

## Green Manuring: Myth or Reality

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### Abstract

A green manure crop is used primarily as a soil amendment and a nutrient source for subsequent crops. The positive role of green manuring in crop production has been known since ancient time. Organic matter is the life of the soil because it contains all the essential elements required for plant growth. Well-stored farmyard manure is most important of all organic manures, but it is not available in sufficient quantity. Moreover, soil degradation is the principal cause of a continuous decrease in crop production at present. Importance of this soil ameliorating practice is increasing in recent years because of high cost of chemical fertilizers, increased risk of environmental pollution, and need of sustainable cropping systems. Green manuring can improve soil physical, chemical and biological properties and consequently crop yields. It also serves as food for soil microbiota. The objective of this article is to review recent advances in green manuring practice, in the context of potential benefits and drawbacks in use of this practice for annual crop production and sustain soil health.

### Keywords

Green manuring; Organic matter; Crop production; Soil health

### Introduction

Soil degradation is the principal cause of a continuous decrease in crop production. The consequences of this are reduced economic income and increased poverty among rural families. One of the principal reasons for this fact is the

continuous utilization of inadequate methods of soil management, including the burning of crop residues, excessive tillage, monoculture and negligible use of manures. Production of sufficient quantity and quality food grains for ever fast growing population of the country without further deterioration of the soil quality and productivity is a one of the major challenges in the present agriculture scenario. The imbalance use of fertilizers and less or negligible use of organic manure and green manure crops is deteriorating the physical, chemical and biological properties of the soil. To get maximum crop production fertilizer must be needed but the rising prices and shortage of chemical fertilizer is another problem. Moreover, farmyard manure and compost are not available in sufficient quantities to the farmers to meet their full requirements. Therefore, to overcome these problems green manure crops may play an important role for maintaining soil health for longer period. An ecological and economical profitable method to increase soil fertility is the cultivation of green manure crops specially legumes, and their subsequent incorporation as green manure into the soil. Green manuring is the process of turning of green plants into the soil either by raising them in same field or plants grown elsewhere at the green stage before flowering, at blooming and incorporated into the soil. Nitrogen binding by leguminous crops reaches its peak in the period of blooming, and starts decreasing in the period of seed formation [1]. The value of green manure was recognized by farmers in India for thousands of years, as mentioned in treatises like Vrikshayurveda. Sunnhemp (*Crotalaria juncea* L.), dhaincha (*Sesbania aculeata* L.), berseem

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(*Trifoliumalexandrinum*) and mungbean (*Vignaradiata*) are most commonly grown as green manure crops (Fig. 1).

There are number of evidences that leguminous crops like cowpea, mungbean, urdbean, pigeonpea, chickpea, lentil, field pea, lathyrus, rajmash, groundnut, soybean, woody legume (eg. *Leucaena*, *Gliricida*, *Pongomia* and *Delonix*), dhaincha (*Sesbania sp.*) and sunnhemp (*Crotalaria sp.*) have ability to fix the atmospheric nitrogen in their root nodules. To get maximum benefits green manure crop should be incorporated into soil at proper age of crop. (Fig. 2).

It should be turned into soil at flowering stage, most of the green crop attained this stage in about 7-8 weeks after sowing. Dhaincha attain maximum growth after 8 weeks of sowing, while sunhemp crop flower around 8-10 weeks after sowing. However, with increase in soil problems due to non-judicious use of agrochemicals, increased fertilizer costs and the public concern for pollution and conservation of energy, green manures is getting importance both to researchers and low input farmers in particular.



Fig. 1: Some suitable green manure crops



Fig. 2: Right stage of green manure crop incorporation in the field

### Criterion of Selection of Green Manure Crops

An ideal green manure crop should possess the following desired characteristics:

- It should contain large quantities of non-fibrous tissues of rapid decomposability containing fair percent of moisture and nutrients.
- It should be a legume with good nodular growth habit indicative of rapid nitrogen fixation under even unfavourable soil conditions.
- It should have little water requirements for its own growth and should be capable of making a good stand on poor and exhausted soils.
- It should have a deep root system, which can be open the sub-soil and tap lower regions for plant nutrients.
- The plant should be of a leafy habit capable of producing heavy tender growth early in its life cycle.

### Advantages of Green Manuring

The green manure crops provide multifold advantages which can broadly be grouped as greater soil fertility. Legumes and other nitrogen fixing plants which take nitrogen from the atmosphere to the soil are particularly beneficial. The physico-chemical properties of soils are affected significantly due to addition of organic matter in the form of green manures. The main benefits of green manures are: increase in soil organic matter, soil structure, texture, infiltration rate, water holding capacity, decreased evapotranspiration, bulk density and erosion produced by plant residue, nutrient cycling and disruption of compacted soil layers [2-5]. The general advantages of green manuring are presented in Figure 3. Other important benefits are the increased microbial activity, decreased incidence of pests and diseases and suppression of weed plants [6].

1. *Improving Soil Structure:* Green manure crops add organic matter into the soil, which significantly improve soil structure, letting more air into the soil and improving drainage. Organic matter binds soil particles together and creates soil aggregates. These clusters of larger particles enable formation of pores, which allows for proper soil aeration, water retention and nutrient distribution.
2. *Compaction:* Green manure crops, when decomposed, increase organic matter which increases microbial activity and aggregation of

soil particles. This increases soil porosity and reduces bulk density.

3. *Prevention of Soil Erosion:* Since the climate of arid region is predominantly warm and hot, one of the principal benefits of green manure/cover crops is the improvement of soil cover (live or dead). This has favourable effects on the physico-chemical and biological properties of soil. Conventional systems of arid and semi-arid regions, in which bare soils predominate, the direct impact of raindrops breaks soil aggregates in the surface layer, resulting in the obstruction of the soil's pores. This causes the sealing of the soil surface and impedes the infiltration of water, which then runs off the surface, carrying with it part of the soil and cause erosion. The principal effect of green manure crops is to reduce erosion, either by preventing the direct strike of raindrops on soil and/or by reducing the velocity of surface runoff. Hence, green manures help soil from the erosion [7]. The importance of green manuring are as follows:
  4. *Soil Aggregation at the Surface:* Aggregate stability increases with the addition of green manure crops and the decomposition of organic material by microorganisms.
  5. *Nutrient Loss or Imbalance:* Decomposition of increased biomass of green manure crops provides a slow release of nutrients to the root zone.
  6. *Microbiota Activity:* Green manure crops increase the available food supply for microorganisms resulting in increased microbiota activity. It provides nutrients rich in organic carbon for the microbial biomass which converts unavailable nutrients in plant residues to ones available for the crops. It also enhances biodiversity of soil microorganisms.
  7. *Suppression of Weeds:* One of the major benefits of green manures is their ability to suppress weeds [8-10]. Some green manures also secrete specific chemicals into the soil (during crop growth and after incorporation) that inhibit weed seed germination. This 'allelopathic effect' is demonstrated by many clovers but also non legumes including rye. Green manures cover the ground well and stop weeds growing beneath them, by competing for nutrients, space and light [11].
  8. *Habitat for Natural Predators and Pollinators:* Green manure crops often serve as a winter home for beneficial predatory insects, including ground and rove beetles. Both beetle species are known for being skilled hunters of various pests and caterpillars (<https://goo.gl/CvhFnn>).

9. *Reduce Soil-Borne Diseases:* The management of soil borne plant pathogens is particularly complex because these organisms live in or near the dynamic environment of the rhizosphere and can frequently survive long periods in soil through the formation of resistant survival structures [11]. Soil-borne plant diseases are caused by numerous pathogens, which live in the soil and affect plant health by infection of the below-ground organs (roots, rhizomes, tubers) or in some cases above ground organs (stem bases, plant crowns or the vascular system). One use of green manures crops for control of soil-borne diseases is their role as a non-host crop as part of a crop rotation strategy. The amounts of readily useable carbon in the form of organic amendments (fresh or dried plant material) added to the soil stimulates the general soil microbial activity [12-13]. Such increases in soil microbial activity can sometimes be correlated with a decrease in the number of soil-borne pathogens e.g., *Verticilliumdahliae* [13].
10. *Improve Soil Organic Carbon:* Incorporation of green manure crop increases the soil organic carbon for long term basis. Soil organic matter content increased due to green manure incorporation [14]. There was considerable build-up of soil organic carbon content due to the addition of organic N sources especially green manures [15]. *Sesbaniaaculeata* application recorded higher availability of soil organic carbon [16]. Addition of green foliage of *Glyricidia* increased organic soil carbon [17]. Organic carbon and total nitrogen contents are good for soil fertility and productivity, influencing soil physical, chemical and biological properties [18]. The green manure used in the plant cover provides numerous beneficial effects in soil and in chemical, physical and biological attributes of soils [19-22].
11. *Increase Crop Productivity and Decrease Production Costs:* The positive role of green manuring in crop production has been known since ancient time. Importance of this soil ameliorating practice is increasing in recent years because of high cost of chemical fertilizers, increased risk of environmental pollution, and need of sustainable cropping systems. Green manuring can improve soil physical, chemical, and biological properties and consequently crop yields. Numerous experiments of effect of green manuring on crop productivity were conducted over worldwide and found the positive result. Inclusion of leguminous green manure in the rice-wheat cropping system enhanced and sustained rice production in the wet season [23]. Many studies have shown that the use of green manure crop can increase the yield of a subsequent crop and reduce the requirements for inorganic fertilizer [24-25]. Green manuring technology is gaining importance due to increasing emphasis on soil health, minimize environmental pollution and cut down the use of chemical in agriculture [26]. At Navsari (Gujarat), incorporation of either of the three green manure crops *Sesbaniaorostrata*, *Sesbania aculeate* or *Crotolariajuncea* was comparable with that of 100 kg nitrogen/ha for grain yield of 5 ton /ha during summer [27]. Green leaf manuring with gliciridia, ipomea or pongamia considerably reduced fertilizer needs of summer rice at Bhubaneshwar [28]. In another study it was found that addition of green manure in combination with chemical fertilizers produced a higher yield as compared to single application of chemical fertilizer alone [29]. An experiment on the effects of green manuring with dhaincha and sunnhemp in combination with different dosages of nitrogen on the productivity of subsequent sugarcane crop and found that the green manures and the supplemented urea increased cane yield upto 57% along with the significant increase in organic matter, total N, available P and S of the soil [30]. Similarly, many researchers reported that maximum dry matter production and yield of different crops were recorded by incorporation of green manure crop along with fertilizer [31-32].
12. *Enhance Nutrient Availability, uptake and Nutrient Cycling:* Microorganisms play an important role in cycling of mineral nutrient from plants tissue bulk to plant tissue *via* herbivore, carnivore and saprophagous food chain. The organic matter introduced into soil with green manuring improves soil humus status and increases soil organic carbon and total nitrogen contents. The biomass produced by green manures positively influences the chemical characteristics of the soil, enabling increase in organic matter over the years, which increases the cation exchange capacity and therefore, the retention of nutrients in the soil particles [33]. *Sesbania* green manure incorporation in rice increases the N, P and K uptake by rice and succeeding wheat crop over control [34]. Similarly, green manuring increases the organic carbon, available N, P and K status of soil in highly sodic soils [35]. Green manure legumes even with a short growth period of 45-60 days can fix 80-100 kg N/ha of which the major portion (about 80%) is derived from biological nitrogen fixation. Therefore, biomass from legume green manure crops can add a huge

amount of nitrogen and carbon to the soil, which improves soil humus characteristics. Legumes can absorb nutrients from lower soil layers, with their well developed and deep root systems and return the nutrients to upper soil layers with their biomass. The relocation of plant nutrients (especially P and K) is particularly useful in organic farming [36-37]. Similarly, [38] conducted an experiment on integrated effect of mineral fertilizers and green manure on crop yield and nutrient availability under Rice-Wheat cropping

system and found that green manuring and green gram residue incorporation enhanced the uptake of N, P and K by rice and wheat, and build up of organic carbon, available N, P and K in soil under graded levels of fertilizers and also with green manure and green gram crop incorporation after the picking of pods.

**Disadvantages of Green Manuring**

Some disadvantages are also associated with green manuring. They are mentioned as under as suggested [26]:



Fig. 3: General advantages of green manuring in biosphere

- Under rainfed conditions, proper decomposition of the green plant material and satisfactory germination of the succeeding crop may not take place if sufficient soil moisture is not available.
- A satisfactory stand and growth of the green manure crops cannot be produced, if sufficient rainfall is not available.
- The practice of green manuring may be uneconomical, especially in the regions where irrigation facilities are available along with easy availability of fertilizers. As it is more economical to add the quantity of N in the form of fertilizer which the crop is expected to fix from the atmosphere.
- Green manure crops may also harbor some of the insects, pests and nematodes which could harm the succeeding crop.

### Conclusion

Green manuring is an inexpensive, eco-friendly alternative to cut down the use of chemical in agriculture and has become an effective technology in economizing the agricultural production system ensuring productive capacity of soil without causing environmental problem in reality. Application of green manure crops supplements the chemical fertilizers and restores soil fertility. Therefore, green manuring is an eco-friendly low cost technology to conserve the natural resources besides maintaining environmental quality in a sustainable manner.

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