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Impact of Climate Change on Agricultural Production and Food Security

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ABSTRACT

This comprehensive analysis provides a detailed examination of the impacts of climate change on the agricultural sector, offering sustainable solutions with the objective of ensuring global food security. The detrimental impact of climate change on agricultural production, including global warming, significant alterations in precipitation patterns, and extreme weather events, has been meticulously assessed, with careful consideration given to their potential consequences for future food supply and security. In this context, a number of critical strategies and policies have been proposed, including the strengthening of water management policies, the advancement of sustainable agricultural practices, the development of climate-resilient seeds, and the enhancement of agricultural technologies. Moreover, the imperative for international collaboration and shared accountability has been forcefully emphasised, underscoring the necessity of maintaining this pivotal issue at the forefront of the global agenda. It is evident that a comprehensive approach is essential for combating climate change and ensuring sustainable agricultural production. Sustainable solutions and international cooperation are vital for guaranteeing a reliable future food supply and food security. In this context, the implementation of the proposed strategies and policies represents a crucial step towards aligning the agricultural sector with future needs and effectively addressing climate change.

Keywords: Climate change, Food security, Food safety, Drought, Agricultural production

İklim Değişikliğinin Tarımsal Üretim ve Gıda Arz Güvenliğine Etkisi

ÖZ

İklim değişikliğinin tarım sektörü üzerindeki etkilerini derinlemesine ele alan bu kapsamlı analiz, küresel gıda güvenliğini teminat altına almak amacıyla sürdürülebilir çözüm önerileri sunmaktadır. Küresel ısınma, yağış desenlerindeki köklü değişiklikler ve aşırı hava olayları gibi iklim değişikliğinin tarımsal üretim üzerindeki yıkıcı etkileri titizlikle değerlendirilmiş, bu etkilerin gelecekteki gıda arzı ve güvenliği üzerindeki olası sonuçları dikkatle gözden geçirilmiştir. Bu bağlamda, su yönetimi politikalarının güçlendirilmesi, sürdürülebilir tarım uygulamalarının daha ileriye taşınması, iklime dayanıklı tohumların geliştirilmesi ve tarım teknolojilerinin iyileştirilmesi gibi kritik stratejiler ve politikalar ortaya konulmuştur. Ayrıca, uluslararası işbirliği ve ortak sorumluluğun zaruriyeti güçlü bir şekilde vurgulanmış, bu hayati meselenin küresel düzeyde sürekli olarak gündemde tutulmasının önemi üzerinde durulmuştur. Sonuç olarak, iklim değişikliği ile mücadele etmek ve sürdürülebilir tarımsal üretimi güvence altına almak için kapsamlı bir yaklaşımın kaçınılmaz olduğu net bir şekilde ortaya konulmuştur. Sürdürülebilir çözümler ve uluslararası işbirliği, gelecekteki gıda arzını ve güvenliğini temin etmek için vazgeçilmez birer unsurdur. Bu bağlamda, önerilen strateji ve politikaların hayata geçirilmesi, tarım sektörünü geleceğin ihtiyaçlarına uygun hale getirmek ve iklim değişikliği ile etkin bir şekilde mücadele etmek adına kritik bir adım teşkil etmektedir.

Anahtar Kelimeler: İklim değişikliği, Gıda güvenliği, Gıda güvencesi, Kuraklık, Tarımsal üretim

INTRODUCTION

Climate change is considered one of the greatest threats facing the world, and its effects are becoming increasingly evident. However, these impacts vary greatly depending on geographical regions, economic conditions, social structures and other factors. In particular, developing and underdeveloped countries, and the agricultural communities living in these regions, are among the groups most vulnerable to the effects of climate change [1].

Agricultural activities are a major target of climate change, and current research suggests that changes in this sector could significantly affect future food supplies. The northward shift of rain-fed agricultural areas and the decline in cereal production in these regions suggest profound changes in the agricultural sector. Productivity studies indicate that significant reductions in crop yields are expected, ranging from 10% to 50%. However, it is hoped that the implementation of adaptation measures will partially mitigate these declines [2].

In countries where agriculture is an important sector, such as Türkiye, various measures are being taken to cope with climate change. In particular, the drought of 2007 has served to heighten awareness of climate change in the country, leading to the implementation of important steps such as agricultural drought management by the Ministry of Agriculture and Forestry. Such management systems are regarded as crucial tools for mitigating the effects of natural disasters such as drought. However, agricultural production not only is affected by climate change but also contributes to an increase in greenhouse gas emissions. In Türkiye, a significant proportion of total greenhouse gas emissions in 2019 was attributed to agricultural activities. This indicates that agriculture is not only affected by climate change, but also contributes to it [3].

Global Warming and Its Causes: Traces of Climate Change

In recent years, the recorded increase in global surface temperatures has continued at an alarming rate. For the period 2011-2020, the average global surface temperature increase has been measured at 1.09°C. This represents a significant increase compared to previous centuries. The temperature increase on land has been particularly pronounced in comparison to the oceans, with an average increase of 1.59°C on land in comparison to 0.88°C in the oceans (Figure 1) [4].

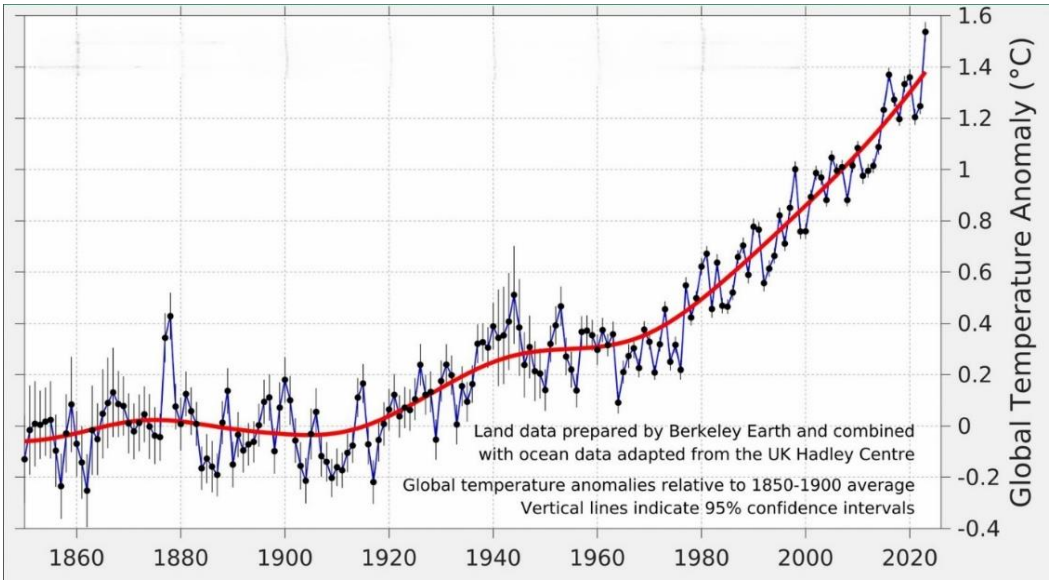

Figure 1. Global temperature increase from 1850 to 2023 [4]

At the beginning of the 21st century (2001-2020), the global surface temperature was observed to be 0.99°C higher than in the period 1850-1900. This increase is faster than any other 50-year period in the last 2000 years. Furthermore, the contribution of human activities to global warming has also been clearly demonstrated. From 1850-1900 to 2010-2019, the likely range of human-induced global surface temperature increase is estimated to be between 0.8°C and 1.3°C. The best estimate is 1.07°C. Over this period, greenhouse gases are likely to have contributed between 1.0°C and 2.0°C to the temperature increase. Furthermore, the effect of aerosols (air pollutants) has caused a natural cooling effect of between 0.0°C and 0.8°C (Figure 2) [5].

The projected increase in temperature is cause for concern. It is estimated that the temperature could reach 4°C by the year 2100. This would result in a significant increase in the problem of climate change, potentially tripling or quadrupling the current levels (Figure 3) [5].

The data presented here serve to illustrate the gravity of the climate change issue and the necessity for immediate and decisive action. International collaboration and the development of comprehensive policies are of paramount importance if we are to mitigate the effects of future global warming and ensure long-term sustainability.

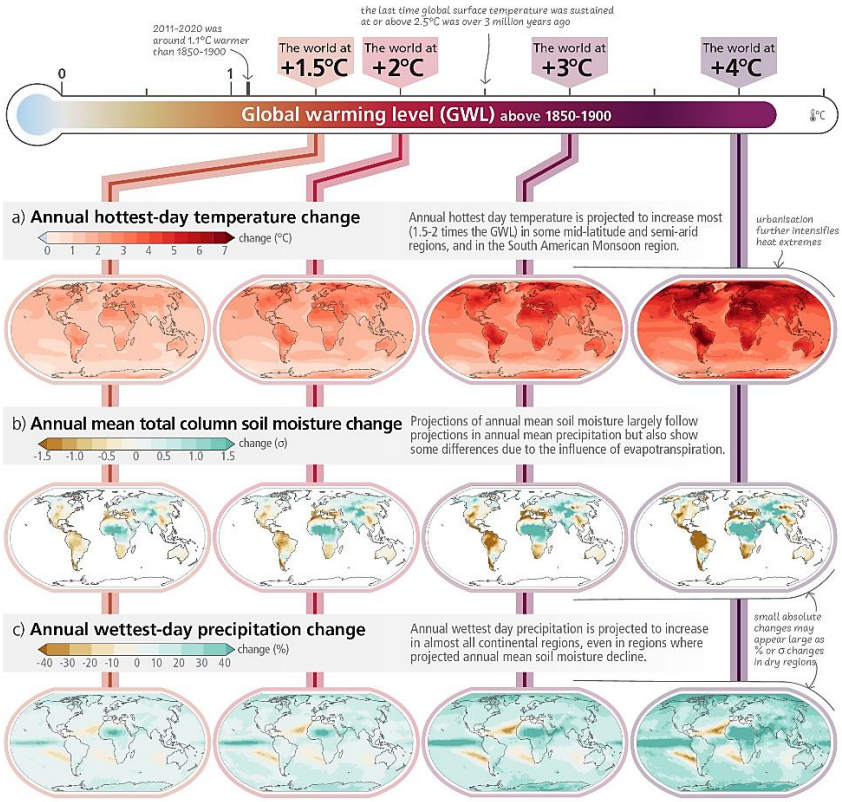

Figure 2. Global temperature increase [5]

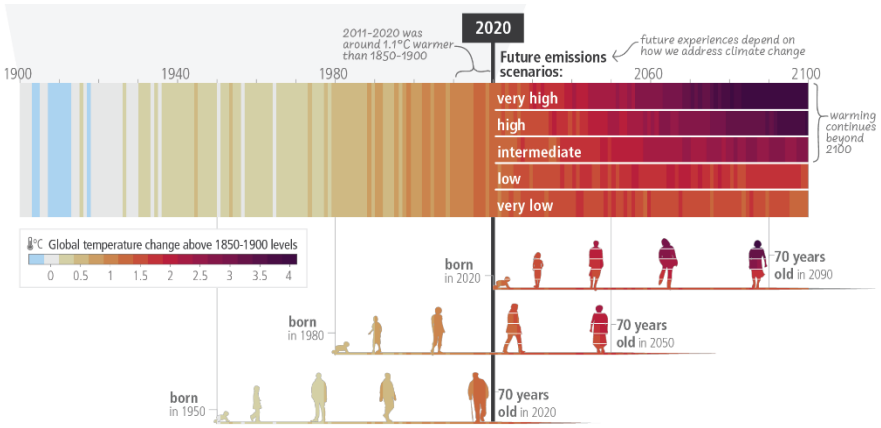

Figure 3. Future emissions scenarios [5]

Climate change and its impact on the agriculture and food sector

The agriculture and food sectors, which are considered to be strategic industries in the 21st century, are facing significant challenges as a result of a rapidly growing world population. The challenge of feeding a global population will place significant strain on current agricultural and food production capacities. Research indicates that to feed the world's population in 2050, agricultural and food production will need to be at least 50% higher than today [2, 6].

The challenges are further compounded by the effects of climate change. Projections indicate that climate change will increase water scarcity and droughts, reducing agricultural productivity. Globally, changes in precipitation patterns are expected to lead to some agricultural areas becoming drier, changes in crop maturation periods, and some agricultural land being inundated by floods or salinized by rising sea levels, reducing yields (Figure 4) [7]. Furthermore, rising temperatures have been observed to increase bacterial growth in food, which poses a serious threat to food safety [8].

It is anticipated that the effects of climate change will result in alterations to cropping areas and production patterns, which will in turn lead to a reduction in yields and a decline in production volumes. The consensus of leading experts and organizations is that agricultural productivity will decline by approximately 25% over the next 30 years [9].

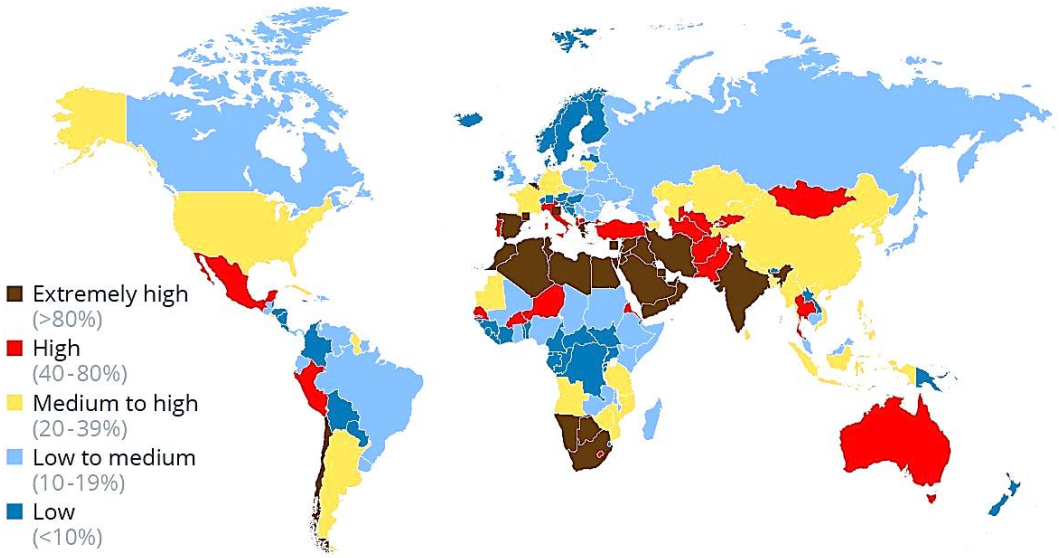

Figure 4. Water stress level sceneraio in 2050 [7]

In light of these impending challenges, it is imperative that the international community take immediate action. It is imperative that the agriculture and food sector be prepared for future challenges by implementing sustainable agricultural practices, strengthening water management policies, developing climate-resilient seeds and improving agricultural technologies. It is similarly imperative to reduce greenhouse gas emissions and intensify efforts to adapt to climate change [10].

Over the next decade, global food demand will be shaped by a complex interplay of factors. A number of factors will influence global food demand over the next decade, including population growth, climate change, advances in agricultural technologies, trade policies and global economic conditions [11].

Population growth will result in an increased global demand for food. It is estimated that the global population will exceed 10 billion by 2030. This will exert considerable pressure on food production and supply. In developing countries, in particular, population growth will result in a rapid increase in food demand [12].

Nevertheless, the consequences of climate change will also have a considerable impact on food production. The adverse effects of climate change, including rising temperatures, droughts, floods and natural disasters, can have a detrimental impact on agricultural productivity and production. This can result in a reduction in the area of arable land, a reduction in the quantity of available water, and a reduction in the yield of crops [13, 14].

Conversely, the advancement and innovation of agricultural technologies can enhance the productivity of food production, thereby facilitating the resolution of these challenges. The implementation of sustainable farming practices, the development of improved seeds, the implementation of enhanced irrigation systems and the utilization of digital farming technologies have the potential to significantly contribute to the ability to meet the growing demand for food [15].

Finally, trade policies and global economic conditions will also affect global food demand. Factors such as trade restrictions, tariffs and trade disputes can cause fluctuations in food supply and demand. Similarly, economic growth, income levels and consumer spending can affect food demand [16].

Taken together, these factors suggest that global food demand will continue to grow over the next decade. However, meeting this growing demand will require sustainable and innovative solutions. Investment in the agricultural sector, technological advances and international cooperation are critical to ensuring global food security [17].

In Türkiye due to 2022 data provided by TÜİK, cereal production is projected to increase by 21.3% compared to the previous year, reaching approximately 38.7 million tones. During this period, the self-sufficiency rate for total cereal production was estimated to be 80.3%. Wheat, which accounts for the largest share of cereal production, had a self-sufficiency rate of 87.3%. Different levels of self-sufficiency were observed for other cereal products. Among the pulses, chickpea production increased by 22.1% to 580 thousand tones, while red lentil production increased by 75.4% to 400 thousand tones. However, production of dry beans fell by 11.5% to 270 thousand tones [18].

The main scenario population projection by TÜİK for 2030 indicates that domestic red meat production is expected to rise from 2.191 million tons in 2022 to 2.436 million tons in 2030. Additionally, chicken egg production increased by 3.6%, and turkey meat production increased by 0.3%. However, chicken meat production decreased by 9.4%, and the number of slaughtered chickens decreased by 12.7%. These projections highlight the expected changes and current trends in the agricultural sector in the coming years. The data clearly emphasize the need for agricultural policies and production strategies to be appropriately shaped to meet future needs [19].

Sustainable Solutions for Agricultural Production and Food Supply

A number of goals and strategies have been identified with a view to adapting to climate change and making agricultural production sustainable. In this context, it is recommended that steps be taken to promote crop varieties that are suitable for the climate and water availability in agricultural basins, to complete land consolidation efforts, and to expand irrigated areas. Additionally, it is necessary to increase awareness and to accelerate grassland improvement efforts in order to combat erosion, desertification, and drought [20]. It is also important to consider the economic, social, and environmental impacts of agriculture and to support the use of environmentally friendly agricultural techniques. Furthermore, it is necessary to increase research at local, regional, and national levels and to identify high-risk areas [21].

Action plans should be developed in the agricultural sector to adapt to climate change, and capacity-building efforts should be carried out at various levels. In addition, it is important to establish early warning systems for agricultural and pasture areas, to conduct national land use planning, and to accelerate climate change adaptation and mitigation activities [22].

Furthermore, the creation of ecosystem-focused food production models and the dissemination of digital and climate-friendly agricultural technologies are also significant steps. Additionally, the development of seed varieties tolerant to drought and cold, the conduct of breeding programs for local animal breeds, and the recording and monitoring of agricultural sector practices are essential [23].

Finally, the importance of international cooperation and shared responsibility in protecting against the adverse effects of climate change and ensuring food security is evident, and this issue should be continually on the global agenda through collaboration efforts [24].

CONCLUSION

The effects of climate change on the agricultural sector have been subjected to rigorous examination, and a series of sustainable solutions for ensuring global food security have been put forth. The detrimental impact of global warming, shifts in precipitation patterns and extreme weather events on agricultural productivity has been subjected to rigorous examination. Furthermore, the prospective ramifications of these effects on future food supply and security have been subjected to thorough evaluation.

A variety of strategies and policies have been put forth as means of addressing climate change and preparing the agricultural sector for future challenges. The key strategies highlighted include the strengthening of water management policies, the promotion of sustainable agricultural practices, the development of climate-resistant seeds, and the improvement of agricultural technologies. Furthermore, the necessity of international cooperation and shared responsibility has been emphasised, leading to the conclusion that this issue must remain on the global agenda.

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