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Review Article

Climate change and sustainable agriculture

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Abstract

This study aimed to explain the effects of climate change on agricultural production and to ensure the sustainability of agriculture against these changes. A change is a new state, different from the current state. Changes in climate affect all factors necessary for agricultural production. This new situation affects agricultural production and may lead to decreases and sometimes increases in yield. For the sustainability of agriculture, it is necessary to ensure the continuity of production. Increasing temperatures are disasters that directly affect human health. The price increases in some products caused by disasters cause consumer preferences to change towards other products and indirectly affect their health negatively. Every person has the right to access to adequate food, that is, the right to life. This right should be guaranteed by the countries of the world. Climate parameters such as temperature, humidity, precipitation, evaporation, wind speed, which affect our natural resources, affect agricultural production. Natural disasters experienced as a result of changes in climate parameters due to climate change cause economic losses by reducing productivity in agriculture. The economic losses experienced affect both the people who make a living from agriculture and the economy of the country. While the countries of the world are planning their economies, they should consider ecology, the sustainability of natural resources and their life cycles, climate, agricultural production, which provides raw materials for many sectors such as industry and tourism. Countries can secure food availability for the future of humanity by restructuring agriculture to adapt to unexpected changes in regions where climate change has adverse effects on agricultural production.

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Introduction

The increase in temperature due to global climate change is spreading all over the world. Global warming, which has been felt more in the world in recent years, attittudes a danger for countries located in arid and semi-arid areas. Şanlı and Özekicioğlu (2007) have reported that as a result of the increase in temperature, the melting of the glaciers causes the water level in the oceans to rise, the evaporation seen in fresh water resources to increase, and thus the deterioration of the natural balance. The main reason for this situation, which threatens the life of many plant and animal species, is the increase in greenhouse gases in the atmosphere.

Gases such as carbon dioxide/CO_2, methane/CH_4, diazotoxide/N_2O, chlorofluorocarbons/CFCs, Ozone/O_3 and water vapor/H_2O, which are less than 0.1% in the structure of the atmosphere, are known as natural greenhouse gases;

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It is permeable to the rays coming from the sun and less permeable to the ground rays reflected back. Therefore, the earth is warming more than it should. This phenomenon is called the "greenhouse effect". If greenhouse gases were not in the atmosphere, the average temperature of the earth, which was 15°C, would have been -18°C, which would have reduced the possibility of life on earth to the lowest level. In other words, the main problem is not the existence of greenhouse gases in the atmosphere, but the increase in the rate of these gases as a result of human activities (Akın, 2006; Arıkan and Özsoy, 2008; Öztürk and Öztürk, 2019).

Türkeş (2008) state that continuation of greenhouse gas emissions at or above today's level will result in further warming and, most likely, many changes in the climate system during the 21st century, at levels greater than those observed in the 20th century. Human-induced warming and sea level rise could continue for centuries, even if greenhouse gas accumulations are to a certain extent stopped, because the timescales associated with climate processes and feedbacks are so varied and long. The international community therefore faces an important task of reducing the climate risk associated with increased anthropogenic greenhouse gas emissions. The most important way of minimizing the predicted climate changes and the possible negative effects of these changes on socio-economic sectors, natural ecosystems and human health is to reduce anthropogenic greenhouse gas emissions and increase greenhouse gas sinks. Rangelands have the potential to provide resistance to climate change and reduce the effects of climate change as important carbon sinks. Protection and improvement of rangelands is important in the fight against climate change (Kalonya, 2022). Horticultural agriculture, which is evaluated within the agricultural sector, has a much greater importance in againist the negative consequences of climate change by providing a better carbon absorption compared to other sectors (Uslu, 2021). Agriculture has the ability to reduce its carbon sinks and greenhouse gas emissions. Green plants capture carbon in the atmosphere through photosynthesis. Carbon is also stored in the soil. The second contribution of agriculture in decrease climate change is biofuels. Preferring the use of biofuels instead of fossil fuels reduces greenhouse gas emissions into the atmosphere (Bayraç and Doğan, 2016).

It is known that drought is the climate event that most affects the agricultural sector from the consequences of climate change. Because aridity is shown as one of the most important reasons for the decrease in agricultural production and quality. It is predicted that the temperatures will increase and access to water becomes difficult, threatening access to adequate, healthy, safe food. This situation has forced countries to apply adaptation and action studies for climate change, drought and food security (Tunç and Demirbaş, 2022).

However, it is much more important issue that these changes, which will change the phenology and living spaces of living things, will bring many uncertainties and innovations. The decrease in agricultural lands due to climate change, the changing phenologies of plants, cause a change in the crop pattern and adversely affect agricultural production. Nowadays because of the effect of climate change, the life cycle of diseases and pests affecting the crops has begun to change, along with all products grown in agriculture. In recent years the harvests sometimes come early due to the increase in temperature in some parts of the world in some years. We need to change the time of the struggle methods, as the cycle of diseases and pests will change in these years. Price fluctuations in agricultural crops also negatively affect agricultural production. This uncertainty in prices is due to the decrease in agricultural areas and the change in the crop pattern, as well as the uncertainty in climate parameters such as sometimes excessive precipitation, frost and hail damage, and drought. Today producers have started to grow alternative products owing to the decrease in agricultural areas and the change in growing conditions due to climate change.

Objectives

Although it is not possible to completely stop the process for global climate change, it is important to accelerate the efforts to slow down the development rate of the negative effects of climate change. This study aimed to make suggestions about what kind of work should be done to combat the negative effects of climate change on the agricultural sector.

Effects of Climate Change on Agriculture

Although the world's climate seems to have not changed over the years, it does not actually have a stagnant structure. According to climate scientists, the world has been going through periods of hot and cold periodically for centuries (Şanlı and Özekicioğlu, 2007). All living and non-living beings in nature are in constant interaction with each other. In addition, animals, plants, trees, oceans and glaciers have different functions within the ecosystem. Trees collect carbon dioxide in the air in their trunks; The oceans absorb and trap the greenhouse gases in nature, and the glaciers not only store viruses, but also create a climate effect by preventing the world from overheating. In the order of nature, the interaction and relationship between the beings in nature form a whole like the links of a chain and become a 'cycle'. Therefore, the health of people, animals, plants, glaciers, the environment is also cyclical. The climate crisis has occurred as a result of the breaking of this ecological chain and the disruption of the cycle (Çetin and Yılmaz, 2021).

Global warming affects the world and all sectors are affected by global warming. However, it is clearly seen that the effects of global warming on the agricultural sector are more than other sectors. Considering that agricultural production is largely dependent on natural conditions, it is thought that changing climate and soil characteristics will cause changes in the yield and quality of agricultural products. Agriculture is a sector of great economic importance with its contribution to population and employment, national income, social nutrition and foreign trade. Therefore, it is clear that this sector will experience great losses both economically and socially with the effect of global warming (Yalçın and Kara, 2014). Dell et al. (2008) used the annual variation in temperature and precipitation over the past 50 years to examine the impact of climate changes on economic activity in the world. The findings show that high temperatures significantly reduce economic growth in poor countries, but not so much in rich countries. Accordingly, in poor countries from 1950 to 2003, a 1°C rise in temperature in a year reduced the economic growth of that year by 1.1 percentage points (Hayaloğlu, 2018). Wiebe (1972) stated that high temperatures due to global warming will accelerate plant development from flowering to fruiting, but products may often have some undesirable properties. Wurr et al. (1996) showed in his study that the temperature increases that occur in the seasons with climate change and the imbalances that occur in the precipitation distribution can negatively affect the productivity of some horticultural crops as they cannot meet the cooling need. Jönsson (2011) investigated the impact of climate change on agricultural production in the Republic of Mauritius with the help of the Ricardian model. In his research, he concluded that the increase in temperatures and decrease in precipitation will negatively affect tomato production (Akcan et al., 2022). Akram (2012) investigated the effect of climate change on economic growth with the help of panel data analysis using data from 1972-2009 in 8 Asian countries (Bangladesh, India, Indonesia, Malaysia, Pakistan, Philippines, Sri Lanka and Thailand). In his research, he concluded that the increase in temperature and precipitation negatively affects economic growth. It has been stated that this negative effect is more effective in the agricultural sector than in the manufacturing and services sector. At the same time, it has been revealed that the increase in the amount of precipitation affects agricultural GDP positively, while the increase in temperature affects negatively (Akcan et al., 2022). Başoğlu and Telatar (2013) analyzed the impact of climate change on the agricultural sector with econometric methods and found that temperatures adversely affected agricultural production, but the increase in precipitation increased the amount of production.

Natural conservation (in situ) is the preservation of ecosystems and natural habitats, the survival of populations in their own environment, or the growing of cultivars in the environmental conditions to which they are adapted. For this reason, natural conservation includes the studies of identifying and managing the species that are planned to be protected under their own conditions. It is a fact that the local diversity centers of some species are also in danger of climate change. However, it has not been sufficiently understood how this danger increases and how climate changes will affect the diversity in use. The effects of adverse conditions on local diversity can be positive or negative depending on the regions (Özgen et al., 2015). In short, natural conservation is the conservation of genetic resources in their natural habitats. In this type of protection, populations can maintain their diversity, plants can continue to evolve, and plants with new characteristics can emerge. However, as is known, evolution not only causes the occurrence of new features, but also

causes the loss of existing old features. This may also require long-term preservation of seed samples in gene banks at the initial stage of conservation. All these show that instead of evaluating natural protection as a method of protecting plant genetic resources alone, it will provide more effective protection if it is considered together as a complementary element of artificial (ex situ) protection (Şehirali et al., 2005; Özgen et al., 2015).

In artificial protection, plants are taken under protection outside the (natural) places where they grow. Artificial conservation includes the collection and storage of species at risk of extinction. The first comprehensive studies began in the 1970s (Frankel and Bennet, 1970; Frankel, 1973; Frankel and Hawkes, 1975), and as a result of these studies, the "International Institute of Plant Genetic Resources" (IPGRI) was established in 1974. Conservation activities consist of collection, storage, renewal, evaluation and information flow activities. An important part of these studies are within the scope of gene banks. These studies, which generally consist of different storage methods under controlled temperature and humidity conditions and carried out in gene banks, can be carried out at the institutional, regional, national or international level (Painting et al., 1995; Özgen et al., 2015). On the other hand, climate change may increase the importance of some plant species that are underproduced today. The most effective solution to climate change problems is again local varieties. Future studies and strategic analyzes should focus on a better understanding of the local-regional-global impacts of climate change on local diversity (Özgen et al., 2015).

Biodiversity, which is planned to be inherited to future generations, faces serious threats due to climate change. For this reason, it will cause a decrease in the yield of basic nutrients such as wheat, corn, rice and product losses. Our plant genetic resources are subject to genetic erosion due to environmental and other pressures and are in danger of extinction. In particular, the protection of the diversity in plant genetic resources of cultivated plant species is extremely important for the sustainability of plant production (Doğan and Gökkür, 2017). Jarvis et al. (2008) predict that 61% of peanut varieties, 12% of potato varieties and 8% of cowpea varieties will become extinct in the next 50 years (Özgen et al., 2015). Afzal et al. (2016) examined the impact of climate change on wheat in Punjab, Pakistan from 1981 to 2012. Findings of the study; It is revealed that the temperature has a positive effect on the production of wheat crops during the planting and harvesting phase, and negatively affects the wheat production during the flowering phase (Hayaloğlu, 2018).

It is seen that climate change will have economic, environmental and social effects. Land and ecosystem degradation, decrease in agricultural production, damage to real estate and infrastructure, decrease in tourism in damaged areas, decrease in employee productivity due to increasing temperatures, mass migration are noted in the first place (UNCTAD, 2021). Kumar et al. (2016) investigated the effects of climate change on soil fertility by using panel data analysis method using data from 1980-2009 in 13 states of India. In their research, they concluded that the increase in average temperatures caused a decrease in productivity by negatively affecting soil fertility (Akcan et al., 2022).

Brown et al. (2010) investigated the impact of climate change on growth for 133 countries during the 1961-2003 period. According to the results, while excessive precipitation (flood) had a negative effect on economic growth, a significant effect of temperature on growth could not be determined (Hayaloğlu, 2018). Lee et al. (2012) tested the impact of climate change on agricultural production with the help of panel data analysis using data from 1998-2007 for 13 Asian countries. In the study, it was concluded that while large temperature decreases in South and Southeast Asia damaged agricultural production, high precipitation and temperatures in summer months affected agricultural production positively (Akcan et al., 2022). In the work of Başoğlu and Telatar (2013), the effects of climate change on the agricultural sector are examined for Türkiye with annual data for the 1973-2011 period. The results of the analysis reveal that the changes in the amount of precipitation affect the share of the agricultural sector in GDP positively, while the changes in the temperature affect it negatively (Hayaloğlu, 2018).

Belloumi (2014) examined the effect of climate change on agricultural production with the help of panel data analysis technique, using data from 1961-2011 in 11 Eastern and Southern African countries. In his study, he concluded that rainfall in South African countries has positive effects on agricultural production, while the general increase in annual average temperatures has a negative effect (Akcan et al., 2022). Abidoye and Odusola (2015) investigated the relationship between economic growth and climate change in 34 African countries during the 1961-2009 period. The results of the

analysis reveal that climate change has a negative effect on economic growth. The results reveal that a 1°C increase in temperature reduces GDP growth by 0.67 points (Hayaloğlu, 2018).

Masud et al. (2012) examined the impact of climate change on rice production in Malaysia. Results; reveals that temperature, precipitation, farm size, educational information, land area and value of labor inputs affect rice production per hectare in Malaysia (Hayaloğlu, 2018).

Gökkür and Şahin (2020) have reported that since fruit growing is done with perennial plants, it is very difficult to change the product patterns from year to year in existing gardens according to climate change. Global warming may positively affect fruit growing in some northern regions, while it may cause negative effects in other regions. Early flowering of fruit trees due to climate change may increase late frost damage. Decreases in the quality of the products may occur. Although early harvest occurs in the first few years due to temperature increases caused by climate change, delays may be seen in harvest dates in the following years, as fruit trees cannot fully meet the need for cooling. Modeling studies on climate change are important. However, the software should be updated with data entries every year in order to provide more accurate results for modeling studies on predicting harvest dates and yield estimations.

The agricultural activity in which the effects of global warming and climate change are most intense is fruit growing and perennial plants are more affected by sudden temperature changes. One of the most common situations in recent years is the extreme weather conditions that occur during the winter rest, flowering, bud formation and fruiting period of fruit trees. While this situation directly affects fruit production and quality, it also has negative effects on the bees involved in pollination. Climate changes trigger the formation of weak colonies in honey bees, causing the spread of diseases, bee losses and deaths (Şahin et al., 2015).

Studies show that the point of no return for global climate change has been exceed. In addition to the studies aimed at stopping or at least slowing down this process, studies should be carried out and measures should be taken to reduce the effects of the process on living things and the ecosystem. It can be said that the most necessary studies on this subject are studies to increase the awareness level of the societies on the subject and to realize the seriousness of the situation (Koç, 2021).

Suggestions for Solutions to Reduce the Negative Effects of Climate Change

Global surface temperature will continue to rise under all emission scenarios considered, at least until mid-century. If there are no serious reductions in CO_2 and other greenhouse gas emissions in the next years, 1.5°C and 2°C global warming will be exceeded in the 21st century. It is almost certain that the land surface will continue to warm more than the ocean surface (probably 1.4 to 1.7 times more). It is predicted that the Arctic will continue to warm more than the global surface temperature (more than twice the global warming rate). Even at 1.5°C of global warming, with additional global warming, there will be an increase in the occurrence of some unprecedented extreme events in the observation record. In the next 2000 years, global mean sea level will rise by about 2 to 3 m if warming is limited to 1.5°C, by 2 to 6 m if limited to 2°C, and by 19 to 22 m by 5°C warming. Sea level will continue to rise in the next millennium. Changes in climatic impact factors will be more widespread and even more pronounced for higher levels of warming at 2°C than at 1.5°C global warming (IPCC, 2021).

Climate change seriously threatens the protection of the world's plant genetic resources, food security, social welfare and public health. The sustainability of life depends on the sustainability of plant genetic resources. Therefore, the protection of plant genetic resources is actually an international obligation. With climate change, the life cycles of all living things are changing. Changing the life cycles also means the deterioration of the life balance in the world (Gökkür and Şahin, 2020). Varieties in use will be lost due to climate change as growers turn to local varieties or newly developed cultivars that are better adapted to changing conditions. For example, it is known that the number of sorghum varieties grown in the Southern Mali Region of Sudan in the last 20 years has decreased significantly because of the shortening of the rainy season due to climate change (Weltzien et al., 2006; Özgen et al., 2015).

To protect means to keep something away from danger, to preserve it. In order to protect the world, first of all, it is necessary to protect the resources, consume them in small amounts, and increase their diversity by developing them.

Conservation of plant and animal genetic resources is important in order not to disturb the balance in nature. Therefore, for the stability of the environment in which all living things live, it is imperative to protect our soil and water resources and even all our natural resources. Rapid population growth in the world, urbanization, industrialization, climate change, environmental pollution, excessive plant collection and removal from nature, excessive consumption of resources, ignoring the integration of technological advances with nature are among the most important problems of today (Gökkür, 2017a).

Irrigation is the introduction of water into the soil by unnatural methods in order to provide the necessary moisture environment for plant growth. It is a door that provides access to food for human beings to survive. The decrease in our water resources due to excessive population growth, industrialization, urbanization, climate change, excessive use of agricultural fertilizers and pesticides, and the decrease in agricultural areas threaten the sustainability of irrigation (Gökkür, 2018a). Excessive fertilization and spraying activities in agriculture cause groundwater pollution and threaten the sustainability of our water resources. Excessive irrigation causes our soils to become saline and lose their productivity. The irrigation program should be rearranged according to the hours when evaporation is less, and irrigation should be done very early in the morning or in the evening. Decrease in water resources due to climate change, decrease in agricultural lands, decrease in the world's biological diversity means the destruction of human habitats (Gökkür, 2016a). If the coherence between plant, climate, soil, water and nature cannot be achieved well, the sustainability of agriculture will be adversely affected. For example, excessive irrigation harms the soil, plants and nature. This causes yield reductions in agriculture. Due to the growing done without considering the climatic factors, very low yields are obtained in some years. To summarize, plant, climate, soil, water, nature are the links of a chain and they all have strategic importance. If one of the rings is damaged, the entire chain is adversely affected. With excessive or irregular irrigation, fruit cracking, yield losses and as a result, income losses in our farmers occur. In orchards with regular irrigation, the cracking rate due to excessive rainfall due to climate change is lower than the cracking rate that will occur in irregularly irrigated lands under the same conditions (Gökkür, 2016b). Climate change is a natural phenomenon that also affects water and soil. It is important to develop strategic action plans and protection policies in order to minimize the negative pressures of water, soil and climate changes, which have various effects on sustainable food security (Akın, 2021). Water, which has an important place in the survival of all living things, is used in the industrial sector and in many other sectors to obtain products. For this reason, water, which is used in the production of many living and non-living products, is one of the unchanging and most important rings of all life cycles.

The agricultural sector is a strategic sector that provides raw materials to many sectors such as industry and tourism. It is known that climate change affects the exports of the agricultural sector and the sectors that provide raw materials from agriculture. The development of the industrial sector depend on the development of the agricultural sector. The effects of climate change on the development of plants in different parts of the world and the effects of adaptations of plants to these changes are not known exactly. The heat or cold resistant fruit species or varieties should be re-determined according to the regions and the newly established gardens should be planned considering these issues. Late spring frosts can cause damage to some fruit species. If the damage is large, the economic loss of the producers will be high as the quality of the products will decrease. However, if the damage is minor, the product quality can be kept at a good level without the need for fruit thinning. Studies should be increased to develop phenological models to predict the effects of climate change on the development of fruit species. Agricultural production systems should be developed to adapt to the unexpected effects of climate change. We can reduce the negative effects of climate change on fruit producers thanks to the evaluation of our fruit genetic resources and the selection of fruit varieties that are resistant to high temperatures and low temperatures. The addition of new rings (activities) to the global value chain in agriculture due to changing climatic conditions may occur in the near future (Gökkür and Şahin, 2020).

Within the framework of the Covid-19 epidemic, problems of access to safe food, increases in demand for agricultural products, and future of disruptions in the global supply chain have led to discussions in the concept of globalization. The blockages in customs and foreign trade and the strategies followed in different sectors revealed that new plans are

needed to create a national value chain. Therefore, it has come to the fore to bring agricultural production to a self-sufficient position and to produce reliable food in every country. In order to reach a self-sufficient position, countries are expected to increase protectionist policies (Bayramoğlu and Bozdemir, 2021).

Awareness is a method of attracting attention and influencing. Every decision taken in economy, agriculture and social life is the result of a choice. Choice means selection. The right decision comes with the right choice and enough thinking. In order for everyone who makes a living from agriculture to make the right decision, it is necessary to evaluate an economic concept, Opportunity (alternative, abandonment) Cost. Opportunity cost awareness is the amount of goods and gains lost if another good is given up to increase production of any good. Opportunity cost awareness is actually the cost of our choices. It is the cost to us of the choices we do not make. So also call it abandonment cost or alternative cost. Production opportunities should be determined by making a good evaluation of alternatives in agriculture. When a farmer grows corn instead of cotton in the field, the income that can be obtained from cotton will be the opportunity cost of corn. The opportunity (alternative, abandonment) cost of growing inefficient varieties is the income that can be derived from efficient varieties. Since low-yielding varieties are grown in some regions, although the production areas of agricultural products are higher than in other regions, the income obtained is low. Our farmers can earn more income by turning to efficient varieties. While determining efficient varieties according to regions, their effects on ecology should also be taken into account. The support given to research and development studies for the breeding of varieties with high yield, high quality, resistant to diseases and the effects of climate change should not lose their continuity. In these studies, cultivars with low yields but superior in some characteristics should be continued to be used as material (Gökkür, 2017b).

Strategic management in agriculture is an important tool that can be used to reduce the income gap in all segments of the society. The reason why lands suitable for agricultural production cannot be evaluated well is due to the growing of low-yield crops in agriculture, lack of inputs and wrong practices. In recent years, the increase in the rate of change of climate change and the decrease in the resistance of ecology to this change affect the environment and the socio-economic life of people. In the future, crops with high efficiency, low cost and low water consumption in agricultural production will begin to become widespread in the foreign trade of countries. The imbalance between production costs and product prices in agriculture can be corrected by the revision of the global value chain. Thus, despite the negative effects of climate change, the decrease in food supply in some products can be prevented and positive contributions can be made to the sustainability of our food security. Import and export costs of countries are of great importance in the foreign trade costs of agricultural products. With the right marketing techniques and the right analysis of consumer behavior, the negative effects of these costs can be minimized. Studies reveal that climate change, which occurs as an effect of global warming, has an impact on agricultural products yield. Accordingly, changes will occur in production regions and trade (Gökkür, 2017c).

Due to the increasing population in the world, the need for food is increasing day by day, but changes in the climate limit agriculture and food production. In some parts of the world changes in temperature and precipitation caused by climate change affect the amount and quality of products by reducing productivity in the agricultural sector. This situation leads to a low contribution of agriculture to GDP, while negatively affecting economic growth. For this reason, developing strategies for adapting to climate change and reducing its negative consequences will prevent possible difficulties in the future (Hayaloğlu, 2018).

Industry 4.0 is the chain of innovations offered to human beings by the developments in technology. In order to get out of the status of the countries that follow Industry 4.0 and to the status of the leading countries, we need to decide in which sectors we can apply the technological advances in all areas of life faster. The solution actually goes from simple to complex. Fully transitioning to Industry 4.0 in the tourism sector and agriculture sector will make great contributions to making our economy prosperous and catching the leadership in some sectors in the world (Gökkür, 2019). Industry 4.0 technology, which is defined as the internet of things, reduces energy consumption and production costs by allowing

plant growers to use irrigation water and fertilizer more economically in irrigation and fertilization activities. Thus, it increases the income of farmers from agricultural production.

When we consider the history of economic thoughts in economy and their global effects, it is evident from experience that the laws and theories determined do not offer the same welfare to all countries of the world. All these considerations should be reinterpreted by taking into account the special circumstances of each country, without reducing the rate of investments in strategic sectors such as agriculture (Gökkür, 2018b). Price fluctuations in the marketing of fresh fruit and vegetable products adversely affect the agriculture sector. The basin-based product support programs, which are created by making production planning according to the basins, aim to end the problems that will be encountered in the supply of agricultural products. However, in agricultural products, structures that include all stages from pre-harvest to post-harvest should be developed. This will have positive contributions in reducing the production costs of the enterprises (Gökkür, 2016b). Producing early and late varieties together in growing zones will prevent excessive price fluctuations in agricultural production by allowing agricultural products to be on the shelves for a longer period of time.

Economic prosperity can be stabilized by structural developments and innovations in the agricultural and industrial sectors. The basic solution is to evaluate these two sectors separately and as a whole. The agricultural sector provides raw materials to many sectors from the industrial sector. While making strategic plans in agriculture, its connection with the industrial sector should not be ignored; incentives and supports should be determined by considering these two sectors together. Policies should be developed by taking more into account the changing activities of the global value chain in the agricultural sector in the world (Gökkür, 2018c).

It is expected that the risks caused by climate change will deeply affect basic macroeconomic variables such as production, consumption, investment, inflation expectations, productivity, wages and international trade. Climate change causes uncertainty in both national and global markets. As a result it is complicating monetary policy implementations (Karagöl, 2022).

The change in the amount of agricultural production directly affects all segments in the chain from food safety to food security, from farmer income to national income, from industry based on agriculture to industry using agricultural product wastes, from production to consumption in agriculture (ÇŞB, 2012).

Adaptation studies are (ÇŞB, 2012):

- Updating agricultural databases
- Updating soil inventory and maps
- Determining the effects of climate change on soil, water, plant and animal product yields on a basin, regional and national basis
- Estimating production pattern changes and planning accordingly
- To determine the possible effects on the quality of plant and animal products, to carry out studies to protect and improve the quality
- Carrying out studies for the prediction and treatment of possible plant and animal diseases
- Estimating the possible effects on the agro-industry
- Developing varieties that will adapt to climate change
- Supporting product varieties suitable for climate and water availability in agricultural basins
- Completion of land consolidation works
- Expanding irrigated areas
- Dissemination of irrigation systems that use water savingly
- Increasing awareness on erosion and desertification
- National, regional and basin-based economic, social and environmental impact analysis studies must be made
- Expanding non-agricultural employment opportunities and increasing training activities
- Facilitating the use of agricultural credits, making efforts to increase the use of credit especially by farmers with small lands

- Increasing the support given to environmentally friendly agricultural techniques
- Carrying out studies to increase the environmental awareness of farmers

World countries should develop policies to achieve a sustainable economy and a cleaner environment by expanding the share of renewable energy consumption in energy resources. It is also particularly important to promote collaboration in technology development when addressing global climate change. Policies to develop public and private partnerships in Research and Development (R&D), especially in energy efficiency, need to be strengthened. This shows that policy makers should expand renewable energy sources in order to achieve sustainable economic growth without compromising environmental quality. Global awareness of the expansion of R&D investments as a viable solution for the transition from non-renewable energy sources to renewable energy sources is required (Küsmez, 2022).

When farmers use more chemicals, pesticides and water to increase crop yield; chemicals compress the soils and increase the probability of encountering adverse events such as drought and erosion. The mixing of chemicals into the waters in the coastal areas makes the soil unproductive with the increase in evaporation due to heating and the remaining salt layers (Hubert and Lenoir, 2015; Kara and Yereli, 2022). Due to the increase in the world population, the necessity of developing agriculture and production has increased the use of pesticides over the years. Excessive use of pesticides harms the crop and food chain. The efficient use of natural resources will provide durability to the agricultural sector for the building of a sustainable economy (Kara and Yereli, 2022).

Conclusion

The sun's rays coming to the earth hit the earth and are reflected back. Since its existence, mankind has changed the earth by using it in line with its needs. Past and present back reflections of the sun's rays coming to the world should be calculated and re-planned so that the total amount of reflection today is equal to the amount of retroreflection in the past. Planning and projecting the colors and shapes of the buildings to the amount of reflection of the rays coming from the sun can be beneficial in the fight against climate change. It has become a necessity for the countries of the world to reduce their greenhouse gas emissions in order to be able to combat climate change. Stopping the use of fossil energy sources in all sectors and replacing them with renewable energy sources will contribute greatly to reducing greenhouse gas emissions. Furthermore the importance of increasing forest areas, which is the key to reducing emissions, is obvious. The protection of existing forest areas and the creation of forest areas filled with fruit trees in every possible area will have positive effects on reducing emissions and on the country's economy. Agricultural production should be planned together with efforts to reduce greenhouse gas emissions and adaptation to global climate change. Moreover the realization of incentives for the use of renewable energy sources by all countries of the world will make positive contributions to the protection of agricultural areas.

Protecting biodiversity is vital for food security. The circular economy contributes to reducing CO_2 emissions by reusing and recycling natural resources and materials. Success can be achieved with circular economy principles in the fight against climate change. Global warming and increasing world population have led to an increase in the demand for water. This situation necessitates the effective use of water resources in the agricultural sector and other sectors. Due to climate change, the change in the hydrological cycle has led to a decrease in groundwater resources in many parts of the world. This causes less irrigation of crops grown in agriculture and reduce yield in these crops. Agricultural production should be re-planned, taking into account the water resources of the basins where agricultural production is made. In places where water resources are insufficient, plants with low water consumption can be grown. Countries should plan their crop production according to water resources. Countries with unsufficient water resources should reschedule their exports by giving priority to products with low plant water consumption, and their imports by giving priority to products with high plant water consumption. Protecting world soil and water resources has become a necessity for the sustainability of agriculture. All societies should be made aware of water conservation. Plants that may be hosts of diseases and pests of crops to be grown in agricultural lands should not grow in the same region. Otherwise, no matter

how much we struggle with diseases and pests, diseases and pests may be observed again the next year due to different host plant species in the region.

Nowadays the rise in petrol and fertilizer prices adversely affected production costs in the agricultural sector. This situation causes yield and quality losses in agricultural crops. Increasing food prices will lead to consume foods with low nutritional value. In addition the change in the areas where agricultural products are traditionally grown due to climate change changes the consumption habits of people. Besides, those who make a living from agriculture are accustomed to growing traditional products. Diseases, drought, flood, hail events, worldwide price increases in agricultural inputs, yield losses in many crops due to climate change, have started to make farmers willing to grow new products. All things considered, climate change threatens the productivity of food, the availability of food, that is, food security.

Standardization should be ensured in protecting farmers against natural disasters in agricultural insurance in the world. Wide agricultural insurance works are carried out at affordable prices, enabling farmers to trust their income from agriculture. Moreover, the areas where agricultural production is made can be increased by making supports to increase the land size of the farmers (credit supports for new land purchases, land rent supports).

The development of modern agricultural techniques for all pre-harvest and post-harvest activities is necessary in terms of increasing productivity in the agricultural sector. Increasing the support of the countries for the use of industry 4.0 technology in irrigation, fertilization, harvesting and post-harvest activities in agricultural production will enable the sustainability of agricultural production. In order for agricultural production to adapt to climate change, studies that can be done to protect soil and water resources, improvement studies to develop seeds and saplings resistant to drought, efforts to protect the world's genetic resources by establishing land and seed gene banks, government support for combating plant diseases and pests, works to increase the use of renewable energy sources, invests to re-plan rural areas according to nature and the needs of life will be beneficial.

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