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## ENHANCING SOIL FERTILITY: THE ROLE OF GREEN MANURE CROPS IN SUSTAINABLE AGRICULTURE

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### Abstract

Frequent soil cultivation and continuous cropping lead to the disintegration of soil aggregates and the loss of organic matter, which lowers soil productivity and fertility. A cheap and effective way to keep soil fertility high and inorganic fertiliser costs down is through green manuring. Many farmers are incorporating green manuring into their practices to prevent soil erosion, improve soil structure, control weed growth, and most importantly, increase the fertility of the soil. This is due to the growing problems facing agriculture, which include climate change, extreme weather events, soil deterioration, and land contamination as a result of the overuse of chemical fertilisers. Because of the sharp decline in the usage of green manure, questions have been raised regarding the long-term viability of soil fertility. Because of the sharp decline in the usage of green manure, questions have been raised regarding the long-term viability of soil fertility. After the addition of organic residues with a high C-N ratio, field crops may suffer a brief setback. Green manuring works as a restoration factory to preserve the soil's fertility for sustainable agriculture by improving the soil's structure, fertility, and nutrient content. Therefore, gardeners that aim to reduce the use of hazardous chemicals for soil fertilisation must utilise green manure. To avoid using artificial fertilisers in their farming operations, many farmers are forced to employ green manure.

**Keywords:** Soil Fertility, Green Manure, Sustainable Agriculture, fertilizers and soil structure

### Introduction

For farmers, green manuring is an important practice since it provides a sustainable and efficient means of enhancing soil fertility. It can improve the amount of organic matter, soil nutrients, and weed control. Long-term agricultural sustainability, fewer negative effects on the environment, and stronger crops are the results of this. After incorporating organic residues with a high C-N ratio, field crops may face a brief setback. Green manuring works as a restoration factory to preserve the soil's fertility for sustainable agriculture by improving the soil's structure, fertility, and nutrient content. Green manuring works as a restoration factory to preserve the soil's fertility for sustainable agriculture by improving the soil's structure, fertility, and nutrient content. Therefore, gardeners that want to reduce the amount of hazardous chemicals they use to fertilise their soil must employ green manure. Green manuring is becoming a common practice among farmers. This is done in order to improve soil structure, reduce soil erosion, inhibit the growth of weeds, and—most importantly—increase soil fertility. The basis of sustainable agriculture is soil fertility, which affects crop quality, productivity, and resistance to pests and diseases. The demand for sustainable agricultural practices has increased because conventional farming operations frequently result in soil degradation. Including green manure crops in your agricultural rotation is one smart move. These crops are crucial for sustainable farming methods because they improve soil fertility and support ecological equilibrium.



Green manuring is one aspect of organic gardening. "Green manuring" refers to the technique of tilling beneath or incorporating any green manure crops into the soil either before or soon after they begin to flower. "The value of green manuring lies in the incorporation of organic matter into the soil". Growing cover crops is primarily done to enrich the soil with nutrients and organic matter which is one of the most crucial elements of the soil for actual soil fertility. Plants cultivated especially to be ploughed back into the soil to increase its fertility are known as green manure crops. Usually, they are planted in between major agricultural cycles or during times of fallow land. Legumes like peas, vetch, and clover are common species of green manure; non-leguminous plants like rye and buckwheat are also common. These crops improve biodiversity, control weeds, and stop erosion by covering the soil. A green manure crop that is 40–50 days old is estimated to be able to supply 80–100 kg N/ha. Even if crops only use half of the nitrogen in the fertiliser, a crop of green manure can replace 50–60 kg of nitrogen per hectare. Potential legumes for green manuring include dhanicha, sunhemp, cowpea, mung, bean, guar, and berseem, among others. Dhanicha, sunhemp, mungbean, and guar cultivated in the kharif season have been demonstrated to contribute 8–21 tonnes of green matter and 42–

95 kg of nitrogen per hectare when grown as green manure crops.



### Mechanisms of Soil Fertility Enhancement

- 1. Nitrogen Fixation** Leguminous green manure crops have the unique ability to fix atmospheric nitrogen through a symbiotic relationship with Rhizobium bacteria. When these crops are incorporated into the soil, they release nitrogen, a vital nutrient for plant growth. This process not only reduces the need for synthetic fertilizers but also improves the overall nitrogen content of the soil.
- 2. Soil Structure Improvement** The organic matter from decaying green manure crops enhances soil structure. Increased organic matter leads to better aggregation of soil particles, improving aeration and water retention. This results in a healthier root environment, promoting robust plant growth.
- 3. Disease and Pest Suppression** Certain green manure crops can help suppress soil-borne diseases and pests. For instance, planting mustard can reduce nematode populations in the soil. By disrupting the life cycles of harmful organisms, green manure crops contribute to a healthier soil ecosystem.
- 4. Weed Suppression** Green manure crops effectively outcompete weeds for resources like sunlight, water, and nutrients. Their dense foliage can shade the soil, reducing the germination and growth of unwanted plants. This natural weed control reduces the need for herbicides, promoting a more



sustainable approach to weed management.

5. **Carbon Sequestration** The incorporation of green manure crops into the soil increases organic carbon levels, contributing to carbon sequestration. This process not only mitigates climate change but also improves soil health, making it more resilient to environmental stresses.

#### **Benefits of Green Manure Crops in Sustainable Agriculture:**

A key component of sustainable agriculture is substituting natural fertilisers with green manure. One aspect of organic farming is the use of sustainable production techniques, which help to restore the natural balance that has been upset by inappropriate farming practices. There are numerous advantages for both the ecology and the economy when applying green manure on agricultural land. A new agricultural strategy that uses techniques like green manure is required for sustainable growth. It was discovered that green manure methods offered farmers a number of advantages, including higher yields, nitrogen fixation, carbon sequestration, enhanced SOC content, biodiversity preservation, etc. Due to high ecosystem service values and poor farmer economic returns, a unique approach to sustainable farming called ecological compensation may gain widespread traction. Benefits of Green Manure Crops given below.

1. **Soil Fertility Improvement:** Green manures enhance soil fertility by adding organic matter and nutrients, particularly nitrogen, when legumes are used.
2. **Soil Structure Enhancement:** The root systems of green manure crops help improve soil structure, promoting aeration and water infiltration.
3. **Erosion Control:** Covering the soil with green manure prevents erosion by wind and water, protecting topsoil and maintaining land integrity.
4. **Weed Suppression:** Green manures can out compete weeds for light,

nutrients, and space, reducing the need for chemical herbicides.

5. **Pest and Disease Management:** Certain green manure crops can break pest and disease cycles, promoting healthier soil ecosystems.
6. **Nutrient Cycling:** Green manures help cycle nutrients back into the soil, making them available for subsequent crops.
7. **Carbon Sequestration:** By incorporating organic matter into the soil, green manures contribute to carbon storage, mitigating climate change.
8. **Biodiversity Promotion:** Planting diverse green manure species fosters biodiversity, enhancing ecosystem resilience.
9. **Water Retention:** The organic matter from green manures improves the soil's water retention capacity, benefiting crops during dry periods.
10. **Cost-Effective Soil Management:** Utilizing green manures can reduce costs associated with chemical fertilizers and soil amendments, promoting economic sustainability.

#### **Implementation in Sustainable Agriculture**

Implementing green manure crops in farming systems requires careful planning and management. Here are some key considerations:

- **Crop Selection:** Choose species suited to the local climate and soil conditions. Legumes are ideal for nitrogen fixation, while non-leguminous crops can provide bulk organic matter.
- **Timing:** Plant green manure crops at the right time to maximize their benefits. For instance, sowing after the main crop harvest ensures continuous soil cover.
- **Incorporation Methods:** Properly incorporate the green manure into the soil. Techniques vary from plowing to using no-till methods, which can help retain soil structure and moisture.
- **Crop Rotation:** Incorporating green manure crops in a rotation scheme can

enhance biodiversity and break pest cycles, further improving soil health.

### Case Studies and Success Stories

Numerous farmers worldwide have successfully integrated green manure crops into their agricultural practices:

- **Brazilian Soybean Farmers:** In Brazil, soybean farmers have reported increased yields and reduced fertilizer costs by planting brachiaria grass as a green manure crop before sowing soybeans. The grass not only improved soil fertility but also enhanced water retention.
- **European Organic Farmers:** Organic farmers in Europe frequently use green manures such as field beans and clover to improve soil health and maintain organic certification. These practices have led to increased crop diversity and resilience against climate extremes.

### Conclusion:

Green manures are a conservation approach that can help produce agriculture in a more sustainable way. One of the worst examples of land degradation caused by humans is the considerable loss of soil fertility brought about by incorrect agronomic practices. Numerous factors, including crop productivity, soil nutrient content, volume of agricultural production, and environmental effects, are impacted by the usage of fertilisers. Green manures have the potential to be highly significant since they can raise the fertility and physical, chemical, and biological qualities of the soil. In addition to improving soil quality, green manuring fixes atmospheric nitrogen in the soil. In terms of weed, disease, and pest insect control, green manuring is also safe. To sum up, it can be said that green manuring might be one. Crops grown with green manure are essential for improving soil fertility and encouraging environmentally friendly farming methods. These crops provide a multimodal approach to soil health by enhancing nutrient availability, soil structure, and pest resistance. The future of sustainable agriculture depends on the

incorporation of green manure crops into farming systems, as the industry confronts obstacles from resource depletion and climate change. A more sustainable food system, healthier soils, and more fruitful crops can result from adopting these natural remedies.