные препятствия первоначально были связаны с распределением зерна, но затем переросли в проблемы, связанные с уязвимостью и устойчивостью. Более того, страны Центральной Азии, расположенные глубоко в глубине Азии с хрупкой экологической средой и низким уровнем сельскохозяйственных технологий, особенно более подвержены серьезным угрозам изменения климата.

## INTRODUCTION

As food is a key determinant of national prosperity and human wellbeing, its security represents a major prerequisite for national security. In recent years, food security has been a concern in both developing and developed regions of the world, but the situation is particularly alarming in Asia and Africa, where the number of people experiencing hunger reached 418 million and 282 million in 2020, respectively. China, home to one-fifth of the world's population, faces different degrees of food production pressures. To maintain food security and to meet the demand of a large population, more grain needs to be produced on the 9% of global arable land and using 6% of global water resources, which suggests that future environmental and resource challenges will increase. Further complicating this situation is that climate change, urbanization, and a shift in food habits from cereals to more meat products have caused or will cause great changes in food security in China. Hence, a multidimensional measurement of China's food security situation will support a more comprehensive and objective assessment of China's food security situation; quantitative and qualitative evaluations of the obstacles affecting China's food security status play a crucial role in determining the central goals of China's food security strategy and agricultural policy. The overall goals of this paper are to systematically evaluate food security status, explore the dominant obstacle indicators of China's food security, and provide policy implications for a path forward. The remainder of the paper is organized as follows.

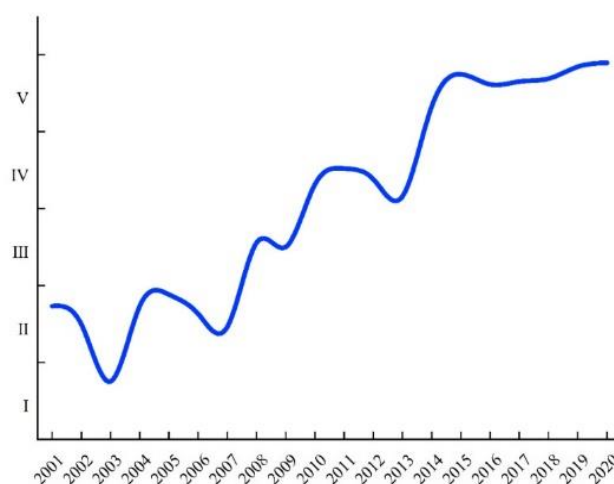
Furthermore. In this study, we utilized panel data acquired from Central Asian countries from 1990 to 2019 to verify the impact of climate change on food security. The data on average annual temperature and annual precipitation, extreme high and low temperatures, and frost days were obtained from the meteorological websites of these countries. Data on food security, agricultural technology investment, pesticide use, fertilizer application, and agricultural labor force were sourced from the official website database of the United Nations Food and Agriculture Organization. The data on the added value of the primary industry and foreign investment in the primary industry were obtained from the World Trade Organization database. Future climate prediction data sources included the United Nations Intergovernmental Panel on Climate Change (IPCC) database.

## THE MAIN RESULTS AND FINDINGS

Food security has emerged as a concern for governments and academia over the past few decades. At the World Food Conference of 1974 in Rome, Italy, food security was defined for the first time as 'ensuring that all people at all times have access to enough food for survival and health'. The concept of food security was refined in the 1996 World Food Summit Plan of Action, and 'when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life' was the most widely accepted. Since its proposal, the concept of food security has been researched abroad. Some studies

have concluded that it focuses on food availability, utilization, and sustainability, while others have characterized it as the eradication of poverty, malnutrition, and hunger. Currently, most studies do not adequately consider the potential tension between food sustainability and the other dimensions of food security. In addition, little related research has addressed the application of policies. Thus, in this study, food security is described as a ‘state in which a region or nation can meet the sustainable and ecological standards, and provide people with sufficient nutrition and healthy food that conforms to certain cultural habits and preferences under the government’s macro control and market regulation mechanism’.

A trend map of food security in China from 2001 to 2020 can be drawn according to the comprehensive correlation degree and evaluation grade. As shown in Figure 1, except for a state of relative insecurity in 2003, China’s overall food security displayed a substantial upward trend with fluctuations during this period. In 2003, the planting area of grain crops in China was less than 100 million hectares, accounting for 65.2% of the total sown area of crops, a record low level. Another possible explanation for this might be that China’s food security is affected by international grain prices and the affordability of food for its residents. Affected by the significant reduction in food production in 2003, China’s food market prices rose for the first time in six years, and international food prices also increased.



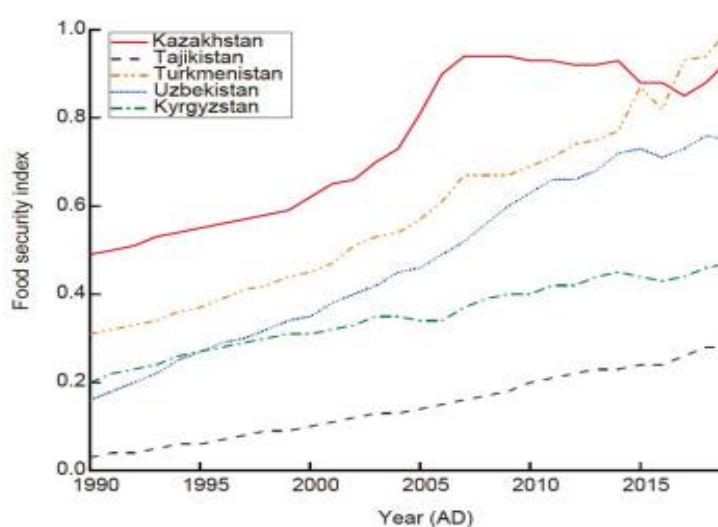
**Figure 1: Trend map of China’s food security grades from 2001 to 2020.**

In this work, we use a scientific method to comprehensively and effectively evaluate China’s food security, which plays a crucial role in determining the central goals of China’s food security strategy and agricultural policy. China’s food security status increased gradually from 2001 to 2020 but exhibited a slight downward trend in 2003. These results indicate that China’s overall food security has been consistently improving. Our findings are supported by Wu et al. and Yao et al., who found that the grain sowing area decreased and the planting area of cash crops increased amid changes to China’s agricultural structure in 2003, resulting in a significant reduction in China’s total grain output.

Adequate grain availability is the fundamental factor affecting food security. The rapid development of agricultural science and technology does seem to steadily improve China's comprehensive grain production capacity. However, China is the world's largest grain importer and imports a large amount of grain every year. Cereal has basically achieved full self-sufficiency, consistent with several populous developing countries, though lower than developed countries, but soybean self-sufficiency has declined significantly. In 2020, 73.0% of China's imported rice came from Vietnam, Pakistan, Thailand, and Cambodia. In addition to rice, the sources of wheat and corn are mainly concentrated in resource-rich countries or regions such as the United States, Brazil, Argentina, and the European Union. China's soybean dependence on foreign countries reached a very high level. Specifically, China's soybean imports enjoyed rapid growth from 13.9 to 100.3 million tons between 2001 and 2020. The main soybean importers are Brazil, the United States, and Argentina, with Brazil accounting for 64% of the total. Therefore, changes to agricultural layouts and grain planting structures should be further promoted; grain planting areas should be stabilized; and potatoes, beans, miscellaneous grains, and other crops should be developed according to local conditions.

### **Trends in food security in the five central asian countries**

Results indicate the five Central Asian countries' food security indices ranged between 0 and 1 during 1990~2019 (Figure 3), generally showing an increasing trend. Among them, Kazakhstan consistently had a relatively high and fluctuating food security index. Turkmenistan's index grew the fastest, surpassing Kazakhstan in 2016 to claim the top rank. Uzbekistan's index surpassed Kyrgyzstan's in 1995 and has since remained stable in third place. Kyrgyzstan ranked fourth in terms of food security, while Tajikistan consistently had the lowest food security index.

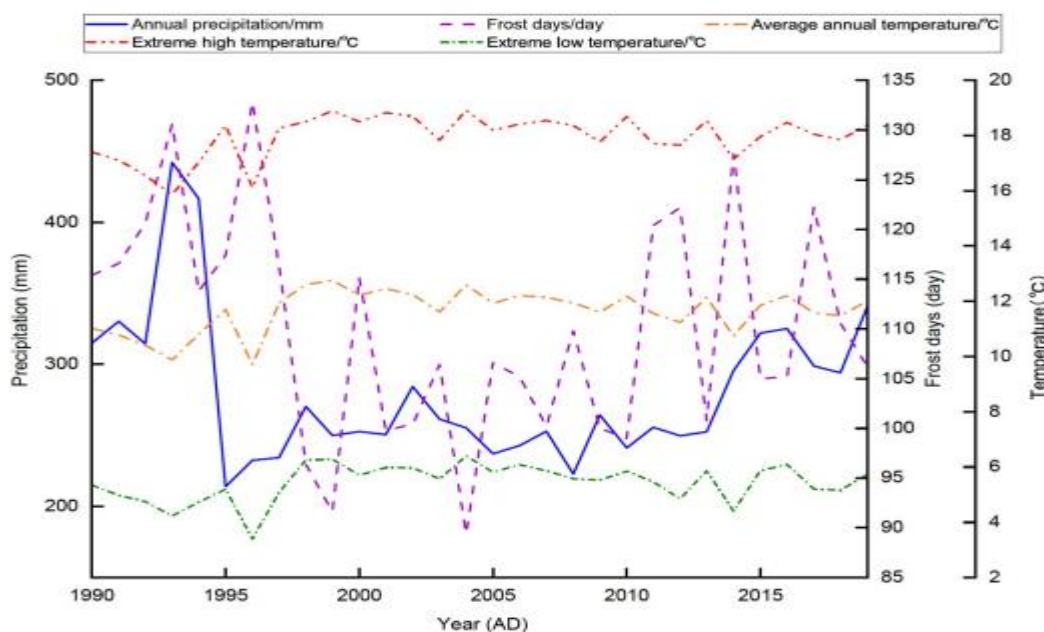


**Figure 3 Trends of food security in Central Asian countries from 1990 to 2019.**

The latter can be attributed to Kazakhstan's substantial investment in agricultural technology, a well-equipped agricultural labor force, abundant and consistently growing grain production, and

lower food security pressure compared to the other Central Asian countries. These factors have positioned Kazakhstan as a major grain producer in the region and globally. Turkmenistan, a perpetually neutral nation, has maintained robust social and economic progress even amid complex international economic changes, thus ensuring stable conditions for food security. The country has consistently prioritized agricultural advancement, achieving increased grain production with a relatively small population, resulting in a high per capita grain yield. Furthermore, Turkmenistan's collaboration with China in modern agriculture, bolstered by the "Belt and Road" initiative, has progressively enhanced agricultural development in the country. By analyzing secondary indicators of food security, we indices. Tajikistan sees a notable increase in food utilization, but still ranks lowest among the countries.

Figure 5 illustrates changes in climate factors in Central Asian countries, including average annual temperature, annual precipitation, frost days, and extreme high and low temperatures. The average annual temperature displayed an upward trend, fluctuating between 9.5°C and 13°C. Notable peaks occurred in 1999 and 2004, with valleys in 1993, 1996, and 2014. Average annual precipitation exhibited instability, rising initially, then declining and stabilizing. A peak was observed in 1993, with low rates in 1995 and 2008. Frost days varied greatly annually, usually extending over 3 months. Exceptional periods were seen in 1992, 1994, and 2014, while 1999 and 2004 had shorter frost periods. Extreme high and low temperatures aligned with the average annual temperature pattern, remaining relatively stable. Extreme high temperatures ranged between 18°C and 20°C, while extreme low temperatures ranged between 3°C and 5°C.



**Figure 5 Climate change trends in the Central Asian countries from 1990 to 2019.**

The Central Asian countries have abundant land, solar, and thermal resources as well as a relatively large proportion of agricultural laborers in the labor market. However, this region still has



problems related to insufficient water resources, a lack of production and processing technology, and a need for development funds. The changes to the average annual climate and the effects of extreme climate events have had a variety of regional impacts on all five Central Asian countries analyzed here (Tables 4 and 6). These countries should respond to climate change from different directions based on the characteristics of their local agricultural development and should work to ensure food security. Kazakhstan has the largest scale of agricultural planting among these five countries. Kazakhstan actively promotes intensive and largescale agricultural planting by using its advantageous geographical conditions such as being located in a landscape with plains and a vast area of arable land. These conditions enhance its extensive grain-processing capacity and promote the grain industry's development, which help mitigate the threat posed by climate change and promotes the vertical development of the grain-based industrial chain. For Uzbekistan, Kyrgyzstan, and Turkmenistan, which can achieve basic food self-sufficiency while ensuring the stability of the original food production environment, a need exists to deeply tap into the potential of food production, strengthen refined cultivation of grain planting, and effectively improve the rate of arable land resource use. Moreover, sufficient financial support should be provided for grain production; mechanisms for benefiting farmers should be improved such as providing training for agricultural workers and subsidies for increasing agricultural production and enhancing the ability of grain growers to resist risks and improve their enthusiasm for grain production.

### CONCLUSION

Based on data spanning from 1990 to 2019, a significant impact of climate change on food security within the five Central Asian countries over the past three decades has been identified. The analysis revealed a distinctive inverted Ushaped relationship between the average annual temperature, precipitation, and the levels of food security across these nations. Both extremely high and low temperatures exhibit a substantial adverse effect on the food security status of these Central Asian countries. Projections derived from a predictive model indicate an anticipated rise in temperature and precipitation across Central Asia from 2030 to 2090, which is poised to sustainably undermine the food security landscape of these nations. In response to these findings, the countries under study must bolster their comprehension of climate-related risks. It is imperative for them to fortify their commitment to scientific and comprehensive research concerning the intricate interplay between climate change and agricultural domains. In tandem, the formulation of multifaceted adaptation strategies becomes a pressing necessity. Additionally, the five nations must intensify international collaborations, embracing equitable and just climate action. Adequate resources ought to be allocated to facilitate technology transfer, endorse political resolve, and foster partnerships. These measures are essential to bolster the efficacy of climate adaptation, curtail greenhouse gas emissions, and enhance the resilience required for ensuring food security

In this study, we developed a new framework using six influencing units of food security (availability, distribution, utilization, vulnerability, sustainability, and regulation) to comprehensively measure China's food security status in a changing world. We first constructed a more suitable and operational food security evaluation system for China based on current circumstances by adopting the EWM. Second, we examined China's food security grade between 2001 and 2020 through the MEEM. Finally, the ODM was used to investigate the key obstacles restricting China's food security. The conclusion of this study is based on the analysis of the influencing factors as a whole, and the results elucidate the steps that China should take to ensure its food security. The main conclusions are as follows:

- Except for a slight downward trend in 2003, China's overall food security displayed a substantial upward trend during 2001–2020. The fluctuation in the comprehensive correlation degree trend map of food security suggests that China's food security cannot be guaranteed only by an increase in total grain output but involves the joint effect of many factors. The next 40 years could be the most critical period for ensuring China's food security, which incorporates demographic, climate change, and resource shortage factors. Therefore, to fully modernize China's agriculture, the food security strategy must be consistent with stable agricultural production and a sustainable development strategy;

- According to the change trend of China's food security, in terms of the obstacle degrees of the indicators between 2001 and 2020, the obstacle degree of grain distribution exhibited a strong downward trend, while vulnerability and sustainability displayed a slow upward trend. China is a country with a large population and few resources; thus, China's per capita share of various resources is extremely small. With the shortage of cultivated land and water resources available for agriculture, issues related to resources and the environment have become a bottleneck restricting the strength and sustainability of food security in China.

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