

# Climate Resilience in Agriculture through Soil Management Practices

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## Introduction

Climate change in today's world due to human activities results in high temperature, uneven rainfall etc that not only affects human health but also soil health and hence crop growth. Extreme unfavorable conditions such as increase in global atmospheric temperature, unpredictable onset of wet and dry season and excessive or substantial decrease in rainfall results in unpredictable crop production impacting food security and livelihood worldwide.

Though climate change being a major issue in agriculture it can be mitigated through various soil management practices singly or combination of two or more approaches. There are various soil management approaches that can be adapted to alleviate negative effect of climate change. Several soil management approaches include mulching, conservation tillage, vegetative and

engineering soil conservation, nutrient management, soil amelioration and soil biological management. Improving soil management is one of the most effective ways to mitigate climate change, as healthy soils help crops withstand unfavorable climatic conditions while sustaining productivity. Organic matter management is main or can be a central approach as it helps in improving water holding capacity, increasing soil infiltration capacity and percolation, buffering soil temperature, improving soil fertility and soil microbial health. Soil management and organic matter management approaches are being known to all but often ignored. Therefore, giving importance and adapting these approaches can help alleviating negative effect of climate change.



### Role of soil in climate resilience

Soil act as an important component in climate change mitigation as it is a living system that regulates water, nutrients, and carbon.

Well managed soil:

- Increase soil infiltration capacity and improve water holding capacity.

- Support crops to withstand severe climatic conditions.
- Reduce nutrient loss and erosion.
- Maintains biological health.
- Act as a carbon sink and mitigate climate change.

### Impact of climate change on soil health

climate change affects various soil properties related to organic matter, soil water and soil erosion. Elements of climate change that affects soil health are:

- Elevated temperature
- Increased soil temperature results in increased microbial activities which in turn accelerates organic matter decomposition reducing fertility.

- Increased microbial activities lead to increased carbon emissions.
- Soil moisture loss through evaporation increases.
- Unpredictable rainfall patterns
- Unpredictable rainfall patterns result in uncertainty in soil moisture availability and hence uncertainty of planting date.

### Heavy rainfall or floods

- Results in soil erosion and nutrient leaching.
- Top fertile layer being washed away with water.

### Low rainfall or drought

- Impact the microbial activity in the soil.
- Lead to soil dryness, cracking and compaction because of high evapo-transpiration.

This results in poor soil structure and low crop yields.

### Increased soil erosion

- Increases soil erosion by removing topsoil through strong winds and heavy rainfall.
- Loss of essential nutrients and humus.

### Altered nutrient cycle

- Affects the carbon, nitrogen and hydrologic cycles.
- Increases breakdown of soil organic carbon.
- Due to increased emission of greenhouse gases like CO<sub>2</sub> and N<sub>2</sub>O from the soil hence soil shifts from carbon sink to carbon source.

### Acidification and Salinization

- Irregular rainfall alters soil ph.
- Salt intrusion increases in coastal areas due to increase in sea level rise.

### Climate resilient approaches through soil management

#### 1. Conservation tillage

- Conservation tillage or minimum tillage can be done to reduce soil disturbances as excessive tillage breaks the soil aggregates into smaller ones which are more prone to erosion.
- Crop residue on surface protects the soil surface from erosion.
- This approach improves resilience to drought and heat stress.

#### 2. Efficient water management

- Mulching can be used to restore the soil moisture.

- Irrigation management which have high efficiency can be used (drip, sprinkler).
- Excess water can be collected incase of heavy rainfall to avoid floods and redistribute it in dry season to reduce drought conditions.

#### 3. Soil carbon sequestration

- Soils which are healthy acts a s carbon sink.
- Various practices like soil amelioration, agroforestry and conservation tillage store atmospheric carbon, helps mitigating climate change.

#### 4. Soil biodiversity conservation

- Addition of organic fertilizers and biofertilizers encourages the growth of soil fauna.
- The conservation of soil biology is done by improving soil conditions which in turn helps in increasing access of plants to nutrients, organic matter decompositions etc.

### 5. Nutrient management

Nutrient management means managing soil and plant nutrients in ways that help crops withstand climate change. Good soil nutrient management helps farms stay productive, stable, and sustainable under changing climate conditions.

#### For good nutrient management

- Use slow release, controlled-release and nano technology-based fertilizers. They improve

nutrient use efficiency (NUE) by releasing nutrients in synchronization with plant growth stages.

- Use satellite images and drones to access crop health and identify nutrient deficiencies.
- Use bioformulations for improving nutrient availability in the rhizosphere.
- AI and machine learning models analyze field data to predict optimal application times and rates, enhancing decision making.

### 6. Addition of organic matter

Addition of organic matter in the soil in the form of FYM, compost, crop residues and green manures improve soil structure, fertility, nutrient availability, soil moisture retention and increases soil microbial activity and soil carbon stock.

### Conclusion

Climate change affects the agricultural production due to unfavorable climatic conditions that results due to climate change. Therefore, there are many climate resilience approaches which can be adapted to mitigate the negative effect of climate change and boost up the agricultural production. These approaches

should be adapted and as small or marginal farmers with poor resources are more vulnerable to climate change because of limited resources to implement the climate resilience approaches. Therefore, they should be made avail to the resources and technologies to withstand climate change through government and civil society.

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