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Negative Effects of Global Climate Change on Agriculture Production

Maham ZAHID

Nigde Omer Halisdemir University, Faculty of Agricultural Sciences and Technologies, Nigde/Turkey

Corresponding author: maham.zahid77@gmail.com

ORCID: 0000-0003-4255-3829

Abstract

Climate is a vital aspect of agriculture production. Change in climate is caused when greenhouse gases are released into the air. High concentration of gases like methane, nitrous oxide and carbon dioxide are the reason of global climate change. Climate change will cause high sea level, modified rainfall patterns and high atmospheric temperatures. As temperature gets higher, crop yields are most probably suffering if dry episodes occur during early stages. Climate changes have endangered the agriculture productivity making it susceptible both physically and economically. Globally, high frequency of unpredictable weather conditions will lead to decrease the agricultural productivity and greater prices, which will lead to food security concerns. Adaptations like alterations in variety of crops, upgraded irrigation and water management system and variation in planting plans and cultivation practices will be vital in restraining the negative impact and taking benefit of the positive effects of climate changes.

Keywords: Agriculture, Greenhouse Gases, Climate, Global Warming, Food Security

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INTRODUCTION

Climate change has become the focus of constant attention of living things and civilizations take into account the climate parameters determined their lifestyles. The increasing or decreasing direction in climate values, changes affect living things negatively. decrease in productivity, especially in agricultural production causes (İstanbulluoğlu et al., 2013).

Climate is a vital aspect of agriculture production. Change in climate is caused when greenhouse gases are released into the air. Accumulation of these gases in the air results in global warming. Parameters linked with climate change include precipitation, sea level, temperature and soil moisture. However, the consistency of the forecasts on change in climate is unclear. There are no evidences about what will certainly be the outcome of high level of greenhouse gases in the air. Agriculture is a main sector to study regarding climate change. Agriculture is not only contributing in climate changes but it is also being affected by changing climate. Anthropogenic activities that include urbanization, industrialization, agriculture, deforestation, modification in land usage patterns is leading to release of GHGs which is increasing the rate of climate change more rapidly.

Changes in climate include high temperatures, precipitation variations, and high carbon dioxide concentrations. Greenhouse Effect might be considered significant for agriculture in three ways. Foremost, high concentrations of CO_2 may have an effect on the rate of growth of plants directly. On Second, changes due to induction of atmospheric CO_2 can modify temperature levels and rainfall patterns. Lastly, increases in sea level can lead farmland loss by flood and high salinity of groundwater in seaside zones.

Climate change is progressing as one of the essential environmental issue faced by present world. Release of greenhouse gases, high concentration of gases like methane, nitrous oxide and carbon dioxide are the reason of global climate change. Change in climate will cause high sea level, modified rainfall patterns and high atmospheric temperatures. Due to change in climate patterns, storms, droughts and flood intensities are likely to be increased. Temperature will be increased globally by 1.8°C - 4°C with an average rise of 2.8°C (IPCC, 2007). We as human are accountable for this evolving enriched carbon dioxide world because excessive usage of fossil fuels and deforestation have raised CO_2 concentration from 280 ppm - 380 ppm (Stern, 2007). Agriculture productivity is reliant on climate conditions. Climate changes have endangered the agriculture productivity making it susceptible both physically and economically. Productivity may be affected by various factors that include rainfall sequence, temperature, variation in sowing and harvesting time, availability of water and suitability of land. Changes in climate might not have vast effects yet local effects are quite widespread. Few areas will get benefit from climate changes whereas some areas will be highly affected. Climate change will not only have an effect on agriculture productivity but it also disrupts the financial stability that will affect the supply and demand steadiness of agricultural produces, viability, trade and rates of these produces (Kaiser and Drennen, 1993). Increase in GHGs will affect the productivity of agriculture in under developed states in comparison to developed states (Kurukulasuriya et al., 2006; Seo and Mendelsohn, 2008). Economy of under developed states are more sensitive to climate as their economy depend on labor services, however; economy of developed countries can manage climate changes by using technology and adaptations (Mendelsohn et al., 2001).

Increases in carbon dioxide concentration due to human activities are now being considered the main reason of greenhouse effect, and experts are also considering that these will lead to earth warming (Houghton et al., 1996). It is evident that climate changes are expected to affect the local evaporation, temperature and precipitation patterns, certainly the whole array of agricultural, meteorological, ecological and hydrological relationships.

The greenhouse effect is producing the warm atmosphere near the earth. Though, the increase in greenhouse gases that include methane, carbon dioxide, water vapors, nitrous oxide, perfluorocarbons, sulfur hexafluoride and hydrofluorocarbons due to anthropogenic actions has cause a raise in temperature, which is now leading to global warming.

AGRICULTURE and CLIMATE

Agricultural activities have contributed around 20 % of the increase in anthropogenic GHGs emissions annually (Charoensilp et al., 1998). This area is contributing to global warming by increasing the concentration of CO_2, CH_4 and N_2O emissions.

The GHGs allow the light transmission reaching the earth, blocking the heat transmission which is trying to escape from the air, so traps heat as a 'greenhouse.' Methane has the maximum global warming potential, that is around 300 times more the potential of carbon dioxide and around 20 times more that of nitrous oxide. The major sources are nitrogen fertilizers, soil management, flooded rice fields, burning o biomass, conversion of land, and livestock production and linked manure management (IPCC, 1996).

CARBON DIOXIDE (CO_2)

Firstly, deforestation due to extension of agriculture and speculation of land was considered a main source of carbon gas emissions. When natural vegetation is renewed into agriculture land, a huge quantity of the soil carbon can also be gone as plants and other organic matter are removed. This occurrence contributed about a third of the over-all carbon dioxide emissions worldwide. In several regions, it is a communal drill to burn huge sizes of crop remains, which results in insects and pest killing and causes soil acidity to neutralize (IPCC, 1996). Respiration, photosynthesis and transpiration are few plant processes mostly affected by change in the concentration of carbon dioxide. Certain changes in plant growth pattern from these crucial effects, some will result in positive outcome while others result in negative (Rosenzweig and Hillel, 1998).

METHANE (CH_4)

CH_4 is the most important GHG released in the agriculture area. Maximum amount of the CH_4 come from paddy fields around 91% and less meaningfully from animal husbandry 7% and the remaining 2% from burning of agriculture wastes. The quantity of gas emission has recognized challenging as the emissions may vary with the amount of fertilizers, land cultivation, density of rice plants, water management and other agriculture practices. China is a major source of methane gas emissions among Asian countries. Livestock and related manure management causes almost 16% of the total yearly production of CH_4.

NITROUS OXIDE (N_2O)

Mostly nitrous oxide emissions in agriculture come from the use of nitrogen fertilizer, cropping of legumes and animal waste. Some nitrous oxide emissions are also added during burning of biomass. Several farmers use nitrogen fertilizers on their lands to improve plant growth. The plant takes up maximum nitrogen, but some of the quantity leach into nearby area and ground waters and remaining into the air. The nitrogen flux majorly depends on the microbial activity occurring in the soil. The amount of nitrous oxide emitted is quite lower in capacity than the amount of methane gas.

REDUCTION in GHG EMISSIONS

Improvement in land usage practices might work toward the lessening of greenhouse gases emissions. The irregular drying of soil and reduced land turbulences like zero tillage and mulching will be beneficial in reduction of emissions. Alterations of cultivation practices like change from planting seeds directly and suitable water management can also cause decrease in methane gas emissions. The organic material reduction and inorganic fertilizers use will help to reduce gas emissions. Some variations in agriculture productivity could be helpful and can cause reduction in necessary soil disturbances like a change from outdated to high-yielding crop varieties, or moving from rice to other crops.

ROLE of TEMPERATURE

High temperatures will affect patterns of agriculture production. Few crops growth might get direct benefit from less temperature, while other crops might be affected by high temperature; or indirectly through the effect of temperature on water, on the extension of insects, pests and diseases, on weeds in different habitats.

When the optimum temperature array for a particular crop in an area is increased, it usually tends to respond in a negative way which will result in low yield. Mostly crops are sensitive to higher temperature ranges. Atmospheric temperatures between 45 - 55°C that last for around half hour directly cause leaves damage in most surroundings; even low temperature ranges like 35 - 40°C might be damaging if they continue (Fitter and Hay, 1987). Susceptibility of plant crop to affect by higher temperatures may vary with developmental stages. As temperature gets higher, crop yields are most probably suffering if dry episodes occur during crucial growing phases.

ROLE of WATER

Increasing world population, changing climate conditions and economic activities are growing with each passing day makes it more important than water. This is where the water demand of the different species and in different locations (Bağdatlı and Bellitürk, 2016b). Global warming will cause temperature raise from 1.4 - 5.8°C in coming century, climate models predicts that both precipitation and evaporation will be increased, as well as occurrence and potential of precipitations. While few areas might become wetter, while others undergo the effect of an increased hydrological cycle result in loss of soil humidity and high soil erosion. Some areas that are already prone to drought might suffer for long duration and more intense dry period. Furthermore, with alterations in patterns of precipitation, moisture in soil will be declined in few mid latitude areas during the summer season, while snow and rain will probably be increased at high latitudes areas during the winter season.

Precipitation, the main source of moisture in soil, is likely to be the most significant factor decisive for crop productivity. Though climate models forecast a complete escalation in precipitation globally, their outcomes also indicate the potential for altered hydrological cycles. Climate change might affect over-all periodic precipitation, its within-season array, and it's between-season frequency. The water necessity of a crop is also susceptible to increase in the regular and seasonal frequency of evaporation and transpiration resulting from high temperature, dry air or windy conditions.

Overheated soil; It will reduce the amount of moisture contained in it and cause the plant to not get enough water. This situation will make the soil inefficient. As the soil temperature decreases, plants that are not suitable for climate conditions and resistant to cold will be affected by root and cause drying. As a result, a constantly increasing soil temperature will adversely affect plant life. It will decrease the efficiency. It will negatively affect your living life (Bağdatlı and Ballı, 2020).

Extremely wet years, might cause yield drops due to lodging, waterlogging and amplified pest infestations. Higher soil moisture content in tropical areas can also obstruct field processes. Extreme bursts of rain might destruct earlier plants and stimulate lodging of standing plant crops with maturing grains, also soil erosion. The level of crops destruction depends on the interval of flooding and precipitation, crop developing phase, and soil and air temperatures.

Drought situations might also be tempted by lesser precipitation. Periods of higher relative humidity, hail and frost might also affect crop yield and quality. Interannual alterations in precipitation is a main reasons of variations in quality of crops and yield percentage. By reduction in vegetative cover, droughts intensify erosion by water and wind, therefore affecting agricultural productivity. In grain crops, pollination, flowering and grain filling are particularly sensitive to water stress.

Consequently, management applications have been developed to increase crops growth in water scarcity situations. Drought and heat stress frequently occur at once; one intensifies the effect of the other. Higher solar irradiation might be supplemented by high frequency winds. When plant crops are exposed to drought condition, it cause stomatal closing, lessen transpiration and, therefore, rising temperatures.

ROLE of CARBON DIOXIDE

Global climate change, the industrial revolution of the then mankind atmosphere to release the carbon dioxide, methane, ozone and nitrogen oxides as gases are very quickly heat the earth by the greenhouse effect that occurred as a result of the increase is a result of an increase above normal. The accumulation of carbon dioxide and other greenhouse gas levels in the atmosphere have reached has increased rapidly since the industrial revolution (Bağdatlı and Bellitürk, 2016a).

High concentration of carbon dioxide stimulates photosynthesis in some plants as they tend to reduce their photorespiration. This is accurate for the major species worldwide and particularly in cold habitats. Few effects on yield is observed for tropical plant crops which are significant for the food security of various under developed countries.

Climate change includes high temperature ranges, precipitation variations, and high atmospheric carbon dioxide concentrations which might affect yield percentages, rate of growth, transpiration and photosynthesis, availability of moisture, irrigation practices and agricultural contributions like insecticides herbicides and fertilizers. Environmental factors like intensity and frequency of soil erosion and soil drainage, availability of land, reduce crop diversity might also affect productivity of agriculture. High carbon dioxide level in the air would result in high photosynthetic rates (Cure and Acock 1986; Allen et al., 1987). High level of CO_2 might also decrease transpiration. The decrease in transpiration rate could be around 30% in some plants (Kimball, 1983). Loss o yield caused by synchronized rise in carbon dioxide and temperature are mainly caused by high temperature tempted spikelet sterility (Matsui et al., 1997a). Higher CO_2 concentrations might also inhibit respiration at night when temperature is greater than 21°C (Baker et al., 2000).

Global warming will speed up various microbial processes in the soil-water system, which impact C and N cycle. Decomposition of crop residues may be changed. High soil temperature might also cause an increase in carbon dioxide loss from the soil caused by root exudates, root respiration and fine-root turnover. Bacterial and fungal pathogens are also expected to be increased in regions where precipitation rates are high. Under warm and humid situations cereal crops would be more susceptible to the outbursts of diseases and pests thus reducing yield percentages.

NEGATIVE IMPACT of CLIMATE CHANGE

Over-all, agriculture contributes slightly to total greenhouse gas emissions. However, the agricultural area remains the key emitter of nitrous oxide gas, which come from manure and fertilizers and methane gas which is coming from rice fields and livestock. Furthermore, deforestation is the another source of carbon dioxide gas emission. Therefore, any impact of climate change on forestry and agriculture unavoidably feeds back to the climate system.

The decrease over time of the changes in the surface of the water is noticeable. This also shows itself as the effect of disorder in the vaporization and current precipitation regime in the water sources dependent on climate change (Albut et al., 2018).

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

The impact of climate changes on agriculture will be different globally. It is complex to determine how climate change will have an impact on agriculture. Variations in temperature and rainfall sequences and an increase in carbon dioxide gas concentration expected to change climate will have significant impact on agriculture worldwide, particularly in the humid areas. It is anticipated that productivity of crops will be altered due to these variations in climate, changed weather conditions and varying pest's activity. The appropriate land parts for cultivation of important crops could experience geographical modifications in response to climate changes. Demonstration of impacts due to climate changes for local food supplies are challenging for few reasons that include;

- Unreliability in local climate change forecasts;
- Our consideration of few agriculture processes like 'fertilization', response of different plant crops to higher concentration of atmospheric carbon dioxide and the probability of changed distributions and patterns of pests, diseases, insects and weeds remains inadequate;
- Ambiguity related to the possibility for adaptation for advanced agriculture practices.

The impact of global climate changes on agriculture productivity are expected to be minor to modest. Though, local effects could be important across the world. Crop yield percentages and productivity changes will be different noticeably across many zones. These positive and negative changes will possibly result in a considerable decline of agriculture productivity.

Susceptibility of climate changes ae dependent on biological, physical and socioeconomic parameters. Inhabitants with less income are reliant on agricultural systems are mainly exposed to hunger. Such populations are already food insufficient, even the least decrease in yields could be very destructive in such regions. The adverse negative effects are anticipated in dryland zones at low latitudes and in dry and semi-dry areas, which are particularly dependent on rain fed agriculture.

It is indicated that marginal farmers might be the most susceptible both to short duration weather variations and long term climate changes. Comparatively little climate changes could noticeably modify the potential for agriculture, therefore causing an incompatibility between current farming practices and current climate factors for agriculture in these regions (Matthews et al., 1994a; Matthews et al., 1994b)

The potential negative effects due to climate changes could influence agriculture productivity undesirably due to;

- Geographic and yield changes in agriculture,
- Water availability reduction for irrigation
- Land loss due to rise in sea level and salinization

The yields of various crops and geographical restrictions might be transformed by variations in moisture content of soil, precipitation, temperature, cloud amount, also carbon dioxide levels. The low rainfall and higher temperatures could cause reduction in soil moisture in many regions, dropping the water availability for irrigation and damaging crop growth in non-irrigated land of the many areas.The variations in soil characteristics like loss of organic matter in soil, leaching down of nutrients in soil, soil erosion and salinization are an expected outcome of climate change. The threat of loss due to insects, weeds and diseases is expected to be increased.

The variety of various insects will be expanded and novel combinations of diseases might appear as natural environments response. The impact of climate on insects and pests might enhance effect of other parameters like the pesticides overuse and biodiversity crisis.

Agriculture in regions nearby to river might be affected by an increase in sea level. Flooding will possibly become an important issue in few already flood affected areas. Reductions in agriculture productivity are most probably in such areas, which are already prone to flood (WRI, 1998). Changes in temperature and rainfall patterns might be inflated and destructive to agriculture.

CLIMATE CHANGE IMPACT on WORLD'S AGRICULTURE

Global reduction of farming lands and population growth rate along with the climate change phenomenon will cause lots of problems for worldwide food supply and we will face numerous nutritional problems in the near future. By gradually reaching to the 8 billion population on the earth, the mankind is really in challenge to provide the growing population food needs. The uncontrolled transformations of climate parameters such as temperature and rainfall affect the agricultural productions in a negative way (Bağdatlı et al., 2015).

Climate changes are expected to have an impact on food production worldwide. Increased temperatures can cause a reduction in interval of several crops and therefore lessen final yield. In regions where temperature ranges are already near physiological maxima for plant crops, warming will effect yields instantly (IPCC, 2007). Worldwide agriculture is facing a severe decrease within this era because of global warming. Generally, agriculture productivity is estimated to decrease by 3 - 16 % by 2080. Under developed states, which already have an average temperature that is close to crop tolerance level, are expected to suffer a typical 10 - 25% decrease in agriculture productivity by 2080s. developed countries, which have usually low temperatures, will experience a much slighter or may be positive effect, ranges from an 8% rise in productivity to a 6% decrease. Individual under developed countries may face even greater drops.

AGRICULTURAL PRODUCTIVITY and FOOD SECURITY

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 reduction of greenhouse gases that cause climate change (Bağdatlı and Arslan, 2020). Climate change has either direct or indirect impact on food security. Any change in the climate factors like humidity and temperature which manage crop development and growth will have an impact on food quantity directly. Certain indirect association relates to fatal actions like drought and flood which are expected to increase as a result of climate changes which will lead to massive crop loss and will leave large areas of arable patches unfit for further cultivation and therefore increases food security concerns. Overall impact of food security is dependent on the coverage to worldwide environmental changes and the capability to handle and improve from environmental changes across the globe. Globally, high frequency of unpredictable weather conditions will lead to decrease the agricultural productivity and greater prices, which will lead to food security concerns. This effect of global warming has important concerns for agriculture production for under developed countries, also a high risk of deprivation.

ADAPTATION

Changes will be essential in order to counter any adverse effects of climate. Agriculturalists must have the capability to amend variations by using latest techniques and modifications. Adaptations like alterations in variety of crops, upgraded irrigation and water management system and variation in planting plans and cultivation practices will be vital in restraining the negative impact and taking benefit of the positive effects of climate changes. More effective use of inorganic fertilizers and some other changes in agriculture practices might also help to counter the impact of climate change.

Different types and levels of scientific and socioeconomic modifications to climate change are promising. The level of these modifications depend on the economical aspect of such methods, mainly in under developed countries. Recent research shows that high costs of agriculture production due to climate changes would be a thoughtful financial problem for under developed countries. Other main aspects will be knowledge of technology, the frequency of change in climate and few biophysical restraints like soil properties, genetics of crops and availability of water (Darwin et al., 1995).

The adaptation of discrete farmer to climate change situation will include variations in crop selection, cultivation practices, irrigation management and pests control. Better climate predictions can help agriculturalists to get ready for any changing weather conditions.

Eventually, the capability of producers to adjust efficiently will not just define the success or failure of specific producers but also might contribute in countries economy. Global warming is not only offering challenges to the agriculture sector but also proposing opportunities. Few farm management practices are acting as a shield against climate changes and reducing GHGs concentrations in the air. Restoration and conversion of land have increased content of organic matter in soil through a process of sequestration while at the same time cause reduction in emissions. Expansions in fertilizer productivity and application of environment friendly types can decrease nitrous oxide emissions. Lastly, biofuels production and usage recycle carbon dioxide gas, therefore giving a direct counterbalance to gas emissions from nonrenewable sources.

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