

Research Article

The Impact of Global Warming and Climate Change on Agriculture and Food Security of the World and Iran

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Abstract

Climate change and global warming caused by the increase of atmospheric greenhouse gases (GHG) are some of the most important challenges of recent years and future generations. With the beginning of the industrial revolution and changes in human life, the human need for energy and consumption of fossil fuels has increased the emission of GHGs. Climate change is one of the most important challenges facing agriculture and food security at the global level. An increase in temperature, change in rainfall pattern, occurrence of droughts, and frequent floods can lead to a decrease in the yield of agricultural products and finally food insecurity. Developing countries are more at risk due to weak agricultural infrastructure. As a country, Iran is located in the arid and semi-arid region of the world and is under the influence of serious climate changes. There are problems such as frequent droughts, reduction of water resources, increase in temperature, and change of precipitation pattern in Iran. These problems can lead to a decrease in the production of agricultural products, a decrease in water resources for agriculture and drinking water, and an increase in economic and social issues. To face this challenge, solutions such as cultivating crops resistant to drought and heat, improving the management of water and soil resources management, developing new agricultural technologies, and promoting sustainable agricultural patterns are necessary. Also, international cooperation and investment in agricultural infrastructure can be helpful. The training of farmers in adaptation methods is also of great importance. By applying appropriate strategies, food security can be strengthened against threats caused by climate change.

Keywords

Climate Change, Global Warming, Food Security, Drought, Sustainable Agriculture

1. Introduction

Climate change and global warming is a natural or human process that refers to sustained changes in the average weather pattern of a region or the entire globe [1]. These changes may include rising temperatures, changes in rain and snow profiles, falling sea levels, and variable weather phe-

nomena such as changing wind patterns. Climate change occurs due to various factors, including the emission of greenhouse gases caused by human activities such as fossil fuel combustion and changes in land use for agriculture and urbanization [2-4]. These changes can have serious effects on

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the environment, economy, and societies, and there is a need for measures to reduce these changes and adapt to them [5, 6]. Climate change has wide and multiple consequences on the environment, economy, society, and human health [7]. These changes lead to an increase in temperatures, unfavorable weather, changes in precipitation patterns, and an increase in natural disasters is a global problem that can affect different and wide areas of the world, including these things; floods, droughts, and storms, the unpredictability of weather patterns, dust storms, disruption of natural habitats and extinction of species and reduction of food resources, it can also intensify earthquakes, tsunamis, and landslides, so the effects of tsunamis become more devastating with the rise in sea levels, rainfall patterns will become unbalanced, some areas will experience heavy rains and floods, while others will witness low rainfall and drought, extreme heat and heat waves that lead to the loss of some heat-sensitive species, widespread forest fires, melting glaciers and rising sea levels that lead to flooding of coastal areas and islands. In addition, climate changes in some regions cause a decrease in water resources and limit access to drinking water. This situation has serious effects on the economy and people's daily lives and requires immediate attention and measures to reduce the consequences of these changes [8, 9]. Climate change has far-reaching effects on agriculture and food security. These changes include temperature increases, rain pattern changes, drought, floods, and changes in minimum and maximum weather temperatures. These factors can destroy agricultural products, reduce crop yields, and put pressure on food reserves in the region. In addition, the increase in temperature and change in the rain pattern can lead to a significant drop in the production of products for human and animal consumption. These problems directly affect the food security of communities, because agriculture provides our most important food resources [10]. To deal with these challenges, there is a need to develop adaptation strategies in agriculture. These solutions include the use of resistant products to temperature changes, optimization of water and soil management, promotion of multipurpose agriculture, and development of agricultural technologies compatible with climate change [11]. Also, access to drinking water and food is of particular importance for communities at risk, including the disadvantaged. Increasing awareness and training of farmers also plays an important role in increasing food security in the event of climate change [12]. These countries mainly rely on the agricultural sector for food and employment due to their less developed agricultural infrastructure. Climate change can put pressure on natural resources and agricultural products. Increasing temperatures and frequent droughts can lead to a decrease in food production in the region [13]. Therefore, these countries are facing problems such as increasing the risk of hunger and malnutrition, reducing agricultural productivity, and losing biodiversity in their regions. To reduce the negative effects of climate change on developing countries, several measures are necessary. These measures

include strengthening agricultural and environmental infrastructure, promoting the production of products resistant to climate change, improving the productivity of water and soil resources, developing sustainable agricultural technologies, increasing the awareness of farmers and local communities regarding adaptation to climate change, and encouraging multipurpose complementary agriculture [14, 15]. Also, providing access to water and food resources to the deprived and vulnerable sections of society is of particular importance. Interaction between governments, international organizations, and local communities is also essential to ensure the improvement of living conditions and food security in developing countries. Adaptation to climate change is essential to strengthen food security and increase resilience at the global, national, and local levels. At the global level, cooperation between countries to develop common policies and programs is of great importance. This cooperation includes the exchange of knowledge, financial resources, technologies, and experiences and can help accelerate the adaptation process [16, 17]. At the national level, governments should provide effective policies and strategies to deal with climate change in macroeconomic sectors such as agriculture, water, and energy. It is necessary to create sustainable policies and increase public opinion about the importance of adaptation [18, 19]. At the local level, communities and local institutions can help strengthen food security by raising awareness and implementing local measures to deal with climate change and increase resilience [20]. Creating cooperation networks between local ideas, promoting sustainable agriculture, and increasing local capabilities in managing possible crises is also very important. In general, measures in global levels, national, and local to adapt to climate change and increase resilience can help ensure global food security and reduce the vulnerability of communities to climate change.

2. Main Content

2.1. Global Consequences of Climate Change

As a natural process, climate change has played an important role in the formation and fall of ancient civilizations [21]. Throughout history, climate changes could be effective sudden and severe or gradual. These climate changes are sometimes cited as an important factor in the collapse of ancient civilizations.

According to scientific research conducted in recent decades, it is predicted that the global temperature will increase significantly by the year 2100, which can range from 1.4 to 5.8 degrees Celsius [22]. This increase in temperature is related to the increase in the accumulation of greenhouse gases caused by human activities and can have extensive effects on the climate and the environment. Therefore this phenomenon can seriously endanger many species as well as the master of different arts and sciences, who is human. This temperature

increase is an unprecedented rate of warming over the past 10,000 years and indicates the seriousness of climate change in modern times. Climate change has been seen practically and visibly all over the world. These changes include increasing temperatures, changes in precipitation patterns, decreasing snow and ice cover, and rising sea levels [23, 24]. An increase in temperature can lead to a decrease in the production of agricultural products and an increase in the amount of heat generation in the region. Also, the reduction of snow and ice cover can lead to a drop in sea level and the retreat of natural glaciers, such as the destruction of polar ice caps. Asia and Pacific regions are known as one of the most vulnerable regions to climate change [25, 26]. These regions include the countries of South and Southeast Asia, the Indian Ocean, the Pacific Ocean, and countries such as Bangladesh, India, Indonesia, and Thailand. Sea level rise and changes in precipitation patterns can lead to major difficulties for agriculture, coastal communities, and urban infrastructure in these areas. Many agricultural areas in these areas are at risk, and sea level rise can lead to reduced agricultural production in coastal lands and agricultural land degradation [27].

2.2. Iran's Situation Regarding Climate Change

Iran, as one of the countries located in the arid and semi-arid region of the world, is seriously affected by climate change [28]. This country is facing problems such as frequent droughts, decreasing water resources, increasing temperature, and changing precipitation patterns [29, 30]. The high evaporation and the creation of a layer of salt on the soil surface on the one hand, and on the other hand, the floods caused by climate change, cause the salinity of the soil and fresh water in that area and the downstream areas. These problems can lead to a decrease in the production of agricultural products, a decrease in water resources for agricultural consumption and drinking water, and an increase in economic and social problems. Iran has experienced frequent droughts, which have been extremely severe in some years and have had extensive effects on agricultural production and water resources.

Changes in precipitation patterns are also important factors in Iran's climate changes. In some regions of this country, the decrease in precipitation and increase in evaporation causes a lack of water resources and drought, and soil salinity which destroys the habitat and its biodiversity. Instead, some areas are affected by heavy rains and floods that lead to the destruction of agricultural products and rural infrastructure [31]. According to the geographical situation of Iran, climate change can have adverse effects on the agricultural sector and water resources of this country. Therefore, urgent efforts and planning adapted to climate change are necessary to effectively manage water and economic tensions related to climate change in Iran. These efforts should include promoting sustainable agricultural methods, improving water and soil management, developing modern infrastructure in the

field of irrigation and water storage, and encouraging the production of crops resistant to climate change [3]. Also, participation and cooperation between the government, local communities, and related organizations is necessary to be able to carry out intelligent and economic management of natural resources and ensure water and food security in the country [29-32]. In addition, education and public awareness in the field of climate change and adaptation strategies are very important. Not only farmers and people in the agricultural sector but also all sections of society should be aware of the importance of facing climate change and implementing adaptation measures. Therefore, educational and awareness programs in this field should be considered as a vital part of the measures to combat climate change. Iran should deal with climate change in the agricultural sector with the cooperation of all sections of society and focus on the implementation of efficient programs compatible with climate change. Only by considering the basic needs of the country in the field of food and water resources, Iran can take advantage of climate change as an opportunity for sustainable and resilient improvement in agriculture.

2.3. The Effects of Climate Change on the Agricultural Sector

Weather changes caused by climate change have direct and visible effects on the performance of agricultural products and are considered as one of the key factors under investigation in the field of agriculture. An increase in temperature due to climate change can lead to the destruction of crop performance. Plants have suitable temperatures for their growth and development, and even an increase in relatively low temperatures can reduce crop yields, especially during sensitive periods of plant growth [33]. Also, changes in rainfall patterns can lead to prolonged droughts or flash floods. Droughts can lead to the destruction of agricultural products and the reduction of water consumption for agriculture and drinking water. On the other hand, floods can destroy agricultural products and pollute water resources [34]. Above all, increasing the level of carbon dioxide in the air has important effects on the growth and performance of plants. Carbon dioxide acts as a carbon source for the photosynthesis of plants. Increasing the concentration of this greenhouse gas can be an incentive for better growth and more effective photosynthesis in plants. However, this should be following the environmental conditions of other plants. An increase in carbon dioxide without careful management of appropriate amounts of water and nutrients can lead to an increase in water consumption and a decrease in the efficiency of water resources. Therefore, accurate management of carbon dioxide and other factors affecting the performance of agricultural products is of great importance [35]. An increase in temperature as one of the results of climate change can have negative effects, especially during flowering and fruit formation, which are sensitive periods of plant growth. An in-

crease in temperature can lead to heat stress in plants, which results in a decrease in crop yield. This may result in shorter cultivation times or more optimal cultivation opportunities in some areas [36]. Changes in rainfall patterns have important effects on soil moisture and soil quality. Variable rainfall patterns can increase or decrease the amount of rainfall in two ways: An increase in precipitation can lead to soil saturation and even floods which is dangerous. On the other hand, a decrease in precipitation can lead to water shortage in the soil and drought [37]. Therefore, water resources management, effective use of effective irrigation systems, and promotion of sustainable agricultural methods can be used as effective solutions to deal with changes in rainfall patterns and water shortage in the soil. Also, research in the field of developing drought-resistant crops and lower amounts of water consumption can also help strengthen farms independently of climate change and increase crop yields [38]. Climate changes have wide-ranging effects on soil processes. An increase in temperature and changes in precipitation patterns can lead to a decrease in soil quality and a decrease in soil moisture. These things can lead to a decrease in the performance of the products. Also, temperature changes can cause an increase in pests and diseases in the agricultural environment. For example, an increase in temperature can increase opportunities for the spread of agricultural pests, leading to crop damage [39]. To deal with these changes and their effects on agriculture, it is necessary to take appropriate measures. These measures include the use of up-to-date technologies in agriculture, careful management of water resources, increasing farmers' information on climate change and adaptation strategies, and encouraging sustainable agriculture resistant to climate change.

These measures can help to improve the performance of agricultural products and reduce the damage caused by climate change in agricultural lands. Climate change has major impacts on major crops such as Cereals (rice and wheat), legumes, fruits, vegetables, oil seeds, garden and industrial products, spices, and medicinal plants. These impacts are diverse and mainly related to changes in temperature, precipitation patterns, and other environmental factors associated with climate change. An increase in temperature can limit the growth and development of plants, especially in hot and dry areas.

2.4. Agricultural Production and Food Security

Food security is directly and indirectly related to climate change. Any change in climate parameters such as temperature and humidity that affect the growth of agricultural products has a direct impact on food production. It is indirectly related to the occurrence of events such as floods and droughts related to climate change which are predicted as a result of climate change and lead to the loss of many crops and large tracts of agricultural land that are not suitable for cultivation, thus threatening food security [40, 41]. Climate

change, as a global challenge, seriously threatens all aspects of food security, including food availability, access to them, how food is used, and the sustainability of food security [42]. An increase in temperature and a change in the pattern of rainfall can lead to a decrease in the yield of agricultural products, this decrease in yield can lead to a decrease in food production and an increase in prices which leads to a decrease in food availability [43]. Also, climate change can affect access to food for different communities, especially for vulnerable and deprived communities. Changes in the way food is used may lead to increased evaporation and transfer of food water and affect food quality and safety. Also, climate change can affect the sustainability of food security in the long term, because the long-term effects of climate change may lead to the unsustainability of food production and supply [44]. Climate change, with rising temperatures, changes in precipitation patterns, and increased other climate changes, is likely to reduce agricultural productivity in vulnerable regions such as Africa and South Asia by 2080. These changes can lead to a decrease in the yield of agricultural products and have serious economic and social impacts [45]. As the world's population grows and is expected to reach 9.1 billion by 2050, the impacts of climate change on meeting the increased demand for food will become even greater challenges. Population growth not only creates more demand for food but also leads to increased pressure on natural and agricultural resources. Climate change increases the intensity and number of problems such as water shortage, crop yield reduction, and desertification pattern change. For this reason, providing food for the growing number of the world's population becomes available as a bigger challenge and the need for serious measures in the field of natural resource management and agriculture adapted to climate change increases [46, 47].

2.5. Vulnerability and Adaptation Approaches

Adaptation strategies in agriculture are one of the critical issues in facing climate change and ensuring the food security of the global community [48]. These strategies include several basic aspects: the first one is the use of drought and heat-resistant products. Selection and cultivation of crops that can withstand drought conditions and increase in temperature can ensure agricultural performance [49]. The second strategy is efficient irrigation. The use of effective and efficient irrigation methods such as drip irrigation and water management systems in response to climate change will help water and crop productivity [50]. Diversification cultivation, which is mentioned as the third strategy, increases diversity in the cultivation of different crops and plants and can contribute to different advantages in facing changing conditions [51]. Improving weather warnings is also very important; Informing farmers about climate change and rainfall and drought conditions can best facilitate crop planning and access to water resources [52]. Finally, increasing the capacity

of food storage and distribution can be effective in ensuring access to food during periods of drought and climate change [53]. These strategies require coordination and cooperation between governments, organizations, and farmers to meet climate change adaptation goals and ensure food security. These strategies include the following:

1. Helping farmers deal with current climate risks by providing value-added climate services to farmers, farmers can partially adapt to climate change by changing planting dates, choosing cultivars with different growth periods, or changing crop rotations.
2. An early warning system should be provided to monitor changes in the prevalence of pests and diseases. The overall pest control strategy should be based on integrated pest management because this method emphasizes the management of multiple pests in a given climatic situation.
3. Breeding plants to create climate-resistant plant species that can withstand higher temperatures, drought, and salinity.
4. Development of short-term agricultural cultivars that complete their growing season before the heat reaches its highest level.
5. Genotype selection in products that have a higher production capacity, this activity is to deal with the decrease in production caused by the decrease in the growth period due to the drop in heat stress.
6. Prevention measures against drought, include reservoirs in medium fields, cultivation of legumes and oil seeds instead of rice in the highlands, cultivation of mixed crops instead of cultivation of pure crops in the highlands, covering the land with plant materials and increasing the use of animal manure.
7. Efficient use of water includes frequent but shallow irrigation, drip, and sprinkler irrigation for high-value crops, and irrigation in critical stages of crops.
8. Efficient use of fertilizer includes optimal use of fertilizer, divided use of nitrogen and potassium fertilizers, placement of fertilizer at the right depth, use of nitrification inhibitor products, liming of acidic soils, use of low consumption elements such as zinc and boron, use of sulfur in oil products, integrated management of nutrients.
9. Seasonal weather forecasts can be used as a support measure to optimize planting and irrigation patterns.
10. Strengthening the food production system through technological improvement
11. Develop a long-term plan for optimal land use to ensure food security and resilience to climate change.
12. Stabilization of prices to ensure local food security, national network silos should also be established to store agricultural products at the household and community levels up to the regional level.
13. Incentive programs should be provided to farmers to protect resources and increase efficiency by granting

credit to farmers to transfer adaptation technologies.

14. Technical, organizational and financial support for the establishment of seed and food banks
15. More financial resources should be allocated to strengthen research to increase adaptation capacity and reduce harmful effects in agriculture.

3. Conclusion

Climate change poses significant risks to global food security. Rising temperatures, changing precipitation patterns, and more frequent meteorological events are affecting crop yields and agricultural productivity worldwide. Developing countries that are heavily dependent on agriculture face the greatest threats. India is particularly vulnerable due to its large agricultural population and dependence on the monsoon. To adapt to climate change and ensure food security in the future, coordinated actions at the global, national and local levels are necessary. Efforts to reduce greenhouse gas emissions can help limit the severity of the effects of climate change. At the same time, investing in climate-resistant crops, improving irrigation efficiency, diversifying income sources, and strengthening social networks can increase the measure of sustainability and adaptive capacity of vulnerable agricultural communities. Early warning systems, weather insurance, food storage and distribution infrastructure, and strategic food reserves are also critical. Climate change is a complex challenge that requires an integrated policy response. With proactive measures in adaptation and international cooperation, food security risks can be managed. But continued failure to act will threaten the livelihoods and well-being of millions of small farmers worldwide. Urgent steps must be taken to make agriculture more sustainable for the future and about climate change.

4. Suggestions for Mitigating Climate Change in Agriculture and Enhancing Food Security

In light of the profound impacts of climate change on agriculture and food security, the following suggestions are proposed to improve resilience and ensure sustainable agricultural practices:

1. Development of Climate-Resilient Crops: Research and development of crop varieties that are resistant to extreme weather conditions such as drought, heat, and floods should be prioritized. This includes breeding crops with enhanced tolerance to environmental stressors, thus ensuring consistent yields despite climate variations.
2. Improvement in Water Management: Efficient water management strategies, such as the adoption of drip irrigation systems and rainwater harvesting techniques, can significantly mitigate the impact of water scarcity.

Investments in irrigation infrastructure should be encouraged to optimize water use, especially in arid and semi-arid regions.

3. **Promotion of Sustainable Agricultural Practices:** Farmers should be encouraged to adopt sustainable farming techniques that minimize environmental degradation. This includes practices like crop diversification, agroforestry, and conservation tillage, which can improve soil health and reduce vulnerability to climate stress.
4. **Capacity Building and Farmer Education:** It is essential to equip farmers with knowledge and tools to adapt to climate change. Training programs on climate-smart agriculture, water management, and sustainable farming techniques should be widely accessible to farmers, particularly in developing countries.
5. **International Cooperation and Policy Development:** Governments, international organizations, and local communities should collaborate to create policies that promote climate-resilient agricultural practices. This includes the establishment of financial mechanisms, such as insurance schemes and subsidies, to help farmers cope with climate-related risks.
6. **Investment in Agricultural Technology:** The development and implementation of innovative agricultural technologies, such as precision farming and automated irrigation systems, can significantly enhance agricultural productivity while minimizing resource use. Investments in technology and infrastructure should be encouraged at both national and international levels.
7. **Strengthening Food Security Systems:** Strengthening food distribution and storage systems can help ensure food availability during climate-induced crop failures. Developing strategic food reserves and improving food storage infrastructure are critical to safeguarding food security.
8. **Public Awareness and Advocacy:** Raising public awareness about the consequences of climate change on agriculture and food security is essential. Governments, NGOs, and other stakeholders should work together to promote climate change adaptation strategies and encourage sustainable consumption patterns.

Abbreviations

GHG Green House Gases

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Conflicts of Interest

The authors declare no conflicts of interest.

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