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Global Food Security: Diplomacy and Conflict Amidst the Climate Crisis and Changing Production Patterns

Loso Judijanto
IPOSS Jakarta, Indonesia
e-mail*:losojudijantobumn@gmail.com

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ABSTRACT

Global food security is increasingly threatened by climate change, geopolitical conflicts, and shifting agricultural production patterns. Extreme weather events such as droughts, floods, and irregular rainfall have significant impacts on agricultural productivity, exacerbating food shortages, especially in vulnerable areas. In addition, armed conflicts in countries such as Somalia, South Sudan, Yemen, and Afghanistan further exacerbate food security by disrupting agricultural infrastructure and food distribution systems. This study uses a qualitative approach with descriptive-analytical methods, utilizing a literature review of academic journals, reports from international organizations, and policy documents. Data analysis was conducted using content analysis and comparative analysis to identify key patterns and strategies in food security across regions. The results show that the climate crisis and armed conflict are key drivers of food insecurity, with direct consequences for food availability, accessibility, and stability. In addition, major global actors, including China, the European Union, and Russia, are using food diplomacy as a strategic tool in international relations, impacting global trade and political stability. Furthermore, technological advances in precision agriculture, artificial intelligence, hydroponics, and smart irrigation have emerged as potential solutions to improve food security, albeit with challenges related to accessibility and implementation costs. Studies show that sustainable food policies, international cooperation, and technology adoption must be prioritized to effectively address food security challenges. Strengthening global trade networks, enhancing climate adaptation strategies, and promoting diplomatic efforts to resolve conflicts are important steps towards a more resilient global food system.

INTRODUCTION

Food security is a complex issue that affects economic, social and political stability at the global level. As the world's population grows, demand for food continues to increase, while natural resources are increasingly limited. Therefore, urgent and

sustainable solutions are needed to address this problem. A thorough understanding of the factors that determine food security and the implementation of effective policies are key to addressing this challenge.

Economic stability and income inequality play a major role in food accessibility. Low incomes and high unemployment rates can lead to food poverty, requiring targeted economic policies (Adamovsky & Myskiv, 2024; Furey, 2025). In addition, climate change and extreme weather impact agricultural productivity and food supply chains. Therefore, adaptive agricultural practices are becoming increasingly important (Hussain et al., 2025; Рєпіна, 2024). The application of advanced technologies, such as big data and artificial intelligence (AI), can improve efficiency and sustainability in food production. This contributes to the development of more resilient food systems (Yuzefovich et al., 2024).

The climate crisis is significantly impacting food production through a variety of mechanisms, including changing weather patterns, declining crop yields, and increasing food insecurity. These changes threaten agricultural systems globally, requiring urgent adaptation strategies to ensure food security. The following section outlines key aspects of this issue.

Rising global temperatures shorten the growing season of crops, leading to reduced crop yields (Suarja et al., 2024). In addition, extreme weather events such as floods and droughts are becoming more frequent, disrupting agricultural productivity and damaging farmland ecosystems (Anjum et al., 2024). Changes in rainfall patterns also have a significant impact on soil moisture, which ultimately threatens plant health and reduces overall crop yields (TÜRKMEN & Onalan, 2024).

In addition to its impact on crop yields, climate change also affects water availability and quality. The climate crisis exacerbates water scarcity, reduces irrigation effectiveness, and lowers overall agricultural productivity (Anjum et al., 2024). Unpredictable shifts in rainfall patterns can trigger floods or droughts, further complicating water resource management strategies for the agricultural sector (Artık et al., 2024).

The impacts of climate change also extend to aspects of nutritional quality and food security. The decline in nutritional quality of crops due to changes in environmental conditions can increase the risk of food insecurity, especially for vulnerable populations (Suarja et al., 2024). Disruptions to food supply chains also cause spikes in food prices, which disproportionately burden low-income communities (Suarja et al., 2024).

The interplay between conflict, geopolitical instability, and diplomacy plays a critical role in maintaining global food security. Geopolitical tensions, such as the Russia-Ukraine conflict, not only impact the countries involved but also affect the availability and affordability of food in many parts of the world. These disruptions highlight the need for effective diplomatic strategies to mitigate negative impacts and ensure food stability for the global community.

Geopolitical conflicts often disrupt food supply chains, leading to price increases and shortages of basic goods. For example, in West Bengal, 68% of respondents reported difficulty accessing affordable food due to the Russia-Ukraine conflict (Biswas, 2024). Historical analysis also shows that war and political sanctions can exacerbate hunger, especially in vulnerable regions such as Africa and Asia, where dependence on food imports is high (Zhyvko & Nahirna, 2024).

In facing these challenges, economic diplomacy plays an important role in overcoming the food security crisis. Large countries such as the United States and China

use international cooperation strategies to increase access to food and support global food security (Nadolenko, 2023). Meanwhile, Indonesia is an example of how food diplomacy can build successful international partnerships in improving agricultural practices and infrastructure, although challenges such as bureaucratic inefficiency are still obstacles.

However, behind the major role of diplomacy in food security, there are concerns that dependence on international aid can weaken local agricultural resilience. Some argue that this dependence can hinder food self-sufficiency and prolong the food crisis in some countries. Therefore, a balanced approach is needed between global cooperation and strengthening local food production to ensure sustainable food security (Saa, 2024).

Given the complexity of the issue, further research is needed to explore the best strategies for addressing the food crisis amidst climate change and geopolitical instability. An in-depth analysis of the role of diplomacy and food policy can help create sustainable and inclusive solutions to global food security.

METHODOLOGY

The research method used in the study of global food security, diplomacy, and conflict amidst the climate crisis and changes in production patterns is a qualitative method with a descriptive-analytical approach. This approach aims to deeply understand the phenomenon of food security in a global context, including the impacts of the climate crisis, diplomacy, and geopolitical conflict.

Data collection was conducted through library research, by collecting information from scientific journals, reports from international organizations such as FAO, WFP, and IPCC, as well as related books and academic articles. In addition, this study also used document analysis, namely reviewing government and international organization policies on food security, climate change, and diplomacy in dealing with the food crisis. If possible, interviews with experts, diplomats, or academics in the fields of food and international relations were also conducted to enrich the analysis.

The data obtained were analyzed using qualitative analysis methods, especially content analysis, to interpret the contents of documents and reports to find patterns, relationships, and key factors that influence global food security. In addition, this study applies comparative analysis, by comparing food security policies or strategies in several countries to identify best practices that can be applied in dealing with the food crisis. The following is a comparative table of the countries analyzed:

Table 1. List of countries that are the focus of the comparison

Category	Country	Comparison Focus
Impact of Climate Crisis & Conflict	Somalia & South Sudan	Drought, conflict, famine
	Yemen	War, food blockade
	Afghanistan	Conflict & natural disasters
Food Production & Climate Change	United States of America	Extreme drought in the Midwest
	Brazil	Deforestation & dependency
	India	Changes in rainfall patterns & temperatures
Food Diplomacy Strategy	China	Diversification of imports, investment
	European Union (EU)	Food regulations & policies

	Russia	Wheat exports as a strategy
Food Technology & Innovation	Dutch	Precision agriculture, greenhouses
	Japan	AI, IoT, agricultural robotics
	Singapore	Hydroponics, aquaponics, urban farming
	United Arab Emirates (UAE)	Smart irrigation, desert farming

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RESULTS AND DISCUSSION

Impact of Climate Crisis & Conflict Somalia and South Sudan

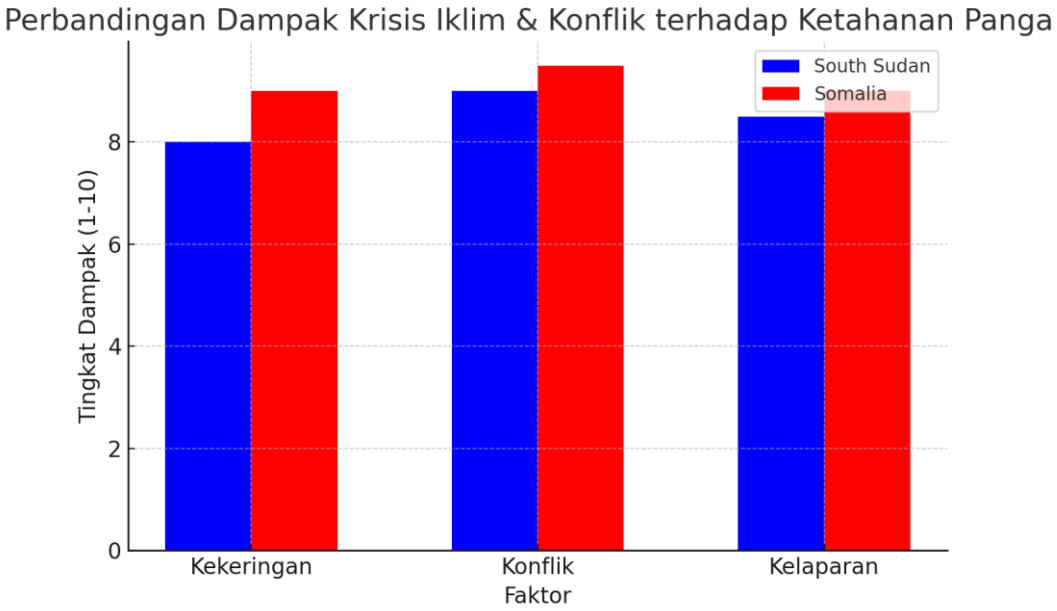

Figure 1. Comparative impacts of climate crisis and conflict on food security in South Sudan and Somalia

This comparative chart of the impact of climate change and conflict on food security in South Sudan and Somalia shows that both countries are facing serious challenges due to the combination of prolonged conflict and extreme climate change. In South Sudan, ongoing civil war has destroyed agricultural infrastructure, hampered food distribution, and left millions of people dependent on humanitarian assistance. Seasonal droughts and floods are further deteriorating food security, increasing hunger and malnutrition. Meanwhile, in Somalia, conflict between armed groups and political instability have exacerbated the impacts of prolonged drought, leading to crop failures and livestock deaths. Somalia also faces a shortage of clean water and a high dependence on food imports, which has caused food prices to skyrocket. The chart shows that while the underlying causes of the crises in the two countries differ in intensity, their impacts on food security are similar: increasing hunger, malnutrition, and dependence on international assistance. Here's a brief explanation of the comparison:

Table 2. Comparison of climate crisis and conflict on food security in South Sudan and Somalia

Aspect	Impact in South Sudan	Impact in Somalia
Drought	Reduced crop yields, increased dependence on humanitarian aid, and worsened food security in vulnerable communities. Infrastructure failures exacerbate the impact of drought on agriculture.	Increases the risk of crop failure and livestock loss, causes water scarcity and reduces land productivity. Erratic rainfall patterns exacerbate soil degradation and water availability.
Conflict	Destroying agricultural infrastructure and food distribution, causing population displacement and hampering economic activity. Political instability and competition for resources exacerbate the food crisis.	Conflict exacerbates food scarcity by limiting access to resources and causing population displacement. Armed groups often exploit limited resources, increasing social tensions.
Hunger	Malnutrition is on the rise, especially among children and pregnant women. Many families are adopting survival strategies such as reducing the frequency of meals or relying on food aid.	Hunger is on the rise due to a combination of drought, conflict and poor food distribution systems. Herding and farming communities are increasingly vulnerable to climate and economic shocks.
Adaptation Strategy	Diversification of livelihoods (e.g., agribusiness-based small businesses), increased investment in agricultural infrastructure, and entrepreneurship training for youth to improve food security.	Community-based adaptations such as urban farming, improved water management, and technological approaches in agriculture to increase productivity and food security.

Source:FAO (2023), WFC (2024), IPCC (2023)

Yemen and Afghanistan

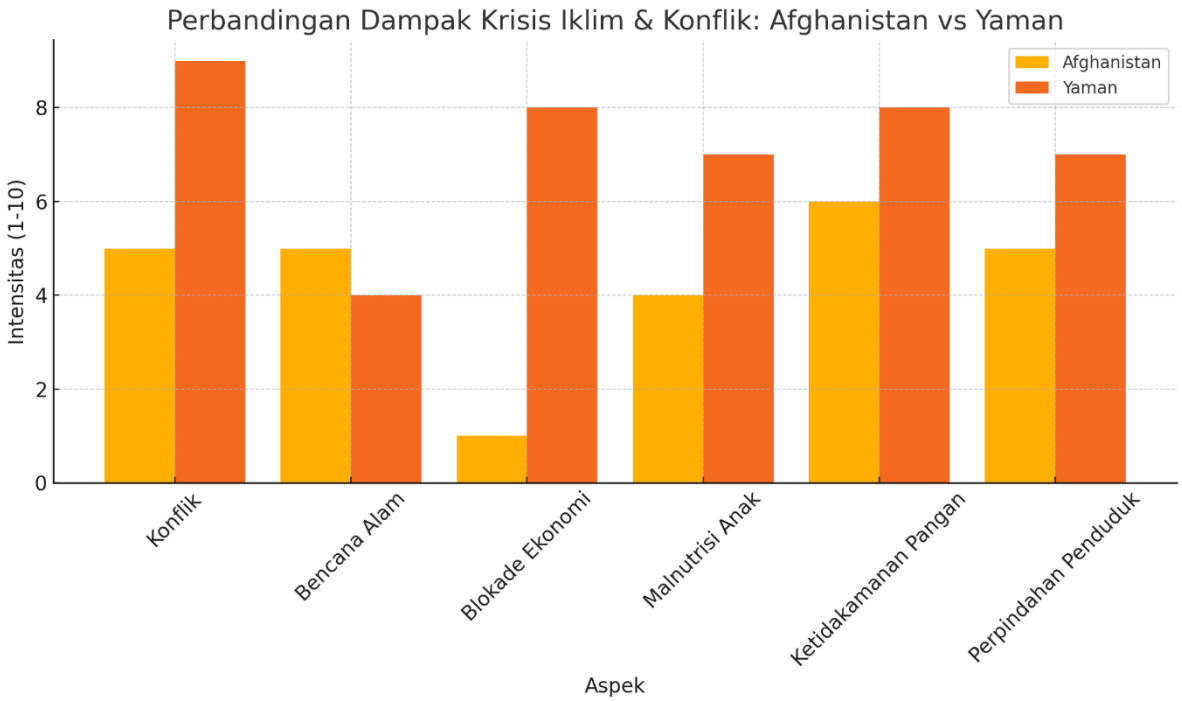

Figure 1. Comparison of the impacts of climate crisis and conflict between Yemen and Afghanistan

This graph shows a comparison of the impacts of climate change and conflict between Yemen and Afghanistan. Yemen has been particularly hard hit by prolonged war and economic blockade, leading to food shortages, high rates of child malnutrition, and large-scale displacement. The food blockade in Yemen has been a major factor in exacerbating the humanitarian crisis, hampering aid delivery, and driving up prices of basic goods. Meanwhile, Afghanistan faces a combination of internal conflict and natural disasters such as drought and floods that have damaged its agricultural sector and undermined food security. Although Afghanistan is not under blockade, it remains vulnerable to malnutrition and food insecurity driven by economic disruption and extreme climate. Here is a brief explanation of the table:

Table 3. Comparison of the impacts of climate crisis and conflict between Yemen and Afghanistan

Aspect	Afghanistan	Yemen
Types of Crisis	Internal conflicts & natural disasters (floods, droughts)	Civil war, food blockades & climate crisis
The main cause	Conflict, drought, floods, inflation, unemployment	War, blockade, food shortages, drought
Impact on food	Agricultural production disrupted, food prices rise	Food distribution is hampered, food supplies are limited
Food Insecurity (IPC)	42%-47% of population in IPC phase 3+ (2020-2024)	45%-60% of population in IPC phase 3+ (2020-2024)

Child Malnutrition (CMD)	Around 17% (2020) down to 3.7% (2023)	GAM median is around 13%-15%, in some areas 31%+
Population migration	Internal & external displacement due to drought & conflict	Mass displacement due to war & humanitarian crisis
Conflict & climate	Conflict exacerbated by the impacts of climate change	War triggers mass starvation and exacerbates climate impacts

Source:FAO, WFP, UNICEF & WHO, UNHCR & IOM, UCDP, and World Bank Climate Data

Impact on Food Production

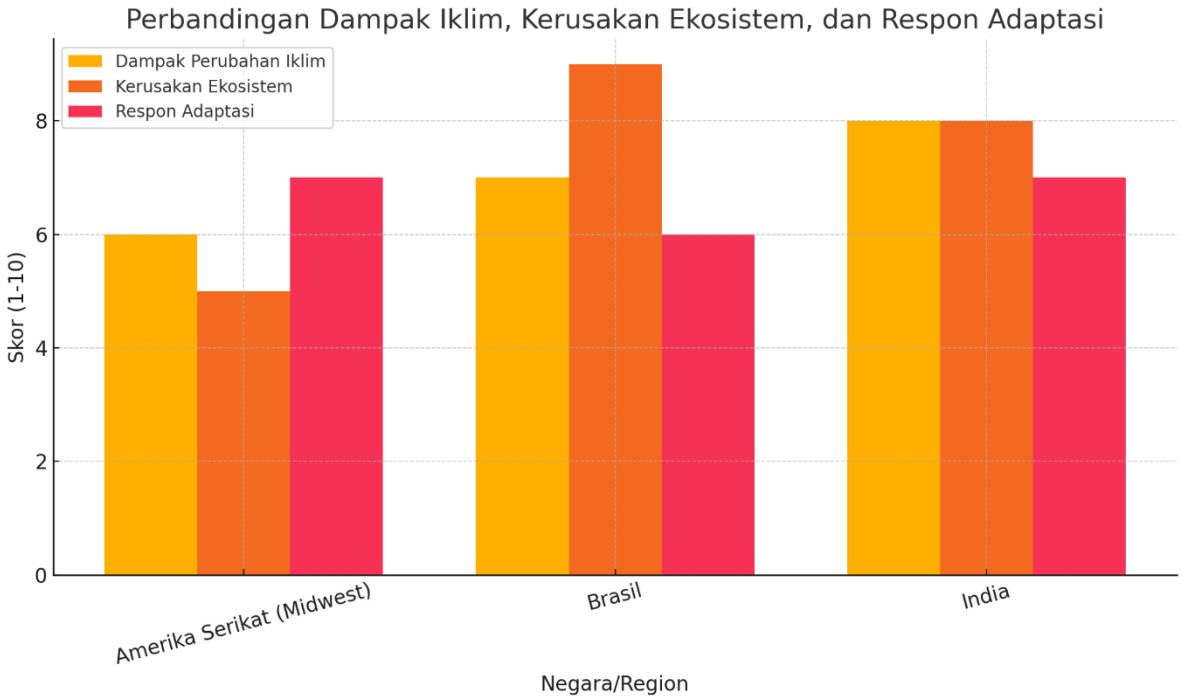

Figure 3. Comparison of the impacts of climate change on food production in the United States (Midwest), Brazil, and India

A comparison of the impacts of climate change on food production in the United States (Midwest), Brazil, and India reveals different but interrelated challenges. In the United States, particularly in the Midwest, extreme droughts have caused yield losses for crops such as corn, soybeans, wheat, and alfalfa, although some areas have been able to mitigate these impacts through irrigation and adaptive farming practices. In Brazil, changing rainfall patterns and droughts triggered by the ENSO phenomenon have exacerbated dependence on rainfall-based agriculture. In addition, massive deforestation, especially in the Amazon and Caatinga, has further exacerbated the vulnerability of ecosystems and the productivity of key crops such as cassava, corn, soybeans, and sugarcane. Meanwhile, India faces challenges from rising temperatures and changing seasonal rainfall patterns that are affecting the productivity of kharif and rabi crops, with the greatest impacts on smallholder farmers who are highly dependent on rainfall. All

three countries face serious risks to food security, but each is responding with different policies and initiatives, such as improvements in irrigation systems in the United States, development of evidence-based adaptation strategies in Brazil, and national and regional programs such as NICRA and PoCRA in India to improve agricultural resilience. Here is a brief explanation table:

Table 4. Comparison of the impacts of climate change on food production in the United States (Midwest), Brazil, and India

Country/Region	Major Climate Events	Impact on Food Production	Ecosystem Dependence/Damage	Adaptation/Resilience Response
United States (Midwest)	Extreme drought (1971–2020)	Yield declines for alfalfa, barley, corn, soybeans, summer and winter wheat varied by location.	Some areas experienced decline, while others were helped by irrigation or other climate factors.	Specific local strategies are needed to improve food security and minimize the risk of crop loss.
Brazil	Recurrent droughts, changes in rainfall, ENSO	Yield declines in crops such as cassava, cocoa, rice, wheat; mixed (positive/negative) yields in soybeans, corn, and sugarcane depending on region and cultivation method	High deforestation especially in the Amazon and Caatinga increases ecosystem vulnerability	The urgent need for evidence-based adaptation strategies and a more inclusive approach to family farming
India	Changes in seasonal rainfall patterns (monsoon), rising temperatures	Agricultural productivity declines by 4.5–9% per year (2020–2039), mainly impacting kharif and rabi season crops.	High dependence on rain-based farming systems; small farmers are more vulnerable	National adaptation programs such as NICRA and PoCRA, promotion of sustainable agriculture and area-based adaptation

Source:USDA, US Drought Monitor, NOAA, NASS, IBGE, MAPBIOMAS Project, AdaptaBrasil, UNFCCC, FAO, ICAR, NICRA, PoCRA, IMD, World Bank.

Food Diplomacy Strategy

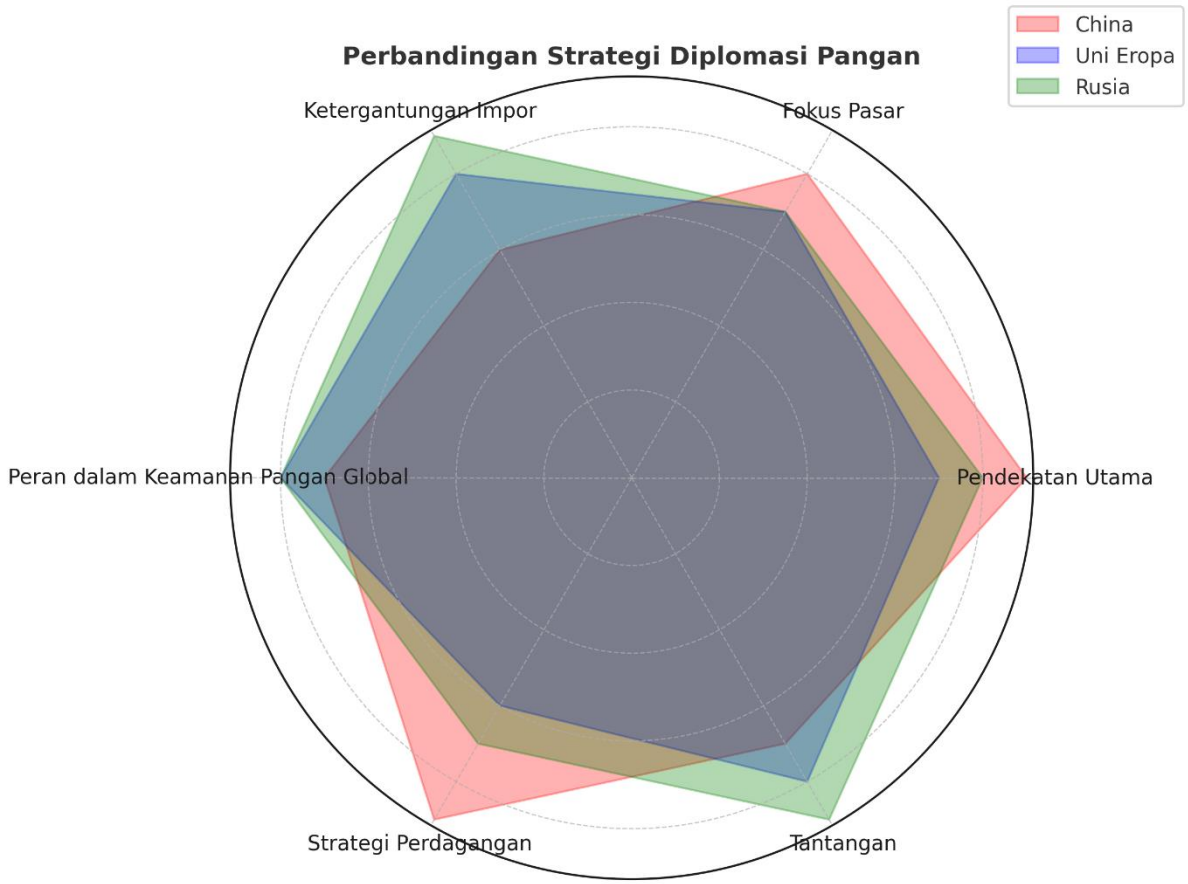

Figure 4. Radar chart of differences in food diplomacy strategies between China, the European Union (EU), and Russia

The radar chart shows the differences in food diplomacy strategies between China, the European Union (EU), and Russia based on six key aspects. China stands out in expanding trade and investing in food infrastructure in developing countries, especially in Africa and Asia, with a high dependence on imports to meet its domestic needs. The EU, on the other hand, prioritizes strict regulation and sustainability standards in its food trade, with a more stable balance between imports and exports. Meanwhile, Russia focuses on market diversification and increasing exports to non-Western countries, especially Africa and the Middle East, with its position as one of the world's major grain exporters.

In their role in global food security, China is a major supplier of raw materials and investor in the food sector of developing countries, while the European Union places greater emphasis on sustainability and food safety standards in its global trade. Russia, as a major wheat producer, plays a major role in supplying food to developing countries. In terms of trade strategy, China relies more on bilateral relations and large investments in the overseas agricultural sector, while the European Union emphasizes strict regulatory policies. Russia, on the other hand, seeks to increase exports to non-Western countries to reduce its dependence on Western markets.

Although these three actors have different approaches, they also face their own challenges. China is grappling with import dependence and global food price fluctuations, while the EU's strict regulations often act as a barrier to expanding trade with other countries. Russia, with Western economic sanctions imposed on it, faces obstacles in accessing key markets. Overall, China is more aggressive in investment and market expansion, the EU is more oriented towards regulation and sustainability, while Russia seeks to strengthen its exports to developing countries to maintain its position as a major player in the global food trade. Here is a brief explanation in table form:

Table 5. Comparison of food diplomacy strategies between China, the European Union (EU), and Russia

Aspect	China	European Union (EU)	Russia
Main Approach	Trade expansion, food infrastructure investment in developing countries, especially Africa	Strict regulations regarding food standards and sustainability, dominance in exports of high-value agricultural products	Market diversification, increasing exports to non-Western countries, especially Africa and Asia
Market Focus	Africa, Asia, Latin America	Africa, Asia, Eastern Europe	Africa, Middle East, Asia
Import Dependence	Large imports to meet high domestic demand	More balance between imports and exports	More as a food exporter, especially grains
Role in Global Food Security	Major provider of food raw materials and investment resources for developing countries	High food standards and focus on sustainability	Major producer of grains such as wheat, major supplier to developing countries
Trading Strategy	Establishing bilateral relations with developing countries, major investments in food and agricultural infrastructure	Establish strict regulation-based trade policies, including sustainability standards.	Increasing exports to non-Western countries to reduce dependence on Western markets
Challenge	Dependence on imports, global food price fluctuations	Strict regulations can be a barrier for partner countries	Western economic sanctions hamper access to key markets

Source:BRICS

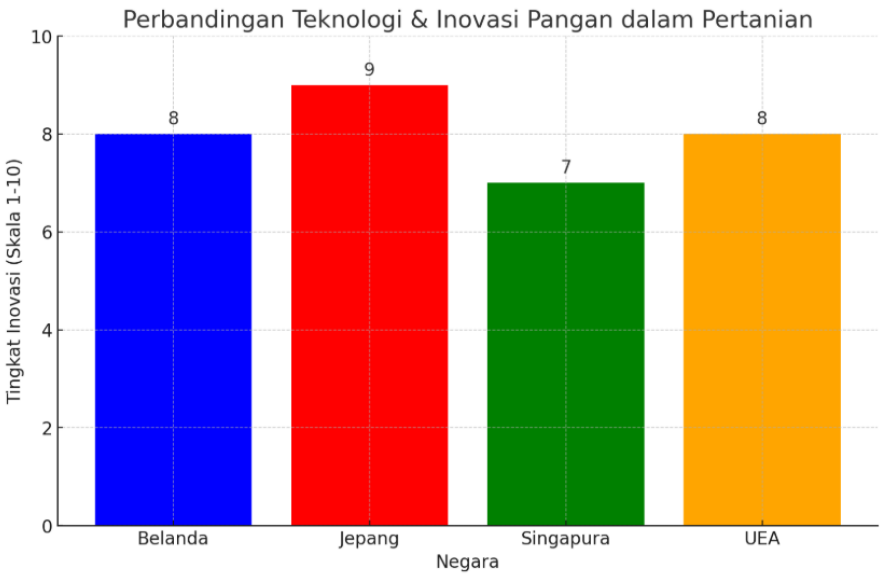

Figure 5. Comparison of the level of innovation in food technology in agriculture in the Netherlands, Japan, Singapore and the United Arab Emirates (UAE)

A comparative chart of the level of innovation in food technology in agriculture in the Netherlands, Japan, Singapore and the United Arab Emirates (UAE) shows how each country is adopting technology to improve efficiency and food security. The Netherlands is known for its precision farming and advanced greenhouse systems, which enable higher food production with more efficient use of resources. Japan excels in the application of AI, IoT and agricultural robotics, which automate various aspects of farming, from monitoring to harvesting, thereby increasing productivity. Singapore, with limited land, is developing hydroponics, aquaponics and urban farming systems, which enable vertical farming in urban areas to meet domestic food needs. Meanwhile, the UAE is focusing on smart irrigation and desert farming, using technology to efficiently manage water resources in extreme environmental conditions. From this comparison, it is clear that innovation in each country is tailored to the environmental challenges and available resources, demonstrating a unique approach to achieving sustainable food security. Here is a brief explanation in tabular form:

Table 6. Comparison of the level of innovation in food technology in agriculture in the Netherlands, Japan, Singapore and the United Arab Emirates (UAE)

Country	Food Technology & Innovation	Main Focus
Dutch	Precision Agriculture, Greenhouse	Optimizing land use, energy efficiency and automation in agriculture with modern greenhouse systems and data-driven technologies.
Japan	AI, IoT, Agricultural Robotics	Integration of artificial intelligence and Internet of Things (IoT) in agricultural monitoring and management to improve yields and efficiency.

Singapore	Hydroponics, Aquaponics, Urban Farming	Utilizing vertical farming, hydroponic, and aquaponic technologies to increase food production in urban environments with limited land.
UAE	Smart Irrigation, Desert Farming	Using smart irrigation technologies and desert farming methods to address dry climate challenges and improve water use efficiency.

Source:FAO, CGIAR, World Bank, WEF, BRICS, and ICARDA

DISCUSSION

ImpactClimate Crisis & Conflict on Global Food Security

Climate crises and conflict can have negative impacts on global food security, especially in vulnerable areas such as Somalia, South Sudan, Yemen and Afghanistan. Climate change causes droughts, floods and instability in food production, while armed conflict destroys agricultural infrastructure and hampers food distribution. In Somalia and South Sudan, the combination of drought and civil war increases dependence on international aid. Meanwhile, Yemen faces food blockades that exacerbate hunger, and Afghanistan is experiencing food insecurity due to conflict and natural disasters. These crises highlight the importance of a multi-sectoral approach, including climate-smart agriculture, conflict resolution and community-based food security strategies.

Climate change and conflict in Somalia and South Sudan have had a significant impact on drought, conflict and famine. Several other studies have suggested that Somalia faces the risk of recurring floods and droughts due to climate change, disrupting agricultural production and destroying livestock, and forcing the displacement of vulnerable populations.(Ahmed et al., 2023; Dirie et al., 2024). Food Insecurity: Climate change exacerbates food insecurity, which is compounded by mutually reinforcing conflicts.(Abdi et al., 2024; Bedasa & Deksisa, 2024). Agricultural and Livestock Exports: Internal and external conflicts reduce agricultural and livestock exports in the long term, although rainfall can increase exports in the short term (Abdi et al., 2024).

Climate Change and Conflict one of them in Bor County, South Sudan, climate change such as extreme temperatures and erratic rainfall patterns cause severe droughts and floods, which trigger community conflicts and worsen environmental degradation.(Mohammed & Laki, 2024). Conflict and climate shocks, together with economic instability and inadequate infrastructure, lead to widespread food insecurity, with heavy dependence on humanitarian assistance.(Shams et al., 2024). From a gender perspective, women are more vulnerable to the impacts of climate change and conflict, with different gender perceptions regarding resource and security implications (Mohammed & Laki, 2024).

Yemen is experiencing a protracted humanitarian crisis, with armed conflict exacerbated by extreme temperatures increasing the likelihood of armed conflict by 42.5% in the following year. This conflict is closely associated with a 45.8% increase in refugee flows.(Ghany, 2024). Yemen faces severe levels of food insecurity, with 45% of the population affected in 2020. Conflict, political instability and natural disasters disrupt agricultural activities and infrastructure, exacerbating the situation.(Sharjabi et al., 2024).

Afghanistan also experiences severe food insecurity, with 42% of the population affected in 2020. Factors such as conflict, natural disasters, and poor socio-economic conditions contribute to this situation (Sharjabi et al., 2024). Conflict and political

instability are the main drivers of food insecurity and malnutrition in Afghanistan, similar to the situation in Yemen. Natural disasters also play a significant role in exacerbating these conditions (Sharjabi et al., 2024). The climate crisis and conflict in Yemen and Afghanistan are causing severe food insecurity and increasing forced migration. Armed conflict fueled by extreme temperatures and political instability are exacerbating this situation. Addressing these challenges requires a multi-sectoral approach that includes conflict resolution, climate-smart agriculture, and integration of emergency responses with long-term strategies.

Food Production and Climate Change

Climate change is having a significant impact on food production in many countries. In the United States, extreme droughts are threatening crop yields, although irrigation and agricultural innovations are helping to mitigate the negative impacts. Brazil is facing major challenges from deforestation and changing rainfall patterns that are disrupting the production of key crops such as soybeans and corn. Meanwhile, India is experiencing declining agricultural productivity due to rising temperatures and changing monsoon patterns, which are hitting smallholder farmers hard. To address these challenges, countries are implementing adaptation strategies such as climate-resilient crop development, agroforestry, and data-driven farming systems to increase resilience to climate change.

Climate change poses a significant threat to global food production, affecting weather patterns and agricultural conditions that impact food security. In many parts of the world, including the United States, Brazil, and India, climate change is presenting unique challenges that require effective adaptation and mitigation strategies. Drought in the U.S. Midwest has led to changes in crop loss risk, with significant variation by crop type and region. The greatest reductions in risk were seen in the Southeast and Upper Midwest, while increases were seen in the Northwest and South.(Rathore et al., 2024). Climatic factors such as high temperature and vapor pressure deficit have a greater influence on changes in crop yield risk compared to irrigation area and nitrogen fertilizer application (Rathore et al., 2024).

In Brazil, climate change has had a negative impact on food production, with 67% of studies reporting negative impacts on crops such as cassava, cocoa, rice, and wheat. However, some crops such as corn, soybeans, and sugarcane showed varying impacts depending on baseline conditions.(Fiorini et al., 2024). Deforestation and land-use change exacerbate the impacts of climate change, emphasizing the need for more transparent and comprehensive strategies to enhance climate resilience in agricultural systems (Fiorini et al., 2024).

In India, climate change such as increasing temperatures and irregular rainfall have a direct impact on agricultural productivity, affecting food security and farmer welfare.(Baraj et al., 2024). Research shows the importance of adaptation and sustainability strategies to address the impacts of climate change, with a focus on sustainable agricultural practices and innovative adaptation strategies (Baraj et al., 2024).

Agroforestry is identified as a climate-resilient system, capable of increasing the resilience of agroecosystems to extreme weather conditions by moderating temperature fluctuations and increasing groundwater infiltration.(Dobhal et al., 2024). Development of climate-resilient crops and diversification of crop species through molecular technologies and precision agriculture can help increase resilience to climate change (Kopeć, 2024). Climate change poses major challenges to food production worldwide,

including in the United States, Brazil, and India. Effective adaptation and mitigation strategies, such as agroforestry and development of climate-resilient crops, are essential to ensure food security and sustainability of agricultural systems in the future.

Food Diplomacy Strategy

Food diplomacy is an important instrument in global trade and food security. China is investing heavily in food infrastructure in developing countries and relies on imports to meet domestic needs. The European Union has strict regulations on food trade with a focus on sustainability, while Russia uses wheat exports as a diplomatic tool, especially to African and Middle Eastern countries. Gastrodiplomacy also plays a role in strengthening international relations through the promotion of food culture. However, challenges such as protectionism, economic sanctions, and geopolitical uncertainty hamper global food trade, calling for a more cooperative and long-term stability-oriented approach.

Food diplomacy is an important tool in international relations, influencing trade, food security, and political relations between countries. China, Russia, and the European Union play significant roles in the global food trade network, with different strategies to advance their national interests. These two countries, along with the European Union, have strong food trade relations with African countries, where they export more than they import. This trade structure helps address food shortages in Africa and indicates an increase in the intensity of bilateral trade relations.(Hu et al., 2024). The European Union, especially France, has significant control over the global food trade network, including with China and Russia. This influence is important in maintaining food stability and security in various regions (Hu et al., 2024).

Political relations play an important role in China's food trade. Memorandums of understanding and state visits are key elements that strengthen bilateral relations and facilitate smooth trade transactions. These political relations have a greater impact on middle- and high-income countries.(Ni et al., 2024). Like China, Russia also leverages political ties to strengthen food trade, especially with countries with which it has strong political ties (Ni et al., 2024).

The concept of gastrodiplomacy, which involves the promotion of national food products and culinary culture, is used by countries to enhance their image and influence on the international stage. This includes the use of food in diplomatic events and participation in global food movements.(Cabral et al., 2024). The European Union uses gastrodiplomacy as part of its cultural diplomacy policy, promoting food and culinary traditions as a tool to strengthen international relations and enhance a positive image (Cabral et al., 2024).

Excessive protectionism and sanctions can threaten international food trade, encourage isolationism and the formation of economic blocs. Therefore, a more cooperative and diplomatic approach is needed to address these challenges.(Glauben & Duric, 2024). With increasing food insecurity, especially in Global South countries, it is important for countries such as China, Russia, and the European Union to balance their geopolitical and geoeconomic interests with a more collaborative approach (Glauben & Duric, 2024).

Food Technology and Innovation

Technological advances have revolutionized the food sector by increasing production efficiency and resilience. The Netherlands is developing IoT-based precision

farming and advanced greenhouses to optimize crop yields. Japan is leveraging artificial intelligence and robotics to automate agriculture, while Singapore is developing hydroponics and aquaponics to address land constraints. In the United Arab Emirates, smart irrigation systems and desert farming technologies are enabling food production in extreme environments. While these innovations offer solutions to food security, challenges such as high costs, farmer technological literacy, and long-term sustainability still need to be addressed for these technologies to be widely and effectively adopted.

Technology and innovation in agriculture play a vital role in improving the productivity and sustainability of agriculture worldwide. Several countries have taken the lead in adopting advanced technologies to address the challenges of modern agriculture. The Netherlands is known for its application of precision agriculture, which leverages advanced technologies such as the Internet of Things (IoT) and artificial intelligence (AI) to improve agricultural efficiency and productivity. This technology enables real-time monitoring of crops and land management, which can reduce labor costs and environmental impacts.(Dhanasekar, 2025; Saini et al., 2025; Sharma & Shivandu, 2024). The use of smart sensors and big data analytics also helps in wiser and more sustainable resource management.(Soussi et al., 2024).

Japan has integrated AI and IoT into precision agriculture to improve crop monitoring and management. This technology includes the use of automated agricultural robots for tasks such as harvesting and weed detection, significantly reducing labor costs and environmental impacts (Sharma & Shivandu, 2024; Saini et al., 2025). In addition, the development of 5G and 6G networks is expected to address connectivity challenges, promoting widespread adoption of smart farming practices (Sharma & Shivandu, 2024).

Singapore has focused its innovation on soil-less farming techniques such as hydroponics and aquaponics, which are well-suited to urban environments. These methods enable farming in limited space and increase crop productivity with efficient use of water and nutrients (Dhanasekar, 2025). IoT technology is also applied to monitor and optimize plant growth conditions in these systems.(Kumar et al., 2024).

The UAE is addressing the challenges of agriculture in a desert environment by adopting smart irrigation systems and precision farming technologies. These technologies help optimize water use and facilitate real-time environmental monitoring, which is essential for improving crop resilience to abiotic and biotic stress.(Xing & Wang, 2024). Advanced irrigation systems and soil conservation techniques show great potential in maximizing water efficiency and maintaining soil fertility (Xing & Wang, 2024).

Although this technology offers many benefits, challenges such as high implementation costs, data security issues, and low digital literacy among farmers still need to be addressed.(Balyan et al., 2024; Gamage et al., 2024). Collaboration between farmers, technology companies, academics, and policymakers is essential to address these challenges and harness the full potential of smart farming technologies (Kumar et al., 2024). Continuous innovation and acceptance of IoT-based solutions are critical to maintaining agriculture as a viable option amid challenges such as climate change and resource scarcity (Kumar et al., 2024).

CONCLUSION

From this article, it is clear that global food security is facing many major challenges. Climate change is making weather more unpredictable—droughts, floods, and storms are becoming more frequent, destroying crops and leaving many people struggling to find food. Conflicts in various countries are also making matters worse

by destroying farmland, hampering food distribution, and driving up food prices. On the other hand, countries like China, the European Union, and Russia are using food diplomacy to maintain international relations, either through exports and imports or investing in other countries' agricultural sectors. However, this strategy does not always work smoothly due to political obstacles, economic sanctions, and the national interests of each country. Fortunately, technological advances offer new hope. Innovations like precision agriculture, artificial intelligence (AI), hydroponics, and smart irrigation have helped increase food production, even in difficult places like deserts. However, there are still many challenges in implementing these technologies, especially for countries that lack funds and infrastructure.

LITERATURE

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