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FOOD SECURITY IN A CHANGING CLIMATE WORLD

ANDREA FEHER*[1,2], MIROSLAV RAICOV[2], IOAN BRAD[1], COSMINA SIMONA TOADER[1], CLAUDIA ELENA SÎRBULESCU[1], RHIDA BEN SALEH[3]

[1] Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I[st] of Romania" from Timisoara, Faculty of Management and Rural Tourism, Romania
[2] Romanian Academy - Branch of Timisoara, Research Center for Sustainable Rural Development of Romania
[3] University of Zawia, Faculty of Economics, Libya
*Corresponding author: andreafeher@usab-tm.ro

ABSTRACT
The purpose of this article is to analyze the potential impact of climate change on food security. Global environmental changes coupled with socio-economic changes are a major food security issue and challenge. The main findings show that all four key elements of food security, namely availability, stability, use and access are significantly affected by changes in the environment. The most vulnerable segment of the population is those whose living conditions and livelihoods are strictly dependent on climate change and their ability to adapt is the lowest due to household income. This category includes children and women, poor people, the elderly and all those who depend on agriculture, animal husbandry, fishing and other natural resources. Climate change and its impact on demographic patterns, urbanization, population movements, and changes in food consumption patterns are intensifying food system risks globally.

Key words: climate change, food security, impact

INTRODUCTION

Climate change is a threat multiplier for food security and nutrition (NOIRET, 2016). To the same extent, climate change is a problem of worldwide concern due to the consequences it has on society (ATANGA AND TANKPA, 2021).
The causes of climate change are both natural and human-induced, the latter being the majority. The main cause of climate change is the increase in the amount of greenhouse gases (mainly carbon dioxide and methane) in the atmosphere. Greenhouse gases can come from natural causes, such as decay, earthquakes and natural wetlands, but most are attributed to human activity. The amount of carbon dioxide in the atmosphere has become higher in the post-industrial era, which underlines the significant contribution of humans to the causes of climate change (MASLIN, 2008). The consequence is the increase in global average temperature. The sixth report of the Intergovernmental Panel on Climate Change IPPC (IPPC, 2022) notes that the global average air temperature has increased by 1.09°C over the past 100 years, and the decade 2011-2020 was one of the warmest on record since 1850.
Global warming with its effects of prolonged drought, rainfall variability and flood disasters has become more and more widespread around the world. The effects on society are direct and indirect. There is a strong impact on agricultural productivity, food availability, accessibility, utilization and stability in communities (PACETTI ET AL., 2017; ARMAH ET AL., 2010).
Akukwe et al. (AKUKWE ET AL., 2020) studied flood-induced food insecurity in parts of Nigeria. They concluded that impacts could occur before and after flooding. The direct effects of floods on farms are materialized in physical damage to crops, animals, leading to a reduction in agricultural production. Flooding can destroy transport networks and access

to farms. Flooding can destroy food markets and consumption points. Floods can cause financial losses to producers, suppliers and consumers, which could reduce an individual's ability to afford food, affecting their food security. So, food security exists where food is available, accessible and stable for people (ATANGA AND TANKPA, 2021).

MATERIALS AND METHODS

This article reviews recent studies that have quantified the impact of climate change on global food security. The article includes an overview of the main aspects of climate change and its impact on the four dimensions of food security: (1) availability of agricultural production; (2) access to food; (3) supply stability and (4) food safety and quality, adapted to the macroeconomic (national) and microeconomic (individual) situation.

The article uses the thematic data analysis strategy to analyze data from primary (FAO Stat) and secondary documents (ATANGA AND TANKPA, 2021). This method allows researchers a clear interpretation from textual data on some scientific problems (BRAUN AND CLARKE, 2006; NEUENDORF, 2019). The literature covers mostly the time between 2000 and 2022. In this review, we used academic search engines and databases such as Web of Science, Scopus, Google Scholar and ProQuest. The thematic areas searched for are: climate change and agriculture, climate change and food security, adaptation and mitigation of climate change, food security and food systems. Taking into account these thematic areas, the article describes several issues in food security and provides future research priorities regarding climate change and food security.

RESULTS

1. Food availability and climate change impacts

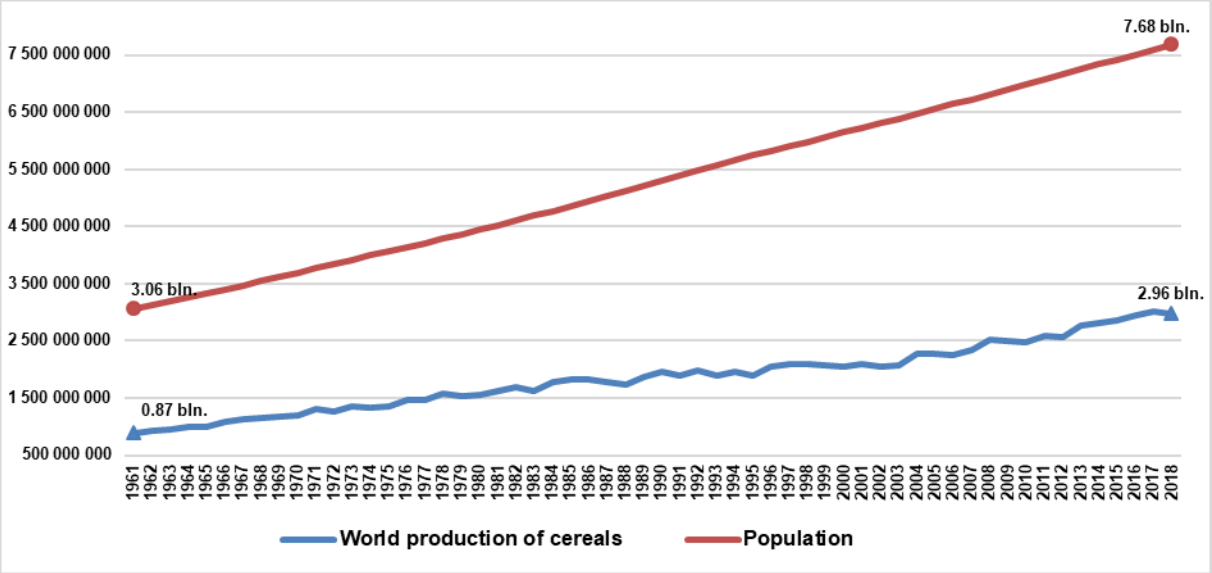
Food availability is the total physical quantity of food available in a country or region in the form of domestic production, import, exchange, processing and stocks, after deducting total exports (FAO, 2008).

Climate change affects agriculture and food production in complex ways (SCHMIDHUBER AND TUBIELLO, 2007). Food availability is compromised by reduced productivity and risks of crop destruction due to extreme weather, pests and diseases (NOIRET, 2016). According to estimates by the Food and Agriculture Organization (FAO, 2016) and the United Nations (UNEP, 2013) the effects of climate change on productivity will be felt differently around the world and the total loss of agricultural production in sub-Saharan Africa could reach 11% in the year 2080 if no measures are taken to adapt agricultural systems (NOIRET, 2016).

World food and agricultural production has increased significantly since the end of World War II. Grain production (including rice) increased by a factor of 3.4, from 876.9 million metric tons in 1961 to 2962.9 million tons in 2018.This growth has been driven both by the continued growth of the world's population (Figure 1) and by economic (wealth) aspects. Global yields have risen steadily since the 1960s (Figure 2). Apart from sorghum and millet, cereal yields have increased since the 1960s. Corn is the most productive crop, with yields increasing from 1.94 metric ton per hectare in 1961 to 5.92 metric tons per hectare in 2018. Rice has increased from 1.87 metric ton per hectare in 1961 to 4.68 metric tons per hectare in 2018. Finally, wheat increased from 1.09 metric ton per hectare in 1961 to 3.43 metric tons per hectare in 2018. Intensive production systems have led to ecological degradation, unsustainable consumption of resources and increased dependence on non-renewable resources such as fossil fuels.

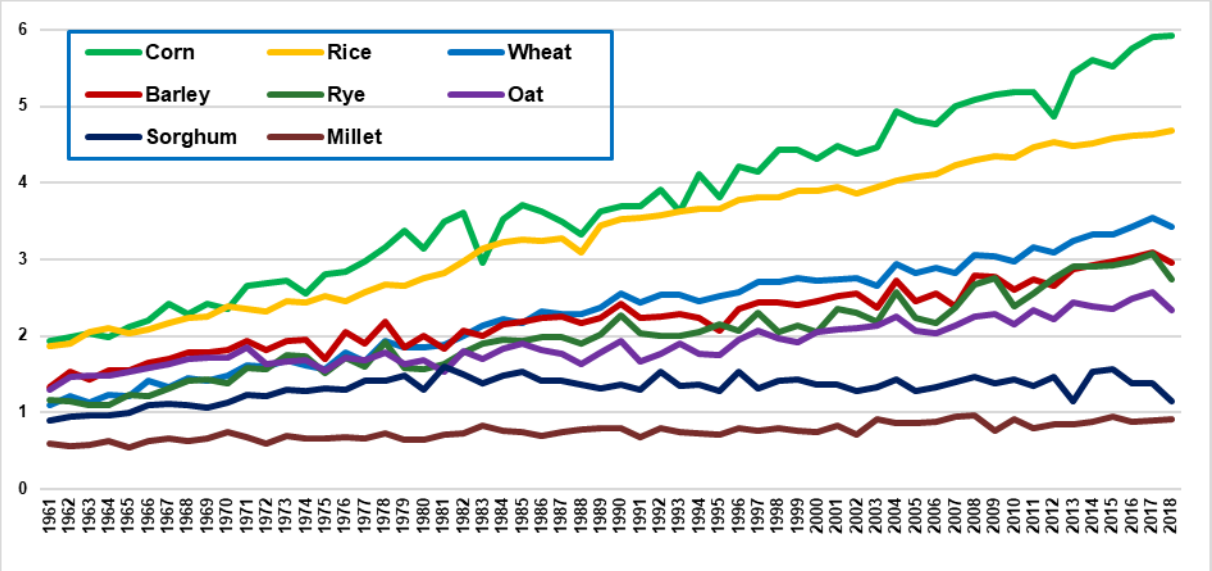
According to the estimates made by FAO (FAO, 2015) food production will have to increase by 60% by the year 2050 to cover the food needs of a continuously growing population.

There are concerns (FAO, 2015; BÁRCENA ET. AL., 2014; NELSON ET AL., 2010) about the global food supply in the coming decades. Recent decades have seen a lower rate of yield growth as genetic potential has been reached for most crops, land is increasingly degraded and there is a structural lack of investment in low-yielding regions. On the other hand, recent trends and policies regarding the cultivation of non-food crops such as biofuels and biomaterials lead to the reallocation of land and other basic resources. This fact leads to less availability of these resources for food production.



Source: Developed by the authors based on FAO Stat, 2022

Figure 1. World production of cereals (in metric tons) and world population (inhabitants)



Source: Developed by the authors based on FAO Stat, 2022

Figure 2. Evolution of the yields of the different cereals cultivated in the world (in metric tons/hectare)

Climate change affects food processing, storage and distribution activities. Countries in high latitude regions will benefit from climate change as cereal production is expected to increase (ROSENZWEIG ET AL., 2014). In addition, dry or cold weather allows easier storage of grain and its handling without specific measures. Conversely, climate change will have a negative impact on agricultural productivity in sub-Saharan Africa (BLANC, 2012) and South Asia (FIRDAUS ET AL., 2019). The tropical climate exposes post-harvest food products to pest, micro-organism and disease attacks, making them unsafe to eat due to infections (FIRDAUS ET AL., 2019). Thus, in most developing countries, investments in logistics and food storage technology, transport networks and food waste management are required to increase food availability to ensure food security.

2. Food accessibility and climate change impacts

Access to food refers to the ability of individuals, communities and countries to purchase food in sufficient quantities and quality. Over the past 30 years, falling real food prices and rising real incomes have led to substantial improvements in food access in many developing countries (SCHMIDHUBER AND TUBIELLO, 2007). Currently, due to the energy crisis, we are witnessing an increase in food prices, which obviously affects especially the low-income population category.

Food price increases are driven by population growth and rising incomes, giving rise to higher demand, as well as the negative effects of climate change on supply (EROKHIN AND GAO, 2020).

According to Nelson et al. (NELSON ET AL., 2010), who based on population growth, income growth and climate change scenarios, concluded that the average price increases projected up to the horizon of 2050 are 87% for maize, 31% for rice and 44% for wheat compared to 2010 levels for an optimistic scenario of low population growth and high income growth and using average results from four climate scenarios.

The lower the level of climate change, the lower the expected price increase due to reduced negative effects on food supply (BARCENA ET AL., 2014).

On the other hand, according to the World Bank (WORLD BANK, 2016) up to 122 million people could fall into poverty by 2050 as a result of climate change. Poor people are most vulnerable to changes in food prices. Livelihood depletion and poverty coupled with reduced food availability and rising prices could become extremely problematic for the poorest (NOIRET, 2016).

Table 1. Changes in agricultural net revenues associated with rising temperatures based on ricardian model

Country	Increase in temperature (°C)	Revenue change (percentages)
Brazil	1.0 to 3.5	–1.3 to –38.5
South America	2.0	0.18 to 0.46
Argentina	2.0 to 3.0	20 to –50
Mexico	2.3 to 5.1	2.3 to 5.1

Source: FAO, 2015; BARCENA ET AL., 2014

Local communities' preferences for staple food crops are mainly determined by traditional cultural norms (FIRDAUS ET AL., 2019). The impact of climate change on agricultural products affects the availability of food and the ability of consumers to buy certain types of food they normally prefer. If the price of a food product rises, consumers react. They can change the food basket by turning to cheaper complementary foods to maintain purchasing

power, or they can reduce their disposable income by maintaining the preference for the same food (FIRDAUS ET AL., 2019).
Most people depend on markets for food supplies, even though poor people and subsistence farmers have more difficult access to market systems. Therefore, any threat to food availability leads to a collapse of social trust in food systems, which could even trigger food riots (TIMMER, 2017).

3. Impacts of climate change on food utilization

Potential impacts of climate change on nutrition have been much less studied. Several impact pathways can be identified. Climate change can affect the ability of individuals to use food efficiently by changing food safety conditions and due to diseases caused by vectors (e.g. mosquitoes), water and food-borne diseases (NOIRET, 2016). Rising daily temperatures lead to an increase in food poisoning, particularly in temperate regions.
Extreme rainfall can increase the risk of waterborne diseases, especially in those areas where traditional water management systems are insufficient (NOIRET, 2016). Also, the impact of floods will be felt most strongly in ecologically degraded areas and where basic public infrastructure, sanitation and hygiene do not exist or are precarious. This increases the number of people exposed to water-borne diseases (eg cholera) and decreases the ability to use food efficiently. In addition, warmer or wetter conditions in certain areas will increase the concentration of aflatoxins in stored staple foods, which poses an additional health risk (NOIRET, 2016).

4. Impacts of climate change on food stability

The stability of the three pillars of food security described earlier is affected by climate change due to higher variability of precipitation and temperatures, irregular occurrence of disasters, outside the usual time frame and geographical area (NOIRET, 2016). These phenomena create critical threats to the stability of food systems, especially for households with limited food consumption capacity (TAN ET AL., 2021).
Climate change and its impact on demographic patterns, urbanization, population movements and changes in food consumption patterns are intensifying food system risks globally (JAHN ET AL., 2018).

DISCUSSION

Climate change has strong, multifaceted and temporal effects on food security. The reviewed literature shows that climate change has adverse effects on all four dimensions of food security (availability, accessibility, utilization, stability).
Most articles address the dimension of food availability and the impact of climate change in this direction. Consequently, the continuation of research with a closer focus on all four pillars represents ways to develop the theme. Multifaceted strategies are needed that include adaptation and mitigation of climate change impacts in the food sector.

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