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REVIEW BASED BOOK CHAPTER

GLOBAL FOOD SECURITY CHALLENGES AND TECHNOLOGICAL SOLUTIONS

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Abstract

This chapter deals with some fascinating facets of food security as it relates to sustainable development, as well as potential variables that could affect both national and international food security. Millions of people worldwide still face a threat to their health and safety due to ongoing food and nutrition instability. Currently, many risk-increasing factors exist, including the Russia-Ukraine conflict, the consequences of COVID-19, climate change, our sustainable development, and our food security are being impacted more and more by overpopulation and some global issues. Together, these components will analyze the problems that the contemporary food system is experiencing, summarize the changes that the food system is undergoing, and explore the courses that will be taken in the imminent to support the sustainable growth of the food system. In addition to outlining probable plans of action and strategies for intensifying social shield in the current situation, principally for low-income countries, in the fight averse to challenges of food security and global food systems improvement.

Keywords
Food Security, Food Systems, Challenges, Opportunities, Solutions

1. Introduction

Food and Agriculture Organization has made a magnificent promise to the world by committing to achieving "zero hunger" by 2030 [1]. However, this pledge has not been carried out quickly, and COVID has made matters worse. The global food system has suffered from several negative side effects as a result of this, in addition to issues like climate change, local conflicts, slow development, and severe pandemics [2, 3]. In 2021, 29.3% of the universal population, or almost 2.3 billion people, faced severe or reasonable food insecurity, up 350 million from the years of the COVID-19 pandemic, conferring to the State of Food Security and Nutrition in the World 2022 study.

Conditions are getting worse in many emerging nations, especially those in sub-Saharan Africa [4].

In Past, The FAO estimates that between 702 and 828 million people will experience food insecurity globally in 2021. The estimated range's median (768 million) indicates that in 2021, there will be 150 million more individuals experiencing extreme hunger than there were in 2020. Over half (425 million) of the world's population who were food insecure in 2021 more than one-third (278 million) lived in Asia and Africa combined. According to recent data, the sum of individuals globally unable to maintain a nutritious diet increased by 112 million to roughly 3.1 billion as a result of the pandemic's effects on consumer food expenditures. In 2030, 78 million more individuals are expected to be undernourished if the current trend continues [5, 6].

The notion of eradicating hunger by 2050 seems unlikely given the ongoing population growth. Population growth, natural catastrophes, armed conflicts, and poverty are the primary causes of malnutrition and hunger. Because of the worldwide financial crisis, it is unable to change the paucity of crescendos, which has led to concerns about hunger [7]. To end hunger, improve nutrition, and achieve food security, the United Nations Development Programme (UNDP) has established sustainable development goals. However, the effects of climate change on agriculture and food poverty are already being seen, increasing the risk that the food supply system won't be able to achieve its stated goals. A backup plan for sustainable agronomic fabrication systems is crucial since new climate change-related problems are becoming increasingly urgent [8].

In 2020 and 2021, growing food insecurity among women was linked to worsening short-, medium-, and long-term nutritional effects, including an increase in the number of anemic women and children as well as a rise in low birthweight newborns and underweight babies. According to projections, there will be 39 million (5.7%) overweight children, 45 million (6.7%) wasted children, and 149 million (22%) stunted children in 2020. While progress was being made toward 2030 goals, children's obesity and stunting rates were rising [6].

2. Food Security

Food security is a flexible and diverse concept that has been explained in a variety of ways. Food security refers to each member of the family having access to and availability of nutrient-sufficient, aesthetically appropriate food that is attained in a way that encourages a healthy lifestyle. Obstinately, food security refers to the sporadic or insufficient availability of nourishing foods [9]. Researchers has utilized the FAO-adopted definition, which is one of the most abundantly used and internationally acknowledged definitions. Food security is a situation in which everybody, at all times, has physical, financial and social access to enough, nutritious and safe food to compensate their dietary requirements and food adoptions for an active and healthy lifestyle. The four basic mechanisms of food security are stability of availability, access, and utilization of food as well as availability (regularly having access to adequate food) [10]. When any or all of the four elements of food security are inconsistent and unstable, a food system is considered susceptible [11].

Figure 1. Four Pillars of Food Security

2.1. Food Security's Current Challenges

Beyond the impacts of violent wars, climate change, extreme weather, the COVID-19 pandemic and its associated economic shocks have contributed to an increase in world hunger. There is a substantial impact of violent conflicts on current food devastations. More than 99.1 million people in 23 different states experienced food emergencies connected to armed conflict in 2020 [12]. Over 39 million population in Asia and the Middle East, mainly in Afghanistan, Syria, and Yemen, are affected by food crises brought on by armed conflict in these regions, where economic, social, and political misery or geopolitical rigidities have resulted in protracted armed conflict [12, 13]. Once more, COVID-19 has affected the economies of several developing nations. These nations often have high levels of debt, which lowers their purchasing power and makes it challenging for them to import food, creating severe food shortages [14].

2.1.1. The Influence of Russia-Ukraine Conflict on Food Security

The Russia-Ukraine conflict has brutally destroyed the markets for goods, primarily energy, and food, and has had an impact on global trade, manufacturing, and consumption habits. Prices are predicted to remain at record-maximum levels through the end of 2024, imperiling global food security. Rome: World Food Programme, 2022. According to the US Department of Agriculture, Russia and Ukraine account for around 25% of global wheat exports [15]. The continuous war in Russia and Ukraine is impeding supply chains and raising prices for food, fertilizer, and oil. This resulted in significant rises in food prices in the beginning half of 2022 [16]. Furthermore, significant volumes of corn and other fine grains are exported, with the Ukraine and Russia contributing to about one-fifth of all world exports. Russia and Ukraine are responsible for 80% of worldwide sunflower oil exports. The prices of wheat and other yields would increase due to consents and disrupting supply lines, adding to the world's already severe inflationary pressures. In some emergent nations where food is a significant percentage of family consumption that entirely depend on importing grains, there could also be uncomplimentary political repercussions [17]. As a result of their dependance on food imports from Russia and Ukraine, several importing nations are more susceptible than others. In the (MENA) Middle East and North Africa region, for illustration, a substantial percentage of barley, maize, and wheat consumed is imported from Russia and Ukraine, accounting more than half of the region's grain consumption [6].

According to the World Food Programme (WFP), from a pre-war starting point of 276 million individuals who were struggling with severe malnutrition, the number of individuals going through severe food insecurity is expected to rise by an additional 47 million by 2022, implying that up to 323 million people may practice severe food insecurity by 2022 [18]. According to World Bank projections, a single percent rise in food costs pushes ten million people into unembellished poverty. If food prices continue to high for a year, the total number of people living in poverty might rise by more than 100 million [19]. The COVID-19 epidemic, high global demand, an extended drought, and poor crop yields in South America the previous year all added to already-high food prices, thus the conflict occurred at a bad time for the global food markets. The sum of these elements raises food prices [20].

The conflict also has certain unanticipated and rippling effects. Similarly, Costs for necessary commodities, like wheat, fertilizers, and fuel are almost at record levels. Food and fuel costs are expected to increase by three percent in 2022 and 2.3 percent in 2023. Because rising costs of food and energy would disproportionately affect the poor and the middle class, this might have serious societal consequences [21]. Export restrictions have atrocious inadvertent implications for susceptible entities in food-importing countries, increasing costs and raising concerns about food insecurity, which has already been intensified by the COVID-19 [22]. Hoarding and fright buying are essential elements of crisis and disaster related customer comportment that have received significant media devotion, and they constitute yet another cascading effect of the conflict on both national and personal dimensions. The war may affect individual's and governments' purchasing power, reducing their ability to purchase food [23].

2.1.2. COVID-19's Impact on Food Security

In comparison to foot and mouth disease, Listeria, E. coli and avian flu the COVID-19 pandemic has less direct impact on productivity since it spreads through animals or agricultural goods [24]. That the pandemic has already had an impact on food supply systems shouldn't be shocking. The lack of necessary and fresh products in supermarkets caused many farmers who sold directly to clients to see their markets disappear, while demand for other commodities increased [25]. Due to record-high output and stock levels for the bulk of staple goods, prices are most likely to be constant in 2020. However, there can be a disruption in the flow of commerce, the distribution of inputs, or the labor force when agricultural products are being produced. Supply chain disturbance have already arisen in the export of perishable products such as fruits and vegetables to developing and emerging markets [26]. Further consideration should be given to sociodemographic traits that identify those in susceptible categories [27].

Before COVID-19, about 820 million people suffered from hunger and famine as a result of a lack of food to maintain a healthy lifestyle. However, given the horrendously terrible living circumstances in conflict and war zones, the number will surely increase with the release of COVID-19 [27]. The Covid 19 epidemic had a substantial negative impact on nations whose agriculture considerably contributes to GDP due to the stoppage of agricultural pursuits, restrictions on craft in agricultural properties and agricultural industry, and certain African states (Chad, Mali, Niger, and Sierra Leone) [24]. Following a momentous intensification in 2020 through the COVID-19 pandemic, there was a further spike in global hunger in 2021. The pandemic's persistence and long-term significances, which intensified already be extant imbalances, have subsidized to further hindrances in the effort to attain the Zero Hunger goal by 2030 in 2021 [6].

2.1.3. Climate Change

Variability in the climate and extremes have a substantial impact on global hunger. The increasing frequency of climate changeability and extremes harms all four components of food security [6]. Some of the most pressing concerns confronting the globe today are the food chain and how land is employed and maintained. Some of the most pressing global concerns are the need to minimize emissions of greenhouse gases and modify them, to eliminate desertification and deprivation of land, and to maintain food security [28]. These are going to be referred to as "land challenges" from now on. Given the interdependence of many land issues, it is obvious that major changes to land supervision and agricultural production systems are needed to discourse these worldwide land concerns [29].

Emergent stressors like climate change disrupt both longer time spans and shorter time scales by altering climatic norms and increasing the occurrence and severity of exciting weather proceedings. Implications of climate change on communities and food security are widely established [30]. Food insecurity is indication of a malfunctioning global food system, which is being influenced by an unprecedented combination of various stresses, including climate change [6, 31].

Climate change will undoubtedly have a severe influence on the availability of food in all of its dimensions [32]. Even if there are other reasons, such as severe weather events that lower urban inhabitants' earnings and thus their access to food, climate change has a huge influence on food security through agriculture [33]. It has a direct impact on crop yield, reducing global yields of major crops by 3.1% to 7.4% for each degree increase in worldwide average temperature [34].

In Sub-Saharan Africa (SSA) and South Asia, where most of the world's malnourished individuals reside, climate change has a detrimental effect on agricultural produces, fish and animal productivity, and availability of food. Crop and animal production losses are a result of rising temperatures, worse droughts, floods, and greater weather unpredictability [31]. Global warming may lengthen the growing season and agricultural area in certain northern nations, like Russia, with favorable implications on agricultural output [35]. Farmland may quickly grow into unsuitable places due to a lack of technology investment and larger agricultural output fluctuations brought on by climate change, including natural forest adaptation [36].

2.1.4. Growing Population

The medium-variant estimate predicts that by 2050, there will be 9.7 billion people on the planet if present trends continue. The planet's population is now growing by roughly 1.1% a year. There is a high degree of certainty that by 2050, there will be between 9.4 and 10.1 billion people on the earth, notwithstanding the inherent uncertainty in population estimates and the present overestimation of population increase [37].

Between 2019 and 2050, it is estimated that Sub-Saharan Africa will see more than half of its population growth or an additional 1.05 billion people. The U.N. estimated that between now and 2030, the population will grow by 0.96% per year, and between 2030 and 2050, by 0.63% per annum, fetching the total number of individuals on earth to 9 billion (UNFPA). However, a very small number of nations may be responsible for the mainstream of the worldwide population increase. Just nine nations will responsible for more than 50% of the global population evolution between 2019 and 2050: Indonesia, India, Pakistan, Ethiopia, Nigeria, Tanzania, the Democratic Republic of the Congo, and the United States of America [37].

To meet the demands of a growing population and rising wages, worldwide agricultural and food output will need to increase up to 50% by 2030 and 110% by 2050. As an illustration, it is predicted that from 2015 to 2050, demand for beef would climb by 40% in higher income nations and 69% in lower income countries. Likewise, desire for dairy products is expected to climb by up to 70% between 2000 and 2050 [38]. Urbanization is a drift that will mostly affect low-income countries and have a substantial influence on the creation of global areas of high demand, which will increase the need for food supply chains [39].

Since low-income countries are the mainstream of these countries, it is predicted that there won't be enough possessions or access to technology to sustainably develop food production to meet the needs of rising populations. Even while technology spending in agriculture is rising globally, it is doing so unevenly, with high-income nations accounting for 3.25% of the average. Only 0.52% of the agricultural GDP is allocated to research and development for low-income nations, where the mainstream of the anticipated rise in food demand is expected to occur and where bridging the yield gap may have the greatest impact. Despite compelling evidence that this theory significantly decreases scarcity [40].

2.2. To Combat Global Food Security, These Practices Should be Adopted

Diet modifications	Sustained balanced diets are a group of dietary changes meant to expand human meals make them wholesome and nutritious, and make them (economically, ecologically, and socially) sustainable [41].
Food waste reduction	The consumer or retail stage is where most food loss occurs in industrialized countries, hence practices that lessen waste generated by consumers or retailers can ease environmental pressure [42].
Small farming	Due to their ability to produce larger quantities and a wider variety of food, small farms have a significant impact on nutrition concerns and help reduce poverty [43].
Genetically Modified Organism Technology (GMO)	Many crops have undergone genetic modification to boost their resistance to pests, diseases, and herbicides, among other advantageous traits. These contemporary biotechnologies have improved agriculture's sustainability, yields, the usage of pesticides, and the availability of more nutrient-dense food [44].
Management of supply chains	Enhancing efficiency and sustainability in supply chains can lower climate risk and profitably cut emissions [45].
Enhancement of urban food systems	One of the creative approaches being utilized to increase food access in urban settings is the development of alternate food sources and technology, such as vertical farming, in addition to regional food policy and planning projects. These tactics seek to lessen hunger and enhance livelihoods [46].
Improved retailing and food processing	As part of enhanced food processing and retailing, waste reduction in retailing, reductions in agri-food GHG emissions through dispensation and transportation, and advancements in processing, packaging, cooling, drying, and extracting are all taken into consideration [47].
Decreased post-harvest losses	During post-production procedures, one third of the food intended for people to consume is vanished. In developing nations, infrastructure problems are the primary drivers of post-harvest waste, demanding strategies that process, preserve, and, where necessary, convey food to locations where it may be disbursed

	proximately [48].
Sustainable sourcing	Sustainable sourcing includes strategies to guarantee that goods are manufactured in an environmentally conscious way, which includes low-impact agricultural sector, supply chains that stop deforestation, or goods derived from forests that were harvested sustainably [49].
Enhanced energy efficiency in food systems	Increasing outputs per unit of input or lowering energy inputs are two ways to promote agricultural energy efficiency and lessen reliance on nonrenewable energy sources. In certain nations, the primary cause of lost energy efficiency is managerial inefficiency [50].
Management of disaster risk	The goal of disaster risk management is to decrease the negative effects that weather- or climate-related adversities and occurrences have on socio-economic systems. Proactive preclusion, fast response, effective recovery, and environmentally friendly growth are some of these tactics [51].

3. Global Food Systems

Because they look at connections between all food-related events, their organizational and market structures, as well as the nutritional, environmental, and socioeconomic repercussions, food systems approaches have gained a lot of traction in discussions on rural and human expansion. This attraction is reasonable given its link to methods for raising nutrition, halting climate change and enhancing the long-term sustainability of agricultural output [32]. Food systems frameworks are commonly used in political discourse to promote certain strategies and modifications to fight poverty and malnutrition or to promote healthier and more sustainable food system consequences [52]. Food systems assessments must provide critical insights into the causes of global dietary imbalances and specific socially disadvantaged populations, as well as the environmental implications of food production, processing, and consumption. These insights may include the roles that manufacturers, dealers, processors, customers, and decision-makers play in the production, distribution, and consumption of food [53].

The global food system, especially in underdeveloped countries, is by far the greatest employer. Even while the amount of money that comes from farming, food processing, sales, and distribution differs from one country to the next, they all considerably contribute to the GDP of each one. To prevent exceeding the planetary bounds of biophysical processes and further destabilizing earth systems, global food systems must increase players' financial stability, address the health problems associated with obesity and starvation, and minimize environmental repercussions [54].

3.1. Challenges in Global Food Systems

The major hindrance to the food system is water scarcity, and there is growing compression to safeguard essential resources. High-intensity and protracted production practices in some nations and areas cause structural disparities and functional collapse of agropastoral ecosystems [55]. There is a serious clash among small farmers and the big markets. Small farmers make up more than 98% of the world's main agricultural producers, and they plow 70% of the world's arable land [56]. The effects of climate change are deteriorating. Climate change puts agricultural livelihoods and food security at serious risk by increasing the frequency and area of disasters including pest and disease outbreaks, floods, droughts, hailstorms, and extremely high temperatures [57]. Food is still desperately needed. Consumer demands for food and agricultural goods have increased, how people consume food has changed over time, and the market for food consumption has continued to develop rigidly [58]. The percentage of nutritional imbalance rose. Malnutrition of the structural imbalance type is still an issue, and the incidence of nutrition-related chronic illnesses is significant [59].

3.2. Transformational Strategies for Global Food Systems Sustainability

3.2.1 Fostering the Revolution of Food Systems to Ones that are Efficient and of High Quality

Improve the system for agricultural science and technology innovation, advance the use of improved seeds and machinery through technical research, transform the way that agricultural technology extension services are provided, encourage the development of competitive international leaders in agriculture, and steadily increase the effectiveness of agricultural accessibility [60]. Create vibrant, distinctive, contemporary rural sectors that will benefit the general public, extend the supply chain of the agricultural business, raise the price of agricultural goods, and boost the sector's efficiency [61].

3.2.2. Transformation of Food Systems for Dietary Health

We should focus on ensuring the supply of vital agricultural and auxiliary items like meat, sugar, dairy, and oil is safe in addition to guaranteeing the fundamental self-sufficiency of coarse grains and the overall security of consignments. Improve the planning of agricultural production, encourage careful grain preparation, the study of economics and nutrition, integrate farming, forestry, livestock keeping, and fishing, improve the planting framework, thoroughly advance contemporary animal husbandry, encourage environmental and strong aquatic development, and satisfy the ever-evolving requirements of humanity [61].

3.2.3. Agricultures Zoning

By integrating the existing natural possessions, socioeconomic statistics, and GIS, agricultural zoning using GIS may easily develop a range of arithmetical charts of agricultural zoning. The remote sensing (RS) system and the geographic information system (GIS) may be used in tandem, and the GIS's advanced capabilities can be used to leverage the RS's remote sensing discoveries to energetically simulate and appraise alternative zoning strategies. Many intricate estimating and dividing maps may be created to demonstrate the zoning outcomes both qualitatively and numerically [62].

3.2.4. Artificial Intelligence

Unavoidably, changes in farming accompanied the shift from orthodox practices to digitalized means of accomplishing the best operational fallouts. Data is collected via agricultural platforms with the farmer as the focus to offer planting aid, tailored advice, and an overall strategy for making sense of the data emerging from the fields. Farmers' human cognition and reasoning, which are aided by AI and computer logic, might interfere with how the farming industry functions as a whole [63]. While keeping an eye on the crop's development, drones and farming robotics examine the fields for various agricultural risks. Drone technology boost production effectiveness in sustainable ways resulting data-intensive judgments for Agri-Food processes [64].

3.2.5. Agriculture Disaster Forecasting and Management

Crop yield analysis and tracking are crucial if the nation is to successfully anticipate crop yields, set food prices, and decide on import/export regulations. Estimating the agricultural planting area and selecting a yield estimation model that makes use of unit yield modeling and growth monitoring by remote sensing make up the majority of its content. To assess production precisely and scientifically and to provide digital and visual agricultural information, the government must make educated decisions. For agricultural monitoring and analysis, several countries have opted for the "3S" technology solution, which combines RS, GIS, and GPS modern information transmission technologies. China has estimated crop production using remote sensing [65].

4. Conclusion

Changing food consumption patterns and increasing population are the main reasons of the rising food demand. Producing sufficient food of adequate quality and quantity to rectify the dietary needs of growing population while being sustainable for the environment, the marketplace, and society as a whole is the main challenge facing the food and agriculture sector. To tackle food security, some strategies should be used, including smart farming, dietary modification, decreased food waste, supply chain management, improved food infrastructure, and disaster risk management. The major transformation of the food system that is needed will involve future technologies and systemic innovations.

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