Food Safety and Food Security: Challenges and Solutions for a Sustainable Future

Umair Raza[1,*], Ushna Momal[1], Asfa Sabir[2], Ali Iqbal[3], Misbah Sharif[4], Hira Jabeen[1], Bushra Iram Fatima[5], Aniqa Saeed[5], Muhammad Hammad ul Hassan[1] and Dua Tariq[5]

[1]Department of Food Science and Technology, Faculty of Food and Home Sciences, MNS University of Agriculture, Multan, Pakistan
[2]Department of Human Nutrition and Dietetics, Faculty of Food and Home Sciences, MNS University of Agriculture, Multan, Pakistan
[3]Department of Nutrition, China Medical University, Taichung Taiwan
[4]Department of Home Sciences and Technology, Faculty of Food and Home Sciences, MNS University of Agriculture, Multan, Pakistan
[5]Faculty of Food Science and Nutrition, Department of Food Science and Technology, Bahauddin Zakariya University, Multan, Pakistan
*Corresponding author: umairraza5588@gamil.com

Abstract

Sustainable future is complemented by two aspects, food security and safety. Food safety is the ability of a product to prevent the level of contamination and risks inherent in the supply system. Good security on the other hand is the guarantee of a reliable and equally adequate supply of food. They jointly contribute to fight malnutrition, improve population's health, and achieve United Nations sustainable development goals. Nevertheless, some factors like expansion of population, increased resource depletion, climate change, and globalization of food and markets make food borne illnesses, food wastage, and inadequate access to foods. Other threats include; emerging paths from attachments to technologies; chemical residues; and microbiological contaminant that also put into question the vulnerabilities of global food systems. Different policies and governance present the solution to these challenges, embracing organizations such as Codex Alimentarius and ultimately enhance system partnership. Intensive food processing techniques, highly sensitive system for checking contaminants and reinforced laws and policies are required for making food secure universally. Hence for future research the following broad research ideas for consumers, sustainable production knowledge, and flexible policies for the new threats must be given high priority for the construction of sound, good, and stable food systems in the future.

Keywords: Food safety, Contamination, Climate change, Food wastage, Sustainable production

Cite this Article as: Raza U, Momal U, Sabir A, Iqbal A, Sharif M, Jabeen H, Fatima BI, Saeed A, Hassan MHU, and Tariq D, 2025. Food safety and food security: challenges and solutions for a sustainable future. In: Farooqi SH, Kholik K and Zaman MA (eds), One Health Horizons: Integrating Biodiversity, Biosecurity, and Sustainable Practices. Unique Scientific Publishers, Faisalabad, Pakistan, pp: 97-105. https://doi.org/10.47278/book.HH/2025.95

A Publication of Unique Scientific Publishers

Chapter No: 25-013

Received: 08-Feb-2025
Revised: 09-March-2025
Accepted: 21-May-2025

Introduction

International stability requires principles of food security and safety to be implemented. Food safety measures to ensure that persons' food is not contaminated with physical, chemical, or biological agents that are injurious to human health. Very rigorous measures need to be observed in every stage of production, processing, distribution, and storage (Hiroshi Shiigi, 2019). On the hand, food security is the ability of society to access and utilize healthy and safe food at all the time. All together contribute to economic and environmental steadiness, decrease hunger rate, and improvements in population's health, which creates the foundation for achieving sustainable development (Makarov et al., 2020). Addressing issues such as pesticide residues, microbial contamination and, food fraud, food safety operates through the food supply chain. Besides legal compliance, food safety involves the use of innovative tools such as block-chain and predictive analytics in the case of risk assessment. In contrast, the concept of food security focuses on the societal inequalities which hinder the access through adoption of policies and procedures that ensure adequate production, distribution and availability of foods. With the link between food security and safety in sustainable development, the nations can enhance sustainable development, protect the environment, and ensure well-being of the generation to come (Munirah & Norfarizan-Hanoon, 2022).

To attain food security, hunger and malnutrition become the major factors that require to be fought. Globally, about 9:2 percent of the population is still undernourished and according to the Food and Agriculture Organization (FAO). Since hidden hunger is prevalent in a large population and is characterized by micronutrient deficiency, people should consume micronutrient-dense foods (Meijl et al., 2020). According to World Health Organisation, at least 600 million of people get sick through consuming unsafe food and this gives a real-life example of the effect of food safety on health. These risks have to be managed applying efficient controls, including HACCP systems for these Supply Chain risks have to be managed applying efficient controls, including the implementation of Hazard Analysis and Critical Control Points (Hiroshi Shiigi, 2019). Especially in the emerging countries where agriculture is the main economic sector food safety and security highly boosts the economic growth and stability. Sustainable food chains assure the farmers 'fair revenues create employment and minimize reliance on import.

Global environmental issues including; gas emissions, water scarcity, and deforestation are highly linked with food systems. All these questions are aggravated by food wastage and uncooperative technique of crop production. Addressing food safety and security simultaneously promotes efficiency in use of resources such as the sustainable agriculture and precision farming (Brimbetova et al., 2023).

Through compliance to a set of advanced technologies, strengthening of already existing legal instruments, as well as encouragement of diplomatic relations, there can be improved food system resilience and equity in the distribution of foods. The global sustainability agenda should therefore have to keep stressing on food security and safety in order to enable the world acre (Meijl et al., 20220).

Current Challenges in Food Safety and Food Security

High consumer expectations of safe food, the high incidences of contamination, and the interconnected nature of today's food chains offer serious challenges to food safety. There are some current challenges in food safety and food security as following:

Climate change and environmental impact:

Climate change hardly has any effects, and as much as it continues to threaten the world's stability, basic necessities such as food will be highly affected throughout the world. These environmental changes favor growth of mycotoxins, pesticide residues and food borne pathogens which are great threats to food safety (Oyedele et al., 2020). Food systems are also influenced by characteristics such as higher temperatures and humidity levels, and the later has been associated with increased contamination of major staples like maize and wheat (Hasan & Hussain, 2020).

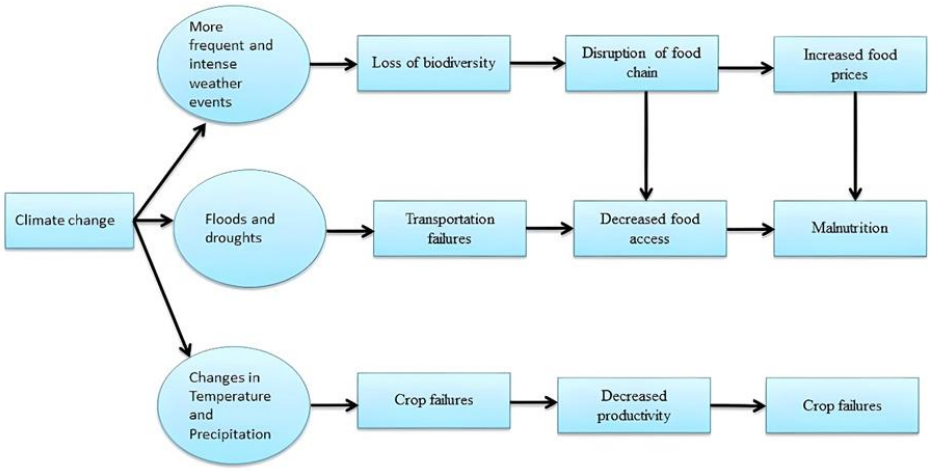

Fig. 1: Climate changes and food security

Socio-economic impacts also present other hurdles to food security, a reality that is unfortunate at best as it impacts the vulnerable most, especially in the emergent countries most. Agricultural production has reduced, and the costs of food are increasing across the world, making millions of people malnutrition thus lack quality foods that are healthy for consumption. Thus, the subject of food security and the associated policies must be discussed and reconsidered as the living standards of rural communities worsen and the volatility of global food trade increases (Sixt & Strzepek, 2022).

The link between climate change and food safety is rather undefined because of many threats and many factors associated with the issue as shown in (figure 1). There is supposing that climate change would harm individuals, plants, animals, and environmental processes. Higher temperatures together with increased levels of CO_2 change in rainfall patterns, and extreme events leading to food safety hazards are highlighted in the Fourth Report of the United Nations International Panel on Climate Change (European Food Safety Authority, 2020).

Thus, for freshwater and marine algal blooms bacterial, fungal, viral, and parasitic diseases, as well as vectors that are lethal to plants and animals have been all by climate change through occurrence, persistence, dominance, and toxicity. The probable fields through which climate change is likely to affect foodborne pathogen include the origin and transmission, growth and survival, as well as ecology of the microorganisms (Duchenne-Moutien & Neetoo, 2021).

Population growth and Resources Constraints

Food supply mainly in the area of sustainable production is among the greatest challenges the world is facing in present days. At present, the global growth rate is approximately 1.1% per year, and if these tendencies remain the same, according to the medium variant it is expected to reach 9.7 billion of people by 2050. However, the population growth would still remain high even if the rates of fertility reduced as present age patterns were believed to contribute to two-thirds of the projected growth (Molotoks et al., 2021). However, a few nations are home to a significant part of the world's population increase. Of the nine countries highlighted such as, India, Nigeria, the Democratic Republic of the Congo, Pakistan, Ethiopia, Tanzania, the United States of America, Egypt, and Indonesia, these countries, together, will be the source of more than half the world's population in 2050 as compared to 2019 (Ganivet, 2020).

Large populations exacerbate the problem of resource scarcity which includes energy, water, and arable land- which are all essential in food production (Adjimoti & Kwadzo, 2018). Also, population growth complicates issues of food insecurity and inequality in its distribution leading to high vulnerability to malnutrition among population in regions such as South Asia and Sub-Saharan Africa. The interactions between

population and resources are hence that there is a need to apply special programs and sound production of foods and feed. Such problems can however be minimized and the use of resources enhanced by adopting tools like precision farming for instance (Subramaniam, 2023).

Global Trade and Foodborne Diseases

There are growing anticipates about food safety issues related to agricultural products, such as fruits, vegetables, meat, eggs, and dairy products, despite the obvious connection between population growth and increased food demand, which has led to mandatory agricultural intensification in low- and middle-income countries (Li et al., 2018). Despite the fact that global food trade exceeded US $1.5 trillion in 2017, upper-middle-income countries saw an annual economic impact of $50.8 billion due to financial losses from FDs. 420,000 people die each year from foodborne infections (Table 1), which affect about 600 million people worldwide (almost one in ten) (Afsana et al., 2022).

Due to internal food shortages, market instability, and emergency trade restrictions and bans on the import and export of different food commodities, food safety concerns have spread widely (Salajegheh et al., 2022). Therefore, national food control systems are essential to public health and safety because they allow nations to guarantee that only safe and superior

International trade can occasionally be affected by food safety regulations, though. Lack of proper surveillance, monitoring, and enforcement of the laws alongside fragmented laws and a large number of jurisdictions hinder the implementation of food safety regulations. Afsana et al. (2022) argue that weak food safety measures in underdeveloped nations lead to much wastage and the loss of substantial amount of money. Trade policy negotiations and attempts to improve agricultural trade have also become more sophisticated because of the growth of food safety standards (Wieck & Jason, 2021). Diseases that are consistently linked to food containing germs and other chemicals, incorrect labeling and packaging, fraud, and food additives are some of the main risks to the global food market trade. The COVID-19 and other factors such as the tariff wars between the US and China as well as regional conflict have greatly affected the food trade and marketing internationally. In addition, more and expanding and widely enacted food standards and regulations are pressuring the global food market (Tibebu et al., 2024).

Table 1: Common Foodborne Diseases

Foodborne diseases	Bacteria	Common foods	Onset time	Symptoms	Citations
Food Poisoning	*Staphylococcus aureus*, *Campylobacter jejuni*	Animal-derived products	3-12 hours	Nausea, vomiting, diarrhea	(Narina, 2020)
Salmonellosis	*Salmonella spp.*	Meat, eggs, dairy	6-72 hours	Diarrhea, fever, abdominal cramps	(Sousa et al., 2022)
Botulism	*Clostridium botulinum*	Improperly canned foods	12-36 hours	Paralysis, blurred vision, muscle weakness	(Rao, 2021)
Listeriosis	*Listeria monocytogenes*	Soft cheeses, meats	Several days-weeks	Fever, muscle aches, complications in pregnancy	(Abebe et al., 2020)
Vibrio Infections	*Vibrio parahaemolyticus*	Seafood, raw fish	4-96 hours	Watery diarrhea, abdominal cramps	(Chen et al., 2022)
Campylobacteriosis	*Campylobacter jejuni*	Poultry, beef, lamb	2-5 days	Diarrhea, fever, abdominal pain	(Shane, 2019)
Yersiniosis	*Yersinia enterocolitica*	Pork, dairy products	4-7 days	Fever, diarrhea, abdominal pain	(Chlebicz and Slizewska, 2018)

Food products reach the food market. The "food code," also known as the Codex Alimentarius, was created to establish global standards for food and agricultural goods' safety and quality as well as to level the playing field for global trade (Wieck & Jason, 2021).

Good agricultural practices (GAP) and the hazard analysis and critical control points system must be followed at every level of the food production process (Gizaw, 2019). Countries should adopt and execute risk-based food control policies, according to WHO recommendations. Monitoring animal illnesses that endanger public health is also encouraged by the International Organization for Animal Health (Li et al., 2018).

Food Waste and Loss

FLW augments social, economic, and ecological risks and is a major concern affecting the global food security and safety. According to the estimates, one third of the produced food is wasted or lost, which puts in jeopardy food accessibility and aggravates sustainability challenges. FLW has tremendous effects when millions of people are food insecure, and this insecurity worsens due to disruptions in supply chains and food systems (Nicastro & Carillo, 2021).

Food loss that is more common in developing countries is brought about by inadequate handling and post-harvesting processes (shown in figure 2); whereas food waste which is predominant in developed countries is as a result of consumer choice and domestic waste (Santeramo, 2021). Food recovery, redistribution, and waste reduction must be given top priority in policy frameworks in order to combat food insecurity. One way to promote sustainable practices and considerably reduce food insecurity is to repurpose excess food. Global programs that support the Sustainable Development Goals also highlight FLW reduction as a means of improving sustainability and resource efficiency (Lai et al., 2022).

In summary, food loss and waste are linked to issues of food safety and security, which calls for focused efforts throughout the food supply chain (Gherman & Balan, 2019).

Economic and Political Challenges

It is difficult for emerging economies, like China, Brazil, and India, to implement food safety (FS) procedures in their food supply chains. The difficulties are divided into five groups: financial, knowledge, global, government, & policy, and organizational. With the use of the "Decision

Making Trial and Evaluation Laboratory" (DEMATEL) and the Best Worst Method (BWM), determined the best and worst obstacles to the FS efforts as well as the causal relationships between them. While DEMATEL find causal link maps for the difficulties that BWM has prioritized, BWM sets priorities for these challenges. The difficulties faced by the effect group are reflected in the knowledge and financial problems. Securing food for all is the second Sustainable Development Goal (SDG), and food safety programs and policies in emerging economies aim to increase public awareness while promoting increased cooperation and efficiency in food supply chains (Mangla et al., 2021).

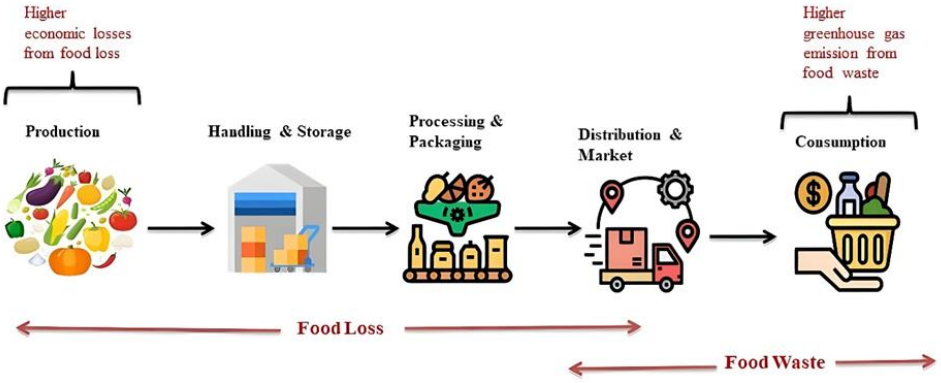

Fig. 2: Food loss and food waste occur at different stages across the food supply chain

Emerging Risks and Threats to Food Safety

For public health and global food security, emerging dangers and threats to food safety pose major challenges. Millions of foodborne diseases worldwide are caused by microbial contamination, which remains one of the most common hazards to food safety. Food is contaminated at several phases of manufacture, processing, and distribution by pathogenic microbes such *Salmonella*, *Escherichia coli*, and *Listeria monocytogenes*. When it comes to sanitary facilities and the ability to control the food safety technology the developing countries are at a disadvantage (Gizaw, 2019). Unfortunately, chemical pollutants like pesticides, heavy metals and industrial pollutants can be stored in the food cycle and may cause chronic diseases. As the fact is that these chemicals developed long-term diseases such as cancer and neurological disorders and hence it demands improved monitoring and risk assessment systems. The use of food additives in school snacks in such regions as Indonesia explains why the lack of supervision has the following health impacts (Table 2) (Njatrijani, 2021).

Table 2: Types of Hazards in Food

Types of Hazards	Examples	Citations
Biological hazards	Pathogens such as *Escherichia coli*, *Salmonella spp*., viruses (e.g., hepatitis A, rotavirus), and fungi (e.g., *Aspergillus* species).	(Cudjoe et al., 2022)
Chemical hazards	Pesticide residues, antibiotics, formalin, and borax.	(Singh et al., 2019)
Physical hazards	Contaminants such as dust, metal fragments, microplastics	(Gao et al., 2020)

Technology can be associated with such products as GMOs and food additives that can increase the yield and shelf life of agriculture products but contain specific risks. For instance, there has been concern with possible GMO ecological effects, potential allergenicity, and other unintended short and long-term health impacts (Hiroshi Shiigi, 2019). These concerns highlight the lack of comprehensive information about the combined effects of these drugs and stress the need for further research as well as the practice of open labeling (de Boer et al., 2020).

One of the potential weaknesses arising from globalization in food supply networks is that food safety is growing more susceptible. Lifestyle risks for example include the unwarranted health risks occasioned by the use of unapproved preservatives and storage methods in some countries. Food criminality which entails product tampering and misbranding erodes the consumer confidence even further which requires stringent inspection measures (Gizaw, 2019).

It has also been revealed through pandemics and natural disasters that the world's food systems are very fragile. Due to COVID-19 and other similar events (shown in figure 3), supply chain disruptions have raised questions on the application of resilience building strategies and management cooperation to safeguard food accessibility and safety (de Boer et al., 2020).

Food Safety: The Strategies & Solution

Some of the strategies of food safety include the new methods of testing for toxins, new technologies used in food processing, policies and regulations as well as number and lengthy teaching and training programs.

1. Regulatory Frameworks and International Standards

It assures the safety of food through setting standards, conducting periodic checks, and ensuring that the various standards are being complied with. Hazard Analysis and Critical Control Point (HACCP), as well as Good Manufacturing Practice (GMP) are extremely important for governments around the world in order to minimize the risk of contamination (de Boer et al., 2020). The FAO and the WHO oversee Codex Alimentarius by which global food safety standards can be harmonized. This reduces trade restrictions as well as consumer risk (Chen et al., 2023).

2. Innovative Technologies in Food Processing and Preservation

Traceability of food has been brought by advanced technologies such as block-chain and RFID tags, which also reduce the probability of food wastage and contamination. They have also been enhanced by safety measures so that advanced cleaning technologies include automated pest management and enhanced sanitization practices (Munirah & Norfarizan-Hanoon, 2022).

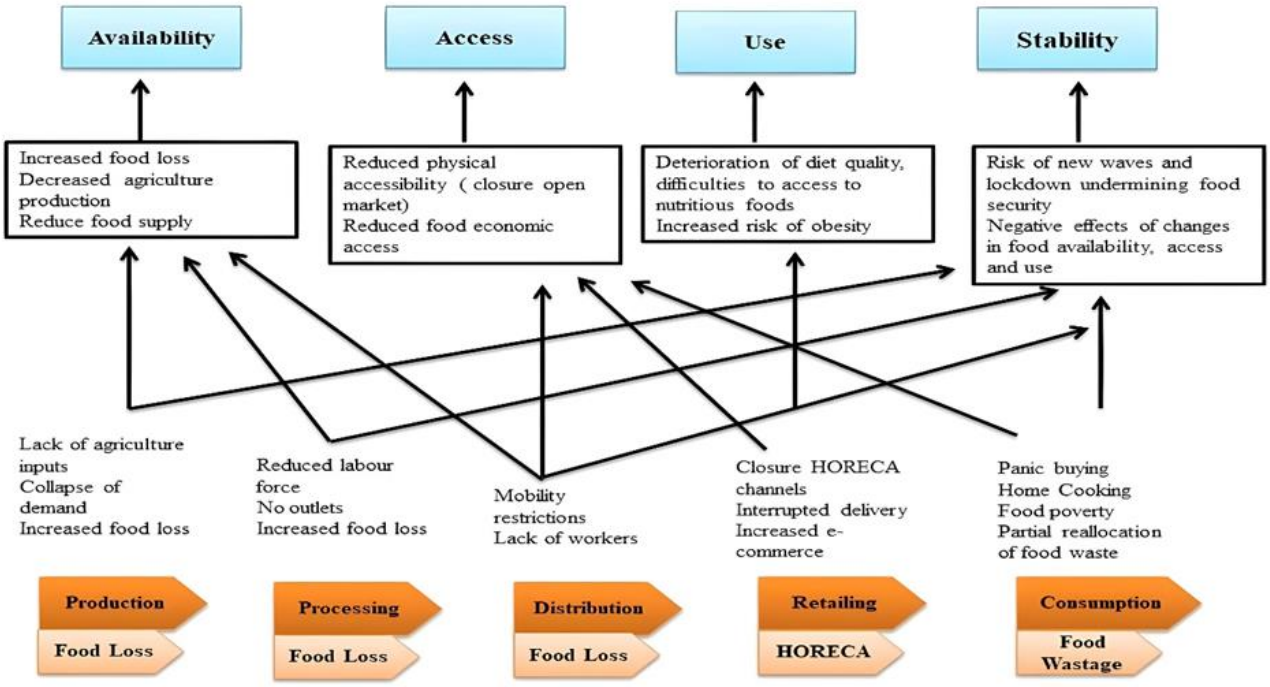

Fig. 3: Impact of COVID-19 on agri-food supply chain and food security

3. Enhancing the Identification and Surveillance of Contaminants

Analyzing pollutants with modern instruments at distinct control points is crucial to managing risk. Real time identification of chemical and microbiological hazards is facilitated by aspects such as AI, analytics, and high performance sensors. Further, the risk assessment models have been advanced to assess the food product safety in the supply chain (Jin & Wu, 2019).

Achieving Food Security in a Sustainable Manner

To eradicate or at least stem problems such as poverty, malnutrition, and environmental degradation, the world needs sustainable food security. These key strategies are implemented:

1. Enhancing Methods of Cultivation

The way in which food is produced must be made more efficient in order to feed the world's population properly. Organizations including Food and Nutrition Security Program (FANUSEP) focus on helping people especially from the third world countries through sustainable farming. Climate change adaptation measures such as the use of improved crop varieties, soil conservation practices and efficient use of inputs through precision agriculture all lead to higher yields but with less harm to the environment (de Boer et al., 2020).

2. Supporting Local and Sustainable Food Systems

The locally diverse and self-reliant food systems reduce demand for foods and other products from other markets; therefore, they enhance food security. Organized by local food outlets, CSAs and urban agriculture ensure delivery of fresh foods with reduced transportation pollution (Munirah & Norfarizan-Hanoon, 2022).

3. Increasing Nutrient Rich Foods Availability

Having access to health-promoting food is one of the critical pillars of both categories of food security. To overcome food disparities, and make healthier foods affordable, programs like the Expanded Food and Nutrition Education Program (EFNEP) are developed for the low income earners (Farrell et al., 2017). Moreover, market-based strategies provide nutrition programs with food systems and vice versa, thus making nutrient-dense foods accessible (Cruz et al., 2019).

4. Food Waste Management across various stages

Awareness creation on the part of the consumer is essential in successful reduction of food wastage hence; ethical practices in the storage, preparation, and purchase of food products should be championed through various campaigns. Using food waste for the production of bioenergy or animal feed is also circular (Table 3) (Irtyshcheva et al., 2019).

Table 3: Successful models for sustainable food safety and security and their examples

Approach/Model	Key features	Examples	Countries	Citations
Good Manufacturing Practice (GMP) and HACCP	Systematic decrease in foodborne diseases and contamination.	Widespread across the world's food businesses.	Worldwide	(Owusu-Apenten & Vieira, 2022)
Agricultural Integration	Integrating development initiatives with food safety in order to accomplish the Sustainable Development Goals (SDGs).	Rwanda's sustainable development initiatives.	Rwanda	(Blakeney, 2022)
Environmental Monitoring in Regulation	Framework that prioritizes food safety and environmental sustainability through policy implementation and monitoring.	Networks for environmental safety in food production.	China, EU	(El Bilali et al., 2021)
Digital Tools in Food Safety	Integrating digital systems to improve fraud protection and data processing.	Use in international food supply networks	Worldwide	(Ali Eltabey, 2023)
Trade-off Management	Utilizing circular food systems and source reduction while maintaining a balance between sustainability, safety, and security.	Combating antibiotic resistance on a global scale.	Worldwide	(Ivar Vagsholm et al., 2020)
Animal-free Testing	Cutting-edge methods for food safety that don't include animal testing	Using non-animal methods to increase the relevance of data worldwide.	Worldwide	(Reddy, 2023)
By-product Valorization	using food processing residues while keeping sustainability, nutrition, and safety	Feasibility studies conducted in the EU.	European Union	(Caponio et al., 2022)
Policy Integration	Resolving concerns between sustainable agriculture and food safety	The Central Coast of California, USA.	USA	(Zaharia et al., 2021)

Role of Policy and Governance

The Role for sustainably protecting food, there is need for policy and governance as well. Some of these are given below:

1. International Politics and Organizations

FAO and WHO set up the Codex Alimentarius Commission which sets the rules for food standards around the world. To promote food safety in the exportation of food, and consumer protection, it supports the standardization of its rules and regulation across the world (Behringer and Feindt, 2019). Besides, food systems diplomacy has emerged as a key approach to addressing global challenges through the integration of economic, environmental, and health concerns into government policies (Garg et al., 2022). The “Farm to Fork” plan of the EU is another example of the collaboration governance structure that has employed short chain and local food system to enhance sustainability and food security (Kapała , 2023).

2. Policies in the Area of Food Safety and Food Security

The rules and regulations that guide procurement, safety, and security of food within the nation are the regulatory rules that employ risk assessment, quality, and campaigns. Specifically, Australian food policies focus on regulatory governance so as to enhance the conditions for food as well as the consumer behavior (Ngqangashe & Friel, 2022). Indonesian government programs focus on food sovereignty through addressing agriculture concerns and using concept of holistic food systems. Through securing the local food production these initiatives aim at reducing the import dependence (Sutrisno, 2022).

Future Directions and Research Needs

The approach to the future of food security and safety involves innovative approaches that address sustainability, policy resilience to new risks, and consumer knowledge and behavior change. Sustainability is a major consideration in the area of food security and safety research. This is one of the main innovations; adopting state of the art technologies such as block-chain and RFID tags in enhancing traceability and reducing food wastage. Other methods are also needed for waste minimization and supply chain enhancement concerns (Munirah & Norfarizan-Hanoon, 2022).

Another promising area is the move to non-animal testing methods like in vitro testing methods that have more safety relevance to humans and which also fit the sustainability agenda. The long-term benefits will also be incredible because the adoption of proactive food safety systems that are risk-based in their nature will replace the current reactive systems. Flexible regulation of food safety is required in connection with newly emerging threats at the global level, such as pandemics, changes in climate, and geopolitical crises. Therefore, the need to enhance the food safety surveillance methods in a way that will not contaminate the samples and meet the modern standards of safety is well understood. More research is also needed on nutrition and environmental intervention, and how they interact with food production systems, and this is by including cumulative risk assessments into policy (Ozimek, 2018).

Conclusion

Food security and food safety are related concepts and show how much they are significant in providing people with a stable future. On the other hand, foods security refers to the state where there is consistent availability of adequate, safe, and nutritious food and on the other hand, food safety is the safeguarding of food from hazards at stages of production, processing, distribution, retail, preparation, and

consumption. These ideas focus directly on the four pillars of sustainability and improve health, reduce inequality, and build environmental resilience for the world.

Weaknesses of world food systems are amplified through such modern factors as population increase, climate change, and scarcity of resources. The need for proper mitigation measures is justified by on-shore new threats, chemical and microbiological pollutants; and on supply chain frailty. Approaches to food safety focus on the advanced methods of monitoring, innovative technologies for food processing, or legislation. Raising the dietary quality of foods, preserving local food supply chains, minimizing food waste, and improving farming techniques are must have strategies towards food security. There are reasons to emphasize that policy and governance, as well as national and global circuits, has to be established to support the cooperation between the states. It is also suggested for future studies to explore consumer knowledge and their change in behavior, governmental policy updates on new risks and for developments in food sustainability. They also said that the future generations will be able to have food systems that are safe, sustainable, and egalitarian, provided that these problems work hand in hand.

References

Abebe, E., Gugsa, G., & Ahmed, M. (2020). Review on major food-borne zoonotic bacterial pathogens. *Journal of Tropical Medicine, 2020*, 1–19. https://doi.org/10.1155/2020/4674235

Afsana, K., Jolly, S. P., & Akhter, F. (2022). Nutrition, food safety and global health. In I. Kickbusch, J. M. Told, & S. Reddy (Eds.), *Handbook of global health* (pp. 1–28). Springer International Publishing. https://doi.org/10.1007/978-3-030-05325-3_93-1

Eltabey, R. A. (2023). Utilizing digital technologies to ensure food safety. *International Journal of Artificial Intelligence and Emerging Technology*, *6*(2), 42–65. https://doi.org/10.21608/ijaiet.2024.275187.1007

Makarov, A. N., Maksyutina, E. V., Hubiev, K. A., & Gimadeev, A. D. (2020). Global and national food security issues in the context of land and water resources. *Caspian Journal of Environmental Sciences*, *18*(5), 467–472. https://doi.org/10.22124/cjes.2020.4472

Behringer, J., & Feindt, P. H. (2019). How shall we judge agri-food governance? Legitimacy constructions in food democracy and co-regulation discourses. *Politics and Governance*, *7*(4), 119–130. https://doi.org/10.17645/pag.v7i4.2087

Blakeney, M. (2022). Agricultural innovation and sustainable development. *Sustainability*, *14*(5), 2698. https://doi.org/10.3390/su14052698

Brimbetova, N. Zh., Temirova, G. K., & Sultanaev, A. A. (2023). Food security and social development of regions: International experience. *Economics: The Strategy and Practice*, *18*(1), 36–54.https://doi.org/10.51176/1997-9967-2023-1-36-54

Bukhtiyarova, T., Artamonova, I., & Baturina, I. (2022). The state and problems of food security ensuring in Russia. *IOP Conference Series: Earth and Environmental Science*, *949*(1), 012107. https://doi.org/10.1088/1755-1315/949/1/012107

Caponio, F., Piga, A., & Poiana, M. (2022). Valorization of food processing by-products. *Foods*, 11(20), 3246. https://doi.org/10.3390/foods11203246

Chen, L., Wang, J., Zhang, R., Zhang, H., Qi, X., He, Y., & Chen, J. (2022). An 11-year analysis of bacterial foodborne disease outbreaks in Zhejiang Province, China. *Foods*, 11(16), 2382. https://doi.org/10.3390/foods11162382

Chlebicz, A., & Śliżewska, K. (2018). Campylobacteriosis, salmonellosis, yersiniosis, and listeriosis as zoonotic foodborne diseases: A review. *International Journal of Environmental Research and Public Health, 15*(5), 863. https://doi.org/10.3390/ijerph15050863

Cruz, M., Lynn, M. L., Kaganzi, E., Norell, D., Sriram, V., & Tumusiime, E. (2019). Better together: Improving food security and nutrition by linking market and food systems. *Enterprise Development and Microfinance, 30*(3), 189–205. https://doi.org/10.3362/1755-1986.18-00019

Cudjoe, D. C., Balali, G. I., Titus, O. O., Osafo, R., & Taufiq, M. (2022). Food safety in Sub-Saharan Africa: An insight into Ghana and Nigeria. *Environmental Health Insights, 16*, 11786302221142484. https://doi.org/10.1177/11786302221142484

Chen, Y., Chen, A., & Zhang, H. (2023). The application of food safety standards in food safety management practices. *International Journal of Food Science and Agriculture, 7*(2), 242–246. https://doi.org/10.26855/ijfsa.2023.06.011

De Boer, A., Krul, L., Fehr, M., Geurts, L., Kramer, N., Tabernero Urbieta, M., van der Harst, J., van de Water, B., Venema, K., Schütte, K., & Hepburn, P. A. (2020). Animal-free strategies in food safety & nutrition: What are we waiting for? Part I: Food safety. *Trends in Food Science & Technology*, 106, 469–484. https://doi.org/10.1016/j.tifs.2020.10.034

Duchenne-Moutien, R. A., & Neetoo, H. (2021). Climate change and emerging food safety issues: A review. *Journal of Food Protection, 84*(11), 1884–1897. https://doi.org/10.4315/JFP-21-141

El Bilali, H., Strassner, C., & Ben Hassen, T. (2021). Sustainable agri-food systems: Environment, economy, society, and policy. *Sustainability, 13*(11), 6062. https://doi.org/10.3390/su13116062

European Food Safety Authority (EFSA), Maggiore, A., Afonso, A., Barrucci, F., & De Sanctis, G. (2020). Climate change as a driver of emerging risks for food and feed safety, plant, animal health and nutritional quality. *EFSA Supporting Publications, 17*(6), 1881E. https://doi.org/10.2903/sp.efsa.2020.EN-1881

Farrell, J. A., Cordeiro, L. S., Qian, J., Sullivan-Werner, L., & Nelson-Peterman, J. L. (2017). Food affordability, food security, and the Expanded Food and Nutrition Education Program. *Journal of Hunger & Environmental Nutrition, 13*(2), 180–191. https://doi.org/10.1080/19320248.2017.1364186

Ganivet, E. (2020). Growth in human population and consumption both need to be addressed to reach an ecologically sustainable future. *Environment, Development and Sustainability, 22*(6), 4979–4998. https://doi.org/10.1007/s10668-019-00446-w

Gao, P., Mohd Noor, N. Q. I., & Md. Shaarani, S. (2020). Current status of food safety hazards and health risks connected with aquatic food products from Southeast Asian region. *Critical Reviews in Food Science and Nutrition*, 1–20. https://doi.org/10.1080/10408398.2020.1866490

Garg, D. H., Spiker, M. L., Clark, J. K., Reynolds, C., & Otten, J. J. (2022). Food systems governance should be preceded by food systems diplomacy. *Nature Food, 3*(9), 667–670. https://doi.org/10.1038/s43016-022-00585-5

Gherman, E. D., & Balan, I. M. (2019). The impact of food insecurity on the world's population. *Journal Agricultural Management*, 21(3), 76–80.https://www.lsma.ro/index.php/lsma/article/view/1709

Gizaw, Z. (2019). Public health risks related to food safety issues in the food market: A systematic literature review. *Environmental Health and Preventive Medicine*, *24*(1), 68. https://doi.org/10.1186/s12199-019-0825-5

Hasan, A., & Hussain, Z. (2020). Climate change and its impact on food security. *Research Journal of Humanities and Social Sciences*, *11*(1), 91–96. https://doi.org/10.5958/2321-5828.2020.00014.6

Shiigi, H. (2019). Food safety. *Analytical Sciences*, *35*(3), 235–236. https://doi.org/10.2116/analsci.35.235

Irtyshcheva, I., Ponomarova, M., & Dolzhykova, I. (2019). Conceptual fundamentals of development of the food security system. *Baltic Journal of Economic Studies*, *5*(2), 57–64. https://doi.org/10.30525/2256-0742/2019-5-2-57-64

Vågsholm, I., Arzoomand, N., & Boqvist, S. (2020). Food security, safety, and sustainability getting the trade-offs right. *Frontiers in Sustainable Food Systems*, *4*, 16. https://doi.org/10.3389/fsufs.2020.00016

Jin, H., & Wu, J. (2019). Research on risk identification and safety supervision management of food supply chain. *Food Science & Nutrition Research*, *2*(1). https://doi.org/10.33425/2641-4295.1011

Kapała, A. (2023). The role of short supply chains and local food systems in the concept of food sovereignty and food democracy. *Przegląd Prawa Rolnego*, *(1)(32), 117–138. https://doi.org/10.14746/ppr.2023.32.1.7

Lai, M., Rangan, A., & Grech, A. (2022). Enablers and barriers of harnessing food waste to address food insecurity: A scoping review. *Nutrition Reviews*, *80*(8), 1836–1855. https://doi.org/10.1093/nutrit/nuaco12

Li, Y., Li, Y., Zheng, G., Zhu, L., Wang, J., Mu, S., Ren, Q., & Feng, F. (2018). Cytochrome P450 1A1 and 1B1 promoter CpG island methylation regulates rat liver injury induced by isoniazid. *Molecular Medicine Reports*, *17*(1), 753–762. https://doi.org/10.3892/mmr.2017.7871

Munirah, A., & Norfarizan-Hanoon, N. A. (2022). Interrelated of food safety, food security and sustainable food production. *Food Research*, *6*(1), 304-310.

Mangla, S. K., Bhattacharya, A., Yadav, A. K., Sharma, Y. K., Ishizaka, A., Luthra, S., & Chakraborty, R. (2021). A framework to assess the challenges to food safety initiatives in an emerging economy. *Journal of Cleaner Production, 284*, 124709. https://doi.org/10.1016/j.jclepro.2020.124709

Meijl, H. van, Shutes, L., Valin, H., Stehfest, E., van Dijk, M., Kuiper, M., Tabeau, A., van Zeist, W.-J., Hasegawa, T., & Havlik, P. (2020). Modelling alternative futures of global food security: Insights from Foodsecure. *Global Food Security, 25*, 100358. https://doi.org/10.1016/j.gfs.2020.100358

Molotoks, A., Smith, P., & Dawson, T. P. (2021). Impacts of land use, population, and climate change on global food security. *Food and Energy Security, 10*(1), e261. https://doi.org/10.1002/fes3.261

Ngqangashe, Y., & Friel, S. (2022). Regulatory governance pathways to improve the efficacy of Australian food policies. *Australian and New Zealand Journal of Public Health*. https://doi.org/10.1111/1753-6405.13284

Nicastro, R., & Carillo, P. (2021). Food loss and waste prevention strategies from farm to fork. *Sustainability, 13*(10), 5443. https://doi.org/10.3390/su13105443

Njatrijani, R. (2021). Pengawasan keamanan pangan. *Law, Development & Justice Review*, *4*(1), 12–28. https://doi.org/10.14710/ldjr.v4i1.11076

Narina, S. S. (2020). Bacteria associated with food. *Acta Scientific Microbiology, 3*(4), 137–144. https://doi.org/10.31080/ASMI.2020.03.0557

Owusu-Apenten, R., & Vieira, E. (2022). Food safety management, GMP & HACCP. In *Elementary food science* (pp. 217–236). Springer International Publishing. https://doi.org/10.1007/978-3-030-65431-3_10

Oyedele, O. A., Akinyemi, M. O., Kovac, T., Eze, U. A., & Ezekiel, C. N. (2020). Food safety in the face of climate change: Consequences for consumers. *Croatian Journal of Food Science and Technology, 12*(2), 280–286. https://doi.org/10.17508/CJFST.2020.12.2.20

Ozimek, I. (2018). Food safety in the context of legislation. *Annals PAAAE*, *20*(6), 189–196. https://www.researchgate.net/publication/329582003_Food_safety_in_the_context_of_legislation

Rao, A. K. (2021). Clinical guidelines for diagnosis and treatment of botulism, 2021. *MMWR. Recommendations and Reports, 70*(2), 1–30. https://doi.org/10.15585/mmwr.rr7002a1

Reddy, N., Lynch, B., Gujral, J., & Karnik, K. (2023). Regulatory landscape of alternatives to animal testing in food safety evaluations in the western world. *Regulatory Toxicology and Pharmacology*, *105*, 105470. https://doi.org/10.1016/j.yrtph.2023.105470

Regional Food Security System Policy. (2021). *Policy: Journal of Administrative Science*. https://jas.uitm.edu.my/images/2021_JUNE/4148-Article%20Text-15789-1-10-20210630.pdf

Salajegheh, S., Sobur, A., Zowalaty, M. E. E., Ashour, H. M., & Rahman, T. (2022). Impact of the COVID-19 pandemic on food production and animal health. *Trends in Food Science and Technology*, *121*, 105–113. https://doi.org/10.1016/j.tifs.2021.12.021

Santeramo, F. G. (2021). Exploring the link among food loss, waste and food security: What the research should focus on? *Agriculture & Food Security*, *10*(1), 26. https://doi.org/10.1186/s40066-021-00302-z

Shane, S. M. (2019). Campylobacteriosis. In *Handbook of Zoonoses, Second Edition, Section A: Bacterial, Rickettsial, Chlamydial, and Mycotic Zoonoses* (pp. 311–320). CRC Press. https://doi.org/10.1201/9781003006107-22

Singh, P. K., Singh, R. P., Singh, P., & Singh, R. L. (2019). Food hazards: Physical, chemical, and biological. In *Food Safety and Human Health* (pp. 15–65). Academic Press. https://doi.org/10.1016/B978-0-12-816333-7.00002-0

Sixt, G. N., & Strzepek, K. (2022). Assessing the food security implications of climate change on global food trade. In *Transforming food systems: Ethics, innovation and responsibility* (pp. 82–88).https://doi.org/10.3920/978-90-8686-939-8_11

Sousa, D. F. de, Campos Filho, P. C., & da Conceição, A. O. (2022). Antibacterial activity of jackfruit leaves extracts and the interference on antimicrobial susceptibility of enteropathogen. *Food Science and Technology*, *42*, e49220. https://doi.org/10.1590/fst.49220

Adjimoti, G. O., & Kwadzo, G. T.-M. (2018). Food insecurity and coping strategies among farming households in Benin: A case study of maize

farmers. *Agriculture & Food Security, 7*(1), 1–11. https://doi.org/10.1186/s40066-018-0192-x

Subramaniam, Y. (2023). Population growth, biofuel production and food security. *Green and Low-Carbon Economy*, *2*(4), 259–268. https://doi.org/10.47852/bonviewGLCE3202948

Sutrisno, A. D. (2022). Regional food security system policy. *Journal of Administrative Science*, *13*(1), 28–42. https://jas.uitm.edu.my/images/2022_JUNE/2921-Article%20Text-8112-1-10-20220630.pdf

Tibebu, A., Tamrat, H., & Bahiru, A. (2024). Review: Impact of food safety on global trade. *Veterinary Medicine and Science*, *10*(5). https://doi.org/10.1002/vms3.1585

Wieck, C., & Jason, H. G. (2021). Codex in motion: Food safety standard setting and impacts on developing countries' agricultural exports. *EuroChoices*, *20*(1), 37–47. https://doi.org/10.1111/1746-692X.12286

Zaharia, A., Diaconeasa, M. C., Maehle, N., Szolnoki, G., & Capitello, R. (2021). Developing sustainable food systems in Europe: National policies and stakeholder perspectives in a four-country analysis. *International Journal of Environmental Research and Public Health*, *18*(14), 7701. https://doi.org/10.3390/ijerph18147701