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Carbon Emissions in Agriculture: Challenges and Sustainable Solutions

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Abstract

Agriculture is a major source of greenhouse gas emissions, contributing significantly to climate change. Key gases emitted from agricultural activities include carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). These emissions result from multiple farming operations such as soil tillage, excessive use of chemical fertilizers, burning of crop residues, livestock management, and energy use in irrigation and machinery. Soil tillage exposes organic carbon to the atmosphere, releasing CO₂. The application of nitrogen-rich chemical fertilizers leads to N₂O emissions, a gas with high global warming potential. Livestock, particularly ruminants like cows, emit methane during digestion, and improper manure handling further contributes to CH₄ and N₂O emissions. Additionally, residue burning and diesel-powered farm equipment release large amounts of CO₂ and other pollutants. These emissions not only accelerate global warming but also negatively affect agricultural productivity. Changing weather patterns, increased frequency of droughts and floods, and reduced soil and water quality are direct consequences of agricultural emissions. To address these issues, sustainable farming practices must be adopted. These include reduced or zero tillage, organic manure use, composting of crop residues, adoption of renewable energy, efficient irrigation methods like drip and sprinkler systems, and improved livestock feed and manure management. By reducing its carbon footprint, agriculture can transition into a more sustainable and climate resilient system. Encouraging eco-friendly practices through policy, education, and innovation is essential for protecting both the environment and agricultural livelihoods.

Keywords: Carbon emissions, greenhouse gas, climate change, global warming.

Introduction

Carbon emissions from agriculture are a significant issue; however, with the right measures, they can certainly be reduced. For this, farmers need to adopt sustainable farming practices such as organic farming, reduced tillage, and proper fertilizer management.

Global warming has become a serious issue today. Carbon emissions resulting from human activities are one of its main causes. Agriculture is a vital part of our lives, but it also contributes significantly to carbon emissions. Various agricultural practices such as soil tillage, use of chemical fertilizers, and livestock management release large amounts of greenhouse gases. These gases accumulate in the atmosphere and create numerous environmental problems. Therefore, reducing carbon emissions from agriculture and adopting environmentally friendly farming practices is essential.

Carbon Emissions in Agriculture

Carbon emissions in agriculture refer to the release of greenhouse gases into the atmosphere as a result of various farming activities. These mainly include carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). These gases increase atmospheric heat and contribute to global warming.

Activities Responsible for Agricultural Carbon Emissions

1. Soil Tillage

- Ploughing, digging, and other forms of tillage expose the carbon stored in the soil to the air.
- This organic carbon converts into carbon dioxide upon contact with air.
- Traditional tillage practices disturb the soil more, resulting in higher carbon emissions.

2. Use of Chemical Fertilizers

- Chemical fertilizers contain nitrogen. Excessive use releases nitrous oxide, a potent greenhouse gas.
- Nitrous oxide is much more harmful than carbon dioxide in terms of heat-trapping capacity.
- Unbalanced fertilizer use and poor management increase nitrous oxide emissions.

3. Crop Residue and Waste Management

- Burning of crop residues (grass, straw, husks) emits CO₂, methane, and other harmful gases.
- These contribute to air pollution and reduce soil fertility.
- When residues are not left to decompose in the soil, the carbon in them does not get sequestered.

4. Livestock Management

- Ruminant animals like cows and buffaloes release methane during digestion.
- Methane is more heat-intensive than carbon dioxide.
- Improper livestock management increases methane emissions.
- Poor manure handling also emits methane and nitrous oxide.

5. Irrigation Practices

- a) Use of energy sources like diesel pumps for irrigation contributes to carbon emissions.
- b) Improper irrigation can lead to soil carbon being leached out into the water.

6. Land Use Change

- Converting forests to farmland releases stored carbon into the atmosphere.
- Using wetlands for farming releases methane gas.
- Agricultural machinery like tractors also emit carbon dioxide.

Impacts of Carbon Emissions from Agriculture

1. Climate Change

- Agricultural carbon emissions contribute to global warming.
- Rising temperatures change rainfall patterns, some regions face floods while others suffer droughts.
- This unpredictability affects crop production and makes farming more difficult.

2. Effects on Crops

- High temperatures and CO₂ levels stunt the growth of some crops and reduce their nutrient content.
- For example, wheat yields may decline, and protein content in grains may reduce.
- Irregular rainfall increases pest and disease outbreaks, further reducing yields.

3. Soil Degradation

- Higher emissions degrade soil quality.
- Organic matter decreases, reducing water retention capacity.
- Excessive fertilizer use and frequent tillage reduce fertility and may lead to soil salinity, making the land unfit for crops.

4. Impact on Water

- Climate change reduces water availability.
- Heavy rainfall causes floods, damaging crops; elsewhere, water scarcity leads to droughts.
- Irregular water supply affects irrigation schedules and crop health.

5. Effects on Agricultural Productivity and Income

- Emissions reduce farm productivity and farmer income.
- Crop loss due to weather extremes causes financial stress for farmers.
- Reduced yields threaten food security.

Planning for Reducing Carbon Emissions in Agriculture

Reducing carbon emissions and promoting eco-friendly agriculture is critical. This requires implementing specific sustainable practices.

Soil Management

1. **Zero or Reduced Tillage:** Minimizing or avoiding tillage reduces soil carbon loss. It enhances fertility, improves water retention, and reduces erosion.



(Source: <https://morungexpress.com>)

Fig 1: Zero tillage: A Resource Conserving Technology

1. **Use of Organic Matter:** Applying manure, compost, and other organic fertilizers increases soil carbon content and reduces dependency on chemical fertilizers.
2. **Cover Crops:** Growing cover crops after main crops keeps the soil covered year-round, reducing erosion and carbon emissions.

A. Fertilizer Management

1. **Proper Use of Chemical Fertilizers:** Apply fertilizers in appropriate quantities based on soil testing to reduce nitrous oxide emissions and increase efficiency.
2. **Use of Bio-fertilizers:** Bio-fertilizers help reduce the need for chemical fertilizers and are less harmful to the environment.

B. Crop Residue Management

1. **Incorporating Crop Residue into Soil:** Instead of burning, mixing residues into the soil promotes decomposition and increases soil carbon.
2. **Composting:** Creating compost from crop residues improves soil quality and reduces atmospheric carbon emissions.

C. Irrigation Management

Efficient Water Use: Techniques like drip and sprinkler irrigation save water and reduce energy use, thereby lowering emissions.

D. Energy Use

Renewable Energy: Using solar or wind energy in agriculture reduces fossil fuel dependency and carbon emissions.

