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The Negative Effects of Climate Change on Food Production in Europe

Oluwatosin Abidemi OGUNKALU

Nigde Omer Halisdemir University, Faulty of Agricultural Sciences and Technologies, Nigde, Turkiye

Corresponding author: ogunkaluoluwatosin1@gmail.com

ORCID: 0000-0002-9188-7473

Abstract

Food production is the source of human existence and growth and is known to be affected by global warming. Climate change significantly impacts crop yields, mainly the increased frequency of extreme climate events. Unpredictable crop output losses put our food systems at serious risk, endangering farmers and consumers everywhere. The continent of Europe is extremely sensitive to the rise in temperature brought on by climate change. Climate change forecasts throughout several European locations show consistent warming over the twenty-first century. Reducing the length of the crop-growing cycle brought on by rising temperatures is expected to result in a considerable decline in grain yield between 2050 and 2099. The average annual temperature in Europe has increased during the last three decades, while precipitation has decreased. The European Union's (EU) severe drought is thought to have reduced maize, soybean, and sunflower yields by 16%, 15%, and 12%, respectively, because most cereals are vulnerable to inadequate water as the temperature rises and an increased heat supply. Wheat exports are completely reduced when weather-related shocks or other occurrences cause disruptions in European wheat production; excessive humidity overstimulates vegetation growth, creating denser canopies and increasing the risk of plant epidemics. This review highlights how climate change negatively affects food production in Europe.

Keywords: Food production, Climate change, Europe

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INTRODUCTION

Today's world faces a significant challenge from global climate change. The average annual increase of the land and ocean temperatures since 1850 has been 0.06 °C, more than three times the rate of warming since 1982 when it was around 0.20 °C per decade. The leading causes of global warming throughout the past century include greenhouse gas emissions, fast population growth, and the use of fossil fuels (Yuan et al., 2024). Population growth rate and climate change will cause many problems for the worldwide food supply, and we will face numerous nutritional problems soon. By gradually reaching the 8 billion population on the earth, humanity is challenged to provide for the growing population's food needs (Bağdatlı et al., 2015). Increasing world population, changing climate conditions, and economic activities are growing daily, making it more important than water (Bağdatlı and Bellitürk, 2016b).

Increasing the necessary studies and measures to minimize the emissions of carbon emissions should be taken all over the world and measures that will minimize the greenhouse gas effect will play an important role in reducing the effects of global warming (Bağdatlı and Arıkan, 2020). Changing climate conditions will be an important factor in the current situation and the problems that may arise in the coming years. For this reason, solutions are needed for global warming and reducing greenhouse gases that cause climate change (Bağdatlı and Arslan, 2020).

Food production is the source of human existence and growth, and it is known to be affected by global warming (Ogunkalu, 2024; Bağdatlı et al., 2023; Elsheikh et al., 2023). Climate change and global warming are reducing the available water resources almost everywhere (Uçak and Bağdatlı, 2017). The increase in the impact of global climate change will cause global water crises between countries. Necessary measures and measures should be taken in advance to reduce the impact of global climate change (Bağdatlı and Arslan, 2019). This warming resulted in weather conditions such as flash floods, heat waves, cold waves, droughts, and strong winds. These dangerous events lead to a reduction in crop production and disrupt the ecology of an area and disease prevention and control. Furthermore, the sustainable growth of agricultural output has been impacted by climate change, which has resulted in soil degradation and a shortage of land resources (Yuan et al., 2024). Crop yields in Europe are progressively impacted by climate change, including rising temperatures, altered precipitation patterns, and an increase in extreme (Beillouin et al., 2020; Dövényi-Nagy et al., 2020 ; Oikonomou et al., 2020 ; Ben-Ari et al., 2018; Hernandez-Barrera et al., 2017; Nguyen et al., 2018). Europe's evolving climate impacts the growth of agriculture and its production potential, just like the rest of the world. It is also crucial to keep in mind that even though burning fossil fuels has the most significant influence on greenhouse gas (GHG) emissions, agriculture, the production of cereals and animals, and changes in land use brought on by agriculture, all play a significant role in climate change, contributing roughly 24% of global GHG emissions. It is becoming increasingly apparent that the effects of climate change, such as extreme weather events, are significantly influencing the world and Europe. These occurrences can affect the natural circumstances in which crops grow. In recent years, it has played a role in the decline of food security in nations that are members of the European Union. It is important to remember, though, that its member nations rank among the world's top producers of cereals. Currently, they export 15% of the world's cereal production and supply 20% of it (Łącka et al., 2024). The climate conditions for cereal production are becoming more unpredictable due to the current escalation of the global warming issue. This is especially noticeable when looking at the average annual temperature and precipitation, which show a propensity to de-regulate the conditions of agricultural ecosystems. The average annual temperature in Europe has increased during the last three decades, while precipitation has decreased. Compared to the 5-year average, the European Union's (EU) severe drought in August is thought to have reduced maize, soybean, and sunflower yields by 16%, 15%, and 12%, respectively. Wheat exports are completely reduced when weather-related shocks or other occurrences cause disruptions in European wheat production (Schmidt and Felsche, 2024). According to these highlighted gaps, the aim of this research is an exploration of ways climate change negatively affects food production in Europe and the identification of climate variables that caused the adverse effects on food production, such as temperature and precipitation, drought, soil moisture, and many more, how they reduce the yield of different crops. The findings revealed a complex relationship between climate change and European food production.

Adverse effects of climate change on Food production in Europe

A long-term danger to food security, the amplitude of temperature and precipitation swings has grown, making conditions for cereal production unstable (Simionescu et al., 2019). Nonetheless, this occurrence makes it possible for northern European nations to improve crop conditions. According to Carozzi et al.'s (2022) study, a reduction in the length of the crop-growing cycle brought on by rising temperatures is expected to result in a considerable decline in grain yield between 2050 and 2099. This effect confirmed a regionally distributed impact of climate change, being more noticeable in the Mediterranean and more pessimistic climate scenarios (−7.7% for grasslands and −13% for croplands).

Adverse effects of Temperature and soil moisture extremes on Food Production

The continent of Europe is extremely sensitive to the rise in temperature brought on by climate change. Climate change forecasts throughout several European locations show consistent warming over the twenty-first century (Droulia and Charalampopoulos, 2021). Because of the growing season mean (or average), temperatures have already increased by 1.7 °C between 1950 and 2004, the current historical trend in this area (Droulia and Charalampopoulos, 2022). Soil temperature decreases, and plants unsuitable for climatic conditions and resistant to cold will be affected by roots and cause drying. As a result, a constantly increasing soil temperature will adversely affect plant life. It will decrease the efficiency (Bağdatlı and Ballı, 2020).

According to research by Schmidt and Felsche (2024), increased temperatures had detrimental effects on crop yields for maize in Italy, wheat in Germany, and wheat in Romania in June, May, and August, respectively. In France, however, there is a positive correlation between crop yields and a rise in October temperatures for barley. Based on their reports, they explained that variance drops by 7% and 3%, and extreme climate conditions have the most significant effects on barley in Poland and France. Dryer topsoil layers reduce crop yields for barley in Spain in June, maize in France in May, and barley in Poland in July. Additionally, excessive soil moisture negatively correlates with crop yields; for instance, in November, barley in Germany.

The world is being significantly impacted by global climate change, which also has a detrimental impact on the production of agricultural products. With the increasing global climate change, monitoring the product pattern and assessing regional temperatures is especially necessary (Bağdatlı et al., 2014). The effects of global warming caused by changes in the climate system of the highest peaks and ocean depths are felt throughout much of the world, from the equator to the poles. The polar ice caps are melting, the sea level is rising, and soil losses are experienced in coastal areas. Sea level due to glacier melting increased the temperature from 10 to 20 centimeters (Bağdatlı and Bellitürk, 2016a). Rising sea levels due to climate change can devastate forests, essential food sources in many locations (Afreen et al., 2022).

Adverse Effects of Drought on Food Production

Gradually decreasing rainfalls due to climate changes endanger the living habitat. As a precaution, precise solutions are needed to reduce carbon dioxide in the air, slow global warming, and eventually end it. In this way, the greenhouse effect and global warming can be prevented (Bağdatlı and Can, 2019).

According to the findings of Wang et al., (2024) a significant agricultural drought occurred during the 2022 extreme event, affecting steep-slope vineyards in Spain, northern and central Italy, northern Portugal, and southern France; olive groves in Spain and Italy; and maize and sunflower fields in the north of Spain, central Italy, southern France, and northern Romania. Terraced vineyards in the Alto Douro region of Portugal, the wine-producing region of Soave and Prosecco in Northern Italy, and the Priorate wine region in Spain are a few examples of the devastating effects of drought.

Additionally, there are some terraced olive trees, such as those in Sicily (Southern Italy) and the Malaga Region (Southern Spain). Fields that were treated using different techniques also experienced severe drought effects. For example, vineyards in Provence and the Languedoc districts of southern France are grown along the maximum slope; in central Italy (mostly the Apennines) and northern Spain, various herbaceous crops, such as sunflowers and maize, are grown. The drought negatively impacted crop yields. According to the yield reported by Baruth et al. (2022), the European Union has seen significant yield declines of −8.6%, −5.5%, and −9.6% for maize, sunflowers, and soybeans. While oil prices have increased by 80% in just two years, Spain, the world's largest producer of olive oil, lost over half of its yield from the previous olive season in 2022. Multiple research supports the prediction that the frequency of intense droughts will rise, especially in Europe (Hari et al., 2022; Straffelini and Tarolli, 2023; Ercin et al., 2021). For example, their climate model might affect 40 million hectares of agricultural landscapes in central Europe between 2050 and 2100, and drought episodes would rise sevenfold. In addition, it was projected that a 4 °C rise in Europe by 2100 may lead to a 10% decrease in output (Naumann et al., 2021). Compared to other agricultural regions, steep-slope agriculture is more vulnerable to the effects of drought brought on by climate change. For such systems to be sustainable, competent management is therefore essential (Wang et al., 2024).

Adverse Effects of Precipitation on Food Production

Europe has some of the most important and prestigious wine-making locations and wines, leading the world in wine production and viticultural areas. These are particularly common in the world's leading wine-producing nations (Tomasi et al., 2011), Italy, France, and Spain, where warming trends are unavoidable. For example, Bordeaux, France, has seen an annual mean temperature increase of 2.1 °C, and Veneto, Italy, has seen a growing season mean temperature rise of 2.3 °C over the past 50 years (Aurand, 2017 ; Tomasi et al., 2011). A significant atmospheric factor affecting grape development is precipitation and its temporal distribution, which significantly affects soil moisture and the grapevine's water potential, particularly in non-irrigated vineyards (Schoener et al., 2020 ; Huang et al., 2016 ; Rodrigues et al., 2012). Bud break, stalk and inflorescence development, and the dry, constant air conditions from blooming to berry ripening all need high soil moisture. Excessive vigor caused by abundant soil moisture throughout the growing season may encourage widely covered canopies. This could hurt the vine's performance, including decreased bud break, delayed maturity, increased berry weight, and deteriorated fruit and wine quality. Excessive humidity overstimulates vegetation growth, creating denser canopies and increasing the risk of plant epidemics (e.g., leaf and inflorescence diseases), which has detrimental effects on productivity. Excessive precipitation causes drowned vines to develop (Droulia et al., 2022).

Adverse Effects of Land Usage on Food Production

The usage of land is the first effect of climate change. Changes in land use brought on by natural disasters, human activity, and the climate mean that certain crops may no longer be able to be grown in some areas because of heat or drought (Verweij et al., 2018). At the same time, new locations may do so because of the warmer temperatures there.

Furthermore, structural changes like floods that destroy or wash away existing land could be brought on by climate change (Swain et al., 2020). Also, for reasons other than climate change, such as deforestation or converting productive land for urban expansion, new agricultural land may be acquired, or current land may be lost later in life (Verweij et al., 2018).

Food safety Hazards

Food safety hazards occur as a result of climate change; mycotoxin-based food safety risks are one major category that climate change is predicted to affect certain fungal species that create poisons known as mycotoxins after infecting crops (Zingales et al., 2022). Mycotoxins are undesirable in feed and food since they harm people and animals (da Rocha et al., 2014). Climate change is predicted to significantly affect crop mycotoxin contamination since weather plays a significant role in both fungal infection and mycotoxin generation. One of the most harmful classes of mycotoxins is aflatoxins, which are immunotoxin, genotoxic, and carcinogenic. Aflatoxins can seriously affect humans and agricultural animals (Damiano et al., 2022). *Aspergillus* species, *especially A. flavus*, create aflatoxins, which infect *Zea mays* (maize) and other crops. Thermotolerant fungi that have acclimated to warmer climates are Aspergillus species. Therefore, crops grown in tropical and subtropical regions, such as maize, rice, and nuts, are the primary source of aflatoxins. However, several studies have already indicated that aflatoxins in maize will also become a significant food safety problem in Europe due to climate change. The primary causes of aflatoxin formation are weather extremes like droughts and high temperatures (Focker et al., 2023). Today, among other Southern European nations, Italy, Croatia, Serbia, and Hungary have reported significant levels of *A. flavus* and aflatoxins. High levels of mold development and aflatoxin formation in maize were caused by hot, dry weather in Serbia in 2012. Dairy calves were fed this highly contaminated corn, which resulted in high aflatoxin levels in Serbian milk in 2013 and 2014 and had a significant negative economic impact (Focker et al., 2023; Popovic et al., 2017). The distribution of *A. flavus* spores is known to be influenced by precipitation and relative humidity. On rainy days or when the relative humidity is greater than 80%, spores do not disperse (Battilani et al., 2013). Although it is frequently not a limiting element, water activity affects sporulation. Drought is a significant factor rather than precipitation or relative humidity. Crops are particularly vulnerable to fungal infestations during drought (Chauhan et al., 2015).

Adverse Effects of climate change on Aquaculture and Fisheries production

European seas contribute to over one-eighth of global fisheries catches, making the EU the second-largest trader of fisheries and aquaculture products after China in 2019. European seas, mainly enclosed or semi-enclosed basins such as the North, Mediterranean, and Norwegian, are experiencing rapid warming (Predragovic et al., 2023). Aquaculture and marine ecosystems are expected to be threatened by climate change. Aquaculture species, ideal production ranges, and localization patterns may all undergo substantial changes due to rising sea temperatures.

Seasonal and temperature changes may impact breeding and migration. Climate change regulates several aquatic activities that impact the lifespan of organisms. Higher water temperatures, for instance, may shorten salmon life spans and make diseases more likely (Ogunkalu, 2021). The decrease over time of the changes in the water's surface is noticeable. This also shows the effect of disorder in the vaporization and current precipitation regime in the water sources dependent on climate change (Albut et al., 2018).

This alteration is expected to contribute to a further drop in salmon populations when paired with climate influences. The distribution of aquatic life, especially seaweeds, will change as sea temperatures rise, and farmed organisms will generally move northward. Aquatic animals that are used to living in cold water may be at risk from increased summer sea surface temperatures. The production of aquaculture species may result in decline, and Southern Norway may lose its suitability for species like salmon, with socioeconomic repercussions (Bağdatli et al., 2023; Hermansen and Heen, 2012 ; Stévant et al., 2017). Climate change has become the focus of constant attention on living things, and civilizations consider the climatic parameters determined by their lifestyles. Climate increases or decreases in changes affect living things negatively. A decrease in productivity, especially in agricultural production, causes (İstanbulluoğlu et al., 2013).

Temperature increases and decreases negatively affect the lives of living things. It will be difficult to find clean water in the future as temperature increases increase the evaporation level. Increasing or falling temperatures will cause climate change (Bağdatlı and Can, 2020).

CONCLUSION

The demand for agriculture to maintain global food and nutritional security has increased due to population growth, and climate change is worsening. Numerous studies indicate that climate change will reduce agricultural productivity in the upcoming years in Europe, even though there are uncertainties surrounding the future climate situation and its potential effects. A pest infestation, soil fertility, irrigation supplies, physiology, and plant metabolic activities were severely impeded by the three main determinants of climate: temperature, precipitation, and greenhouse gasses. The resulting changes in temperature and rainfall can alter cereal yields in European Union countries. With the increasing global climate change, monitoring the product pattern and assessing regional temperatures is especially necessary.

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