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AGRONOMY AS AN OPTION FOR CLIMATE CHANGE MITIGATION

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Abstract

Climate change is one of the biggest challenges faced by humanity today, and it poses a threat to food security and agricultural production worldwide. Agronomy, which is the science of crop production and soil management, has a significant role to play in mitigating the effects of climate change. Agronomic practices such as conservation agriculture, cover cropping, crop rotation, and reduced tillage have been found to reduce greenhouse gas emissions and enhance carbon sequestration in soils. These practices also contribute to improved soil health and water conservation, which are important for climate change adaptation. In addition, the use of precision agriculture technologies, such as remote sensing, precision planting, and variable rate fertilization, can reduce the extend of inputs required and improve the efficiency of production, further reducing greenhouse gas emissions. Thus, agronomy has a vital role to play in climate change mitigation and adaptation in agriculture. The adoption of sustainable agronomic practices can contribute significantly to reducing greenhouse gas emissions, enhancing carbon sequestration, and promoting food security. However, to maximize the potential of these practices, it is important to address the challenges and limitations associated with their implementation and to promote the adoption of climate smart agronomy practices mitigating its effects through enhancing productivity, adaptation, and mitigation, ensuring food security, reduce greenhouse gas emissions, and promote sustainable agriculture.

Keywords: Conservation Agriculture, Cover Cropping, Carbon Sequestration, Precision Agriculture, GHGs

Introduction

Climate change is occurring since the time immemorial but the accelerated rate of change mainly due to anthropogenic activity is one of the greatest challenges facing the world today, and it is already having a significant impact on agriculture (IPCC, 2014; FAO, 2021). Rising temperatures, changes in rainfall patterns, and extreme weather events are all affecting crop yields and soil health, which in turn threatens food security and livelihoods for millions of people. Agronomy, the science of crop production and soil management, has an important role to play in mitigating the effects of climate change on agriculture (Seppelt et al., 2022). By adopting practices that promote soil health, conserve water, and reduce greenhouse gas emissions, farmers can help to build resilience to climate change and contribute to global efforts to reduce emissions.

CLIMATE CHANGE IMPACTS ON AGRICULTURE

Climate change is a global phenomenon that is having significant impacts on agriculture. Rising temperatures, changes in rainfall patterns, and extreme weather events are affecting crop yields, soil health, and water availability. These impacts are threatening food security and livelihoods for millions of people around the world. Higher temperatures can lead to heat stress, reduced photosynthesis, and lower yields. Changes in rainfall patterns can also affect crop yields, with droughts and floods having significant impacts on crop growth and development (USDA, 2021). Pests and diseases are also becoming more widespread and damaging as a result of climate change.

Changes in temperature and rainfall patterns can alter soil moisture, which can affect nutrient availability and soil structure. Soil erosion is also becoming more common as a result of extreme weather events, which can lead to nutrient loss and reduced soil fertility. Additionally, changes in soil temperature and moisture can affect soil microbial communities, which play a critical role in nutrient cycling and plant growth (Wu et al., 2022). Changes in precipitation patterns and increased evaporation rates are affecting water availability and quality. Droughts and heat waves are becoming more frequent and severe, leading to water scarcity and reduced crop yields (Table. 1). Flooding is also becoming more common, which can lead to soil erosion and nutrient loss. Additionally, changes in water temperature and nutrient levels can affect aquatic ecosystems and the quality of water for human consumption.

Agronomy practices for climate change mitigation

Agronomic management practices have a significant role in mitigating the impacts of climate change. Agriculture is one of the major contributors to greenhouse gas emissions, but it also has the potential to sequester carbon and reduce emissions.

***Conservation agriculture*:** It involves reducing or eliminating tillage to conserve soil moisture, reduce soil erosion, and increase soil organic matter. By reducing the need for tillage, conservation agriculture can also reduce the use of fossil fuels and the emissions associated with soil disturbance (Jat et al., 2019a). In addition, conservation agriculture can increase the amount of carbon stored in the soil, helping to mitigate greenhouse gas emissions.

Crop diversification: It is the phenomena of bringing out desirable changes in the existing cropping pattern towards a more imperative and sustainable one. Planting a variety of crops to reduce pest and disease pressure, improve soil health, and provide a more diverse range of food and income sources (Jat et al., 2019b). By increasing the diversity of crops grown in a particular area, it can also help to reduce the risk of crop failure due to extreme weather events, such as droughts or floods.

Precision agriculture: It is the new generation technology to optimize the use of inputs, such as fertilizer and water by utilising GIS, GPS and remote sensing technology and to minimize the environmental impacts of agriculture. By using precision agriculture practices, farmers can

reduce the use of inputs, increase crop yields, and minimize the emissions associated with agricultural practices (Padhan et al., 2021a).

Table. 1. Effect of climate change on agriculture

Effect of Climate Change	Remarks
Reduced crop yields	Global crop yields are projected to decline by 1.8% per decade due to climate change. (IPCC, 2014)
Shifting planting and harvest seasons	In the United States, planting and harvest seasons for crops such as corn and soybeans have shifted earlier by 5-10 days over the past 30 years due to climate change. (USGCRP, 2018)
Increased frequency and severity of extreme weather events	Extreme weather events such as floods, droughts, and heatwaves have caused significant crop losses, particularly in developing countries. (FAO, 2021)
Decreased soil fertility and health	Climate change has led to increased soil erosion, salinization, and acidification, negatively impacting soil health and fertility. (IPCC, 2014)
Changes in pest and disease pressure	Rising temperatures and changing precipitation patterns have altered pest and disease pressure, affecting crop yields and quality. (USDA, 2021)
Reduced water availability and quality	Climate change has led to decreased water availability in some regions, particularly in arid and semi-arid regions, as well as changes in water quality due to increased runoff and erosion. (FAO, 2021)

***Agroforestry*:** Integration of trees into agricultural landscapes to improve soil health, provide shade for crops, and sequester carbon along with providing a range of ecosystem services, such as improving soil fertility, reducing erosion, and providing habitat for wildlife. By sequestering carbon in woody biomass and soil organic matter, agroforestry can help to mitigate greenhouse gas emissions.

Cover cropping: It involves planting a crop that is grown primarily for its ability to improve soil health and protect soil from erosion vis-à-vis increasing the soil organic matter, improving soil structure, and reduce the need for tillage. By improving soil health and reducing erosion, cover cropping can help to mitigate the impacts of climate change.

Policy measures: Governments can provide support for sustainable agriculture practices, such as subsidies for conservation agriculture, agroforestry, and crop diversification. Policies that promote the use of renewable energy, such as solar or wind power, can also help to reduce greenhouse gas emissions and mitigate the impacts of climate change on agriculture.

There are also other strategies that can help to mitigate the impacts of climate change on agriculture. For example, research and development can help to develop new crop varieties that are more resilient to climate change, and that can produce higher yields with less water and fertilizer. Climate-smart agriculture approaches can also help to increase agricultural productivity while reducing greenhouse gas emissions. Furthermore, the benefits of agronomy practices for climate change mitigation are not limited to agriculture. By sequestering carbon and reducing greenhouse gas emissions, these practices can also have broader benefits for the environment and society as a whole. For example, agroforestry can provide habitat for wildlife and improve air and water quality, while cover cropping and conservation agriculture can reduce erosion and improve soil fertility. Overall, agronomy practices have the potential to play a significant role in mitigating the impacts of climate change on agriculture by adopting sustainable practices such as conservation agriculture, agroforestry, cover cropping, crop diversification, and precision agriculture, farmers can reduce their environmental footprint while also improving soil health, increasing yields, and contributing to climate change mitigation efforts.

Climate smart agronomy (csa)

Climate smart agronomy (CSA) refers to a set of practices and technologies that enable farmers to adapt to the changing climate while enhancing productivity and reducing greenhouse gas emissions. The concept of CSA is based on three key principles (Figure 1): productivity, adaptation, and mitigation (Barasa et al., 2021).

Benefits of CSA

The adoption of CSA practices has numerous benefits for sustainable agriculture. These benefits include:

- Improved productivity and food security
- Enhanced resilience to climate change effects
- Reduced greenhouse gas emissions
- Improved soil health and fertility
- Reduced soil erosion and water pollution
- Diversification of income sources

Agronomic practices: producer as well as mitigator

Agronomic activities such as land use change, tillage, and fertilizer application can release greenhouse gases (GHGs) such as carbon dioxide, nitrous oxide, and methane into the atmosphere. However, agronomic practices can also be used to sequester carbon in the soil and reduce GHG emissions from agricultural activities (Figure 2). Agriculture is a significant contributor to GHG emissions, accounting for approximately 10-12% of global anthropogenic emissions. The primary sources of emissions from agricultural activities are livestock and soil management practices. Livestock is

responsible for the majority of methane emissions, while soil management practices such as tillage and fertilizer application are responsible for nitrous oxide emissions. Agriculture also contributes to deforestation, which releases carbon dioxide into the atmosphere.

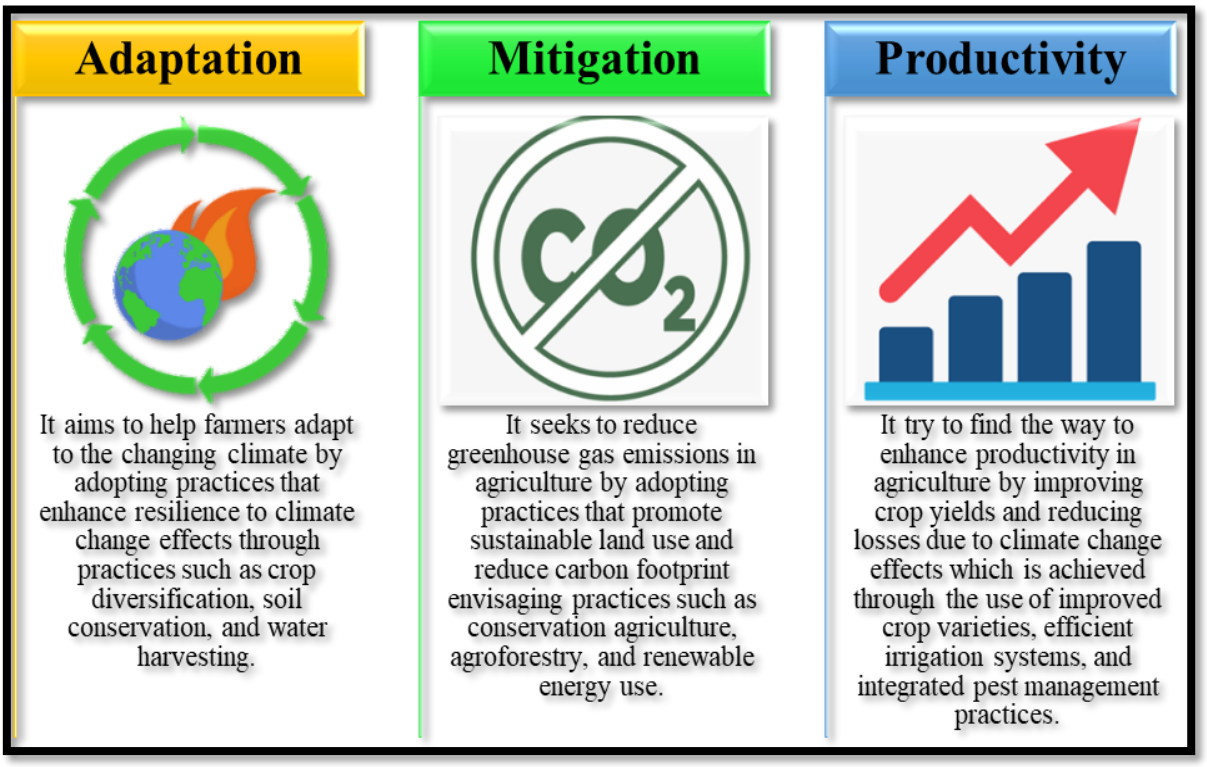

Figure 1. Three pillars of climate smart agronomy

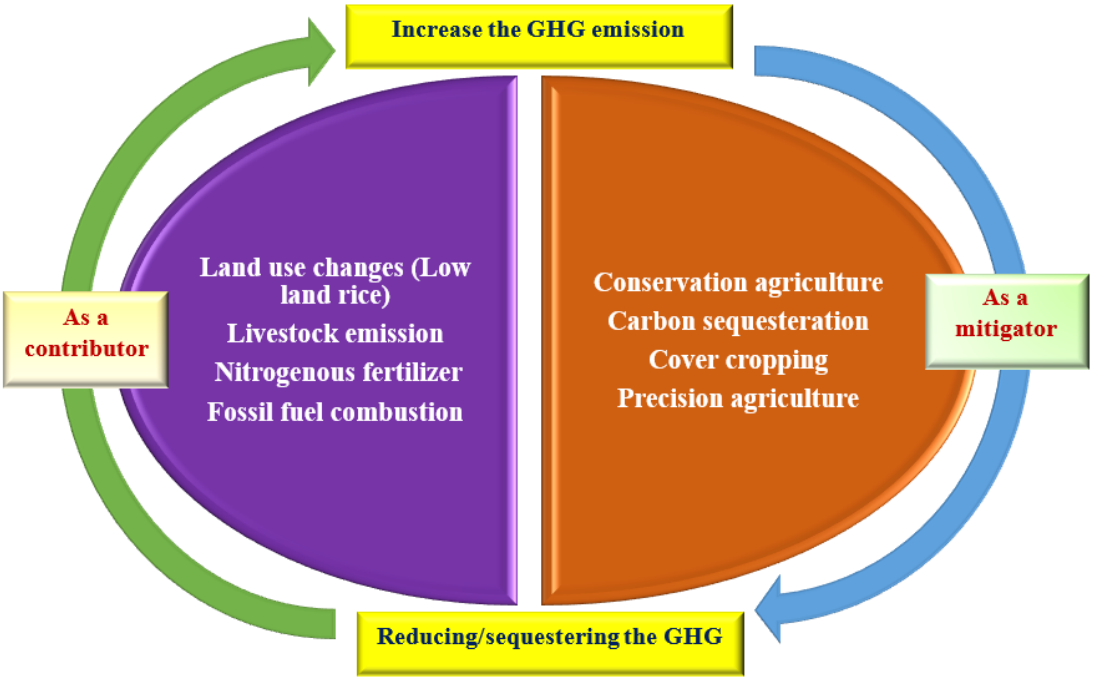

Figure 2. Agronomic practices as a contributor and mitigator to climate change

Agronomy practices can help mitigate climate change by reducing emissions and sequestering carbon in the soil. Conservation tillage, for example, reduces soil disturbance, increases soil organic matter, and sequesters carbon in the soil. Cover crops also increase soil organic matter and fix atmospheric nitrogen in the soil, reducing the need for synthetic fertilizers and reducing GHG emissions. Nutrient management practices, such as using organic fertilizers and precision farming techniques, can also reduce GHG emissions by reducing fertilizer use and improving fertilizer efficiency (Padhan et al., 2021b). Crop rotation can also reduce GHG emissions by improving soil health and reducing the need for synthetic fertilizers and pesticides. Agroforestry, the integration of trees into agricultural systems, can sequester carbon in the soil and reduce soil erosion. Integrated pest management, using a combination of cultural, biological, and chemical methods to manage pests and diseases, can reduce the need for synthetic pesticides and improve soil health. Precision agriculture, using technology such as GPS and sensors to optimize inputs (Shyam et al., 2021), can reduce waste and improve efficiency, resulting in reduced GHG emissions. Therefore, agronomic practices are the contributor as well as mitigator of climate change.

Conclusion

Agronomic practises are essential for reducing the impact of climate change on agriculture. By enhancing soil carbon sequestration, lowering nitrous oxide emissions, and lowering methane emissions from livestock production, greenhouse gas emissions from agriculture can be lowered. Due to a lack of resources and knowledge, smallholder farmers may have trouble implementing sustainable agronomy practises. Governments, extension agencies, and other stakeholders can offer assistance, money, and support to farmers so they can successfully implement these practises. Stakeholders can create a more sustainable and resilient agriculture sector that can address the challenges of climate change while ensuring food security and enhancing livelihoods by giving priority to climate wise agronomy practises.

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