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LETTER TO THE EDITOR

Environmental and Climate Challenges: Implications for Food Safety, Food Security, and Public Health Protection

Rischi ambientali e climatici: sicurezza alimentare-nutrizionale e tutela della salute

Keywords: Climate change; food safety; food security; Public Health

Abstract

Climate change poses a significant threat to global Food safety and security, but it also offers a unique opportunity to transform food systems towards more sustainable and resilient practices.

Sir,

Climate has a complex, critical impact on food safety and security, influencing all stages of the agricultural system from planting to consumption, including transport and storage. Climate change, weather variability, and extreme events significantly contribute to the spread of foodborne pathogens and related diseases (1). Higher temperatures, heavy rainfall or flooding can contaminate agricultural fields with pathogens from polluted surface water seeping into the soil. Marine waters are also at risk. *Vibrio* infections have increased in Europe over the last 20 years. Warmer coastal waters have expanded the areas where *Vibrio* bacteria can multiply, increasing the risk of infection through consumption of raw seafood (2). In addition, changing conditions can favour the establishment of invasive alien species that damage plant and animal health, while warming surface waters and increased nutrient inputs lead to the proliferation of toxin-producing algae, causing epidemics through the consumption of contaminated seafood (3). Similarly, prolonged droughts can increase the concentration of chemical contaminants such as nitrates, pesticides or mercury in seafood, which can enter the human food chain (4). Climate change also affects the distribution and prevalence of parasites and other vectors such as mosquitoes and rodents, which can lead to increased use of pesticides and veterinary drugs.

These extreme events can destroy crops, cause significant damage to storage and transportation infrastructure, contaminate water supplies, and disrupt food supply chains. They also increase the risk of food spoilage and contamination, reducing the availability of safe food (5).

The impact of climate change on food safety and food security is becoming increasingly clear. Studies conducted between 1960 and 2010 have documented a significant increase in infections caused by pathogens such as *Campylobacter*, *Salmonella*, and *Escherichia coli*, particularly during the summer months. This phenomenon highlights how warm climates can favor the proliferation of these harmful microorganisms. In contrast, Noroviruses, known to cause acute gastroenteritis, are responsible for an increase in cases during the winter months, demonstrating how different pathogens can respond to climate conditions in opposite ways (6).

Effective management of the risk of food-borne diseases in an era of climate change requires a concerted effort by governments, the scientific community and the communities in general. International cooperation and continuous updating of practices based on the latest scientific evidence are essential to anticipate and mitigate the impact of

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climate change on food security. Governments, in particular, have a critical role to play in implementing policies that can incentivize sustainable food production and appropriate food choices (7). These include reforming agricultural subsidies, promoting research, supporting technological innovation, providing public education on nutrition, and creating social safety nets to protect vulnerable communities from economic and health impacts (8). Regular and timely implementation of control systems used by the food industry is also a good preventive measure. One example is the Hazard Analysis and Critical Control Points (HACCP) system, which helps food businesses identify, assess and control significant food safety hazards. The adoption of good agricultural and manufacturing practices, supported by HACCP, is therefore essential to ensure the safety of the final product (9). By implementing this system, food business operators can manage and minimize the risk of contamination during production, processing, distribution and storage of food. Only through a proactive and well-coordinated approach will it be possible to protect public health in an increasingly warming and meteorologically unstable world (10,11).

Another of the most alarming manifestations is "nutrient dilution": rising atmospheric carbon dioxide levels reduce the concentration of proteins, essential minerals, and other key nutrients in major food crops such as wheat and rice (12). The reduction in nutritional value occurs because high levels of CO_2 can stimulate rapid plant growth, but with less efficient nutrient production than biomass growth. As a result, although the total amount of food produced may increase, the nutritional quality of food is compromised (13). This phenomenon represents a significant threat, weighing on malnutrition problems, particularly for populations in low-income areas where wheat and rice are essential components of the daily diet and a primary source of protein, vitamins, and minerals.

Proactive measures are needed to address the growing risk of reduced food nutrition and to ensure safer and more reliable food distribution. One strategy could be to develop and promote crop varieties that are more resilient to the effects of climate change and can maintain their nutritional value despite high CO_2 concentrations. In addition, better water and soil management can help maximize the nutritional efficiency of crops and strengthen food supply chains by investing in more appropriate food storage infrastructure.

Promoting sustainable and low impact diets is one of the most promising approaches to address the challenges of climate change and global food security. Such diets not only help reduce the greenhouse gas emissions responsible for global warming, but also promote public health. Eating a wider variety of foods, with less meat and more plant-based products, can have a significant impact not only on individual well-being, but also on the health of the planet. The relationship between diet, health and the environment are complex and require detailed study to fully understand its potential (14). Indeed, the modern diet, characterized by a high consumption of meat and animal products, is a major risk factor for many chronic diseases, including diabetes, cardiovascular disease and some forms of cancer (15). These conditions reduce the quality of life and place a significant burden on global health systems. The intensive agriculture required to support these diets is a major contributor to greenhouse gas emissions, deforestation and biodiversity loss. In addition, conventional agricultural practices often consume large amounts of natural resources such as water and energy and use pesticides and fertilizers that can have adverse effects on the environment and human health. Some researchers have reported that diets rich in meat, especially red and processed meat, are among the most impactful in terms of CO_2 emissions, water pollution and land use. In contrast, low meat or vegetarian diets (e.g. the Mediterranean diet, rich in fruits, vegetables, whole grains, legumes and nuts) can reduce these emissions by almost 50% (14). These diets not only require fewer natural resources to be produced but are also associated with a lower risk of developing chronic diseases. Furthermore, shifting to more sustainable and biodiversity-based agricultural systems can help conserve ecosystems, improve soil and water quality, and increase resilience to climate shocks and adversities.

In summary, while climate change poses a significant threat to global food security, it also offers a unique opportunity to transform food systems towards more sustainable and resilient practices. The challenges are immense, but so are the opportunities for improvement. A future where everyone has access to safe, nutritious and sustainable food is possible, but it will require concerted global commitment, unprecedented intergovernmental cooperation and strong, enlightened political leadership. With timely and coordinated action, it is possible to create food systems that not only nourish the bodies, but also protect the planet.

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