Effect of Climate Change on Food Security, Safety and Nutrition

Mehvish Ayoub
Division of Food Science and Technology, Sher-e-Kashmir University of Agricultural Sciences and Technology-Kashmir
*Corresponding Author: mehvishayoub70@gmail.com

Abstract

Climate change can disrupt food production by influencing temperature, precipitation patterns, extreme weather events, sea levels, and the degradation of agricultural land. The vulnerability to these changes varies across regions, populations, and genders. The impacts of climate change extend to pasture, crop, and livestock production, leading to a reduction in the nutritional value of certain crops. Additionally, fisheries, aquaculture, food manufacturing, logistics, and trade are all susceptible to climate-induced challenges. All four dimensions of food security—availability, stability, access, and utilization are affected by climate change. Changes in availability can contribute to a rise in food prices. Climate change also affects human health and nutrition by influencing the absorption and utilization of nutrients. The incidence of foodborne diseases, influenced by climate change, increases nutritional requirements while simultaneously hindering absorption. Contamination risks in food include microorganisms, animal disease pathogens, fungal toxins, harmful algae by-products, chemicals, pesticides, and veterinary drugs. Environmental factors play a role in the abundance, survival, and virulence of pathogens, leading to an increase in morbidity and mortality from diarrheal diseases due to contaminated food and water. The spatial and temporal distribution of disease vectors and animal reservoirs expand due to climate change, resulting in the wider distribution of vector-borne and zoonotic diseases. Climate change influences the emergence and re-emergence of infectious diseases. It encourages the infection of crops with toxigenic fungi, leading to the production of mycotoxins such as aflatoxin, which can reach humans through the ingestion of contaminated crops. The impact of climate change on the marine environment enhances the formation of harmful algal blooms and the production of algal toxins.

Keywords: Climate change, Food security, Toxigenic fungi, algal toxin, mycotoxin.

Introduction

Undernutrition persists as a severe global socio-economic and health challenge. In 2010, 925 million people were grappling with hunger, and the convergence of undernutrition with infectious diseases led to an estimated annual toll of 3.5 million preventable maternal and child deaths (UN System, Standing Committee on Nutrition, 2010). The IPCC's Fourth Assessment Report (2007) underscores that climate change and its variability will significantly impact both food security and malnutrition. Projections suggest a future characterized by more intense, frequent, and prolonged extreme weather events, including extended periods of drought, heavy precipitation, heat waves, and tropical cyclones. These climatic shifts will directly impact food and nutrition availability, particularly in vulnerable communities. Climate change consequences extend to disruptions in sewage, drainage, and water systems, resulting in increased issues like flooding and sea-level rise. This contributes to water and agricultural land contamination, with more people exposed to diarrheal and infectious diseases, worsening undernutrition challenges, and limiting effective food resource utilization. The intricate relationship between climate change and undernutrition heightens the vulnerabilities of marginalized communities, highlighting the pressing need for comprehensive global interventions.

Climate Change

- By 2050, the global average temperature is projected to increase by 2-4 °C above pre-industrial levels due to climate change, with land experiencing more substantial temperature rises than oceans.
- Generally, rising temperatures will lead to a more dynamic hydrological cycle, resulting in increased overall rainfall. However, certain regions may experience reduced rainfall, and alterations in the timing and intensity of rainfall events could have significant localized impacts.

- Droughts have adverse effects on both the quantity and quality of agricultural yields, diminishing dietary diversity and overall food consumption. This can result in undernutrition, protein-energy malnutrition, and/or micronutrient deficiencies, along with substantial economic losses.
- Climate change contributes to sea-level rise, particularly affecting low-lying coastal zones and river deltas. This leads to salination and the destruction of agricultural land, with significant repercussions on livelihoods and food security due to crop and livelihood asset losses.
- Tropical cyclones pose a threat by destroying crops, agricultural land, infrastructure, and crucial livelihood assets.
- Temperature variations and water scarcity will influence the physiology of both animals and plants.
- Climate change results in compromised sustainability and can contribute to socio-economic and political conflicts.

Disparities in Susceptibility to Climate Change Effects

Climate change stands as a global environmental threat to human health and the environment, affecting hydrological systems, freshwater supplies, land degradation, and putting stress on food production systems (World Health Organization, 2005). Additionally, extreme events have the potential to devastate human settlements.

The impact of climate change exhibits variations across regions, among diverse populations, and is influenced by gender.

Regions at Risk

Areas most prone to negative impacts from climate change are those already facing heightened vulnerability to food insecurity and malnutrition, potentially experiencing substantial losses in agricultural land. Arid and semi-arid regions, especially susceptible to droughts, face reduced crop productivity and diminished food availability due to even minor increases in local temperatures and heightened water stress.

Certain regions heavily reliant on low-lying coastal areas with high population densities, such as mega-deltas and small island states, encounter significant threats from rising sea levels and salt intrusion. Floods in these regions pose risks of destroying crops, livelihood assets, and agricultural land. Coastal conditions may also degrade through beach erosion, impacting fisheries. The adaptation process is particularly challenging for impoverished communities.

At-Risk Population Groups

Climate change heightens vulnerability to food insecurity among groups like smallholders, subsistence farmers, and coastal populations. Individuals with limited adaptive capacities, influenced by factors like age and socio-economic disadvantages, face negative impacts on crop yields and food resources. Climate change has caused over 160,000 deaths and 5 million Disability-Adjusted Life Years (DALY) from malaria, diarrhea, malnutrition, and flooding (McMichael et al., 2004). Projected effects include increased malnutrition, respiratory diseases, and diarrheal diseases, impacting vulnerable individuals and agricultural labor supply. Climate-related extreme weather events force poor families into negative coping strategies, elevating undernutrition risk (UN System, Standing Committee on Nutrition, 2010).

Gender Disparities in Climate Vulnerability

Throughout all stages of climate change-related extreme weather events, including exposure, risk perception, preparedness behavior, warning communication, response, and recovery, men and women experience differential impacts (Fothergill, 1998). Climate change, particularly through its effects on water and food security, has the potential to intensify women's workloads.

Aspects of Food Security

The four essential dimensions of food security include:

1. Availability: Ensuring a sufficient quantity of food is accessible for consumption.

2. Stability: Guaranteeing the regular availability of resources necessary for food consumption.

3. Access: The ability of individuals to obtain food consistently, either through personal production or purchase.

4. Utilization: Involves the quality and safety of food, nutritional aspects, and the body's ability to absorb adequate amounts of nutrients.

It's noteworthy that climate change significantly impacts all these dimensions (The MET Office and World Food Program's Office for Climate Change, Environment, and Risk Reduction, 2012).

I. Climate Change's Impact on Food Security (Cohen et al., 2009 and FAO, 2008)

a. Pasture, Crops, and Livestock Production: Global warming's repercussions on food production vary regionally due to factors like reduced water availability, sea-level rise, and extreme weather events. Developing countries may see a 10-20% decline in agricultural output by 2080. Recurrent droughts impact crops and livestock, affecting food and water availability. A moderate local temperature increase alongside elevated CO2 can have modest positive effects, but CO2 concentration rise may lower nutritional value, impacting staple crop prices (UN System, SC on Nutrition, 2010). Climate change affects farm animal growth, health, reproduction, and dairy production, contributing to increased zoonotic diseases.

b. Fisheries & Aquaculture: Fish are sensitive to temperature changes and ocean acidification, known as "the Evil Twin of Global Warming." Higher water temperatures harm crustaceans and shrimp, and fish distribution shifts risk species extinction. Increased CO2 and ocean acidity impact aquatic organisms and disrupt the food web. Climate factors affect fisheries, impacting productivity and increasing disease vulnerability. Extreme weather events may lead to farmed stock escapes, impacting genetic diversity. Warmer ocean temperatures worsen eutrophication, causing toxic algal blooms. Elevated ocean temperatures promote cholera, increasing the risk of diarrheal diseases (FAO, 2008, McMichael et al., 1996).

II. Climate Change's Impact on Food Availability, Stability, and Access (Cohen et al., 2009)

Extreme weather events pose challenges to the stability and access of food supplies. The exacerbation of food insecurity is evident in the loss of cultivable land and nursery areas for fisheries in low-lying regions. Climate-related issues, including animal and plant pests, diseases, and invasive aquatic species, contribute to crop and animal losses, diminishing aquatic populations and impacting the stability of production systems. These factors also reduce access to food by lowering income from food crops and animal production, altering aquatic populations, and increasing the cost of disease and pest control. The escalation of food prices can further impact the access to food for households. Extreme weather events also play a role in water and food contamination with chemicals, potentially affecting food stability, access, and utilization. In situations where food supplies are insecure, individuals tend to shift towards less healthy diets and consume more "unsafe foods," exposing themselves to various chemical, microbiological, and other health hazards. Without climate change, 640 million people are anticipated to be at risk of hunger by 2060. Climate change is projected to add 40-300 million people to the at-risk category (McMichael et al., 1996).

III. Climate Change Impact on Health and Food Utilization: Food Safety Hazards

Climate change is a significant global health threat, impacting disease burden and mortality (Costello et al., 2009). It affects food safety throughout the production chain, exacerbating nutritional needs. Contaminated food, laden with bacteria, viruses, or chemicals, causes over 200 diseases, straining healthcare and economies (WHO, 2014). Pathogens like bacteria, viruses, and protozoa are influenced by climate change, with water temperature affecting cholera peaks and extreme events impacting disease emergence. Vector-borne diseases like malaria face altered distribution dynamics, with regions contracting or expanding. Climate-sensitive diseases like Rift Valley Fever are influenced by precipitation changes (FAO, 2008; McMichael et al., 1996; The National Institutes of Health, 2014).

Zoonoses and Other Animal Diseases

Zoonotic diseases, transmitted to humans through vectors, direct contact with infected animals, animal products or wastes, or the consumption of contaminated food or water, pose an increased risk as the incidence of such diseases in animals rises. Climate change is a key factor contributing to the emergence and spread of diseases in livestock, facilitating the transfer of pathogens to humans. While many aspects of the impact of climate change on bacteria, viruses, and protozoa are relevant to zoonotic diseases, specific factors include:

- Augmentation of animals' susceptibility to diseases,
- Expansion of the range or abundance of vectors/animal reservoirs, and
- Prolongation of the transmission cycle of vectors.

Increase in the Susceptibility of Animals to Disease

Extreme weather conditions such as intense cold, drought, excessive humidity, or heat can heighten animals' susceptibility to specific pathogens. These conditions increase the chances of disease transmission among animals, elevate livestock exposure to vectors and wildlife, and amplify disease transmission to humans.

Increase in the Range or Abundance of Vectors/Animal Reservoirs

Climate change alters the dynamics of zoonotic diseases by affecting vector sensitivities, leading to shifts in range, seasonality, and abundance. Droughts followed by heavy rainfall create breeding grounds for disease-carrying mosquitoes, impacting outbreaks of vector-borne livestock diseases. Changes in precipitation patterns influence arthropod vector distribution. Examples include Rift Valley fever and tick-borne diseases. Climate change also affects the ecology of animal hosts, prolonging transmission cycles of vectors and increasing the incidence of human infections.

Influence of Climate Change on Molds and Mycotoxin Contamination

Climate change factors such as temperature, humidity, and precipitation can favor the growth of toxigenic molds. Adverse conditions for plants may encourage increased fungal growth and higher mycotoxin production. Indirect triggers, including insect and pest attacks, soil characteristics influenced by climate change, fertilizer usage, droughts, nutrient deficiencies, and excess toxic elements, contribute to fungal colonization and mycotoxin production.

Control measures for fungal development and mycotoxin production involve post-harvest handling techniques, cleaning, drying, and storage, where maintaining suitable humidity levels is crucial for stability. Climate change could potentially impact this aspect of the food chain.

Environmental Contamination, Flooding, and Chemical Residues in the Food Chain

Climate-related events, like increased floods, are linked to agricultural and pastureland contamination with metals, chemicals, and toxicants. Soil contamination arises from mobilized river sediment or pollutants released upstream, affecting areas like industrial sites and landfills. Grazing on flooded pastureland can transfer contaminants to milk and the food chain. Higher temperatures and intensified precipitation contribute to water pollution, carrying pathogens, pesticides, and pollutants into water bodies. Hurricane Katrina's aftermath in 2005 showed floodwaters contaminated with various chemicals, posing risks to water quality. Warming ocean temperatures increase mercury methylation, impacting fish and potentially affecting women and their offspring (EPA, 2005; Booth and Zeller, 2005).

Climate Change Mitigation and Food Security

Climate change mitigation is vital for food security, safety, and nutrition in low- and middle-income countries. However, concerns arise with biofuel production, as burning forests for biofuels can exacerbate climate change. While biofuels contribute to mitigation, policies promoting their use may challenge food security. Bioenergy sources divert resources from food crop cultivation, resulting in lower food production, market shortages, and increased food prices. This leads to reduced access to nutritious foods, impacting health and productivity, especially among the poor (United Nations System, 2010; Cohen et al., 2009).

References

Cohen M, Tirado C, Aberman N and Thompson B (2009): Impact of Climate Change and Bioenergy on Nutrition. International Food Policy Research Institute. Rome, Italy. 236 El Samra GH

Costello A, Abbas M, and Allen A (2009): Managing health effects of carbon dioxide. Lancet; 373: 1693-733.

Food and Agriculture Organization (2005): Special events on the impact of climate change, pests, and disease on food security and poverty reduction. Background Document. 31st session of the Committee on World Food Safety.

Food and Agriculture Organization (2008): Climate change. Implications for food safety. Rome, Italy.

McMichael AJ, Haines A, Slooff R and Kovats S (1996): Climate Change and Human Health. World Health Organization. Geneva. Pp. 107-22.

National Institutes of Health. National Institute of Environmental Health Sciences (2014): Food-borne diseases and nutrition, health impacts of climate change. Research Triangle Park, NC, USA.

The High-Level Panel of Experts on Food Security and Nutrition (2012): Food Security and Climate Change. Rome, Italy.

* * * * * * * *