

Green manuring for optimal yield

and soil health management under changing climate

**Mohammad Hasanain^{1*}, Sandeep Kumar², Gaurav Verma³, Vijay Singh Meena¹,
Sunita Kumari Meena⁴ and Vinod Kumar Singh⁵**

¹ICAR-Indian Agricultural Research Institute, Regional Station, Pusa 848 125, Samastipur, Bihar

²ICAR-National Bureau of Soil Survey and Land Use Planning, Regional Center, Jorhat 785 004, Assam

³Chaudhary Charan Singh Haryana Agricultural University, Hisar 125 004, Haryana

⁴Dr Rajendra Prasad Central Agricultural University, Pusa 848 125, Bihar

⁵ICAR-Central Research Institute for Dryland Agriculture, Hyderabad 500 059, Telangana

Amid concerns for soil health and fertility due to intensive agriculture and improper fertilization practices, green manuring emerges as a promising solution. By incorporating green plant material, it enriches soil with organic matter and nutrients, addressing erosion and nutrient depletion. Green manure crops suppress weeds, reduce herbicide use, and aid pest management without synthetic pesticides. Enhancing nutrient cycling, it sustains soil fertility, reducing reliance on synthetic fertilizers and offering cost savings. Crucially, it bolsters agricultural resilience to climate change, buffering against extreme weather. Green manuring presents a sustainable, cost-effective approach, balancing high yields with soil and environmental health, essential for resilient, eco-conscious farming and long-term global food security.

Keywords: Climate change, Green manuring, Optimal yield, Soil health

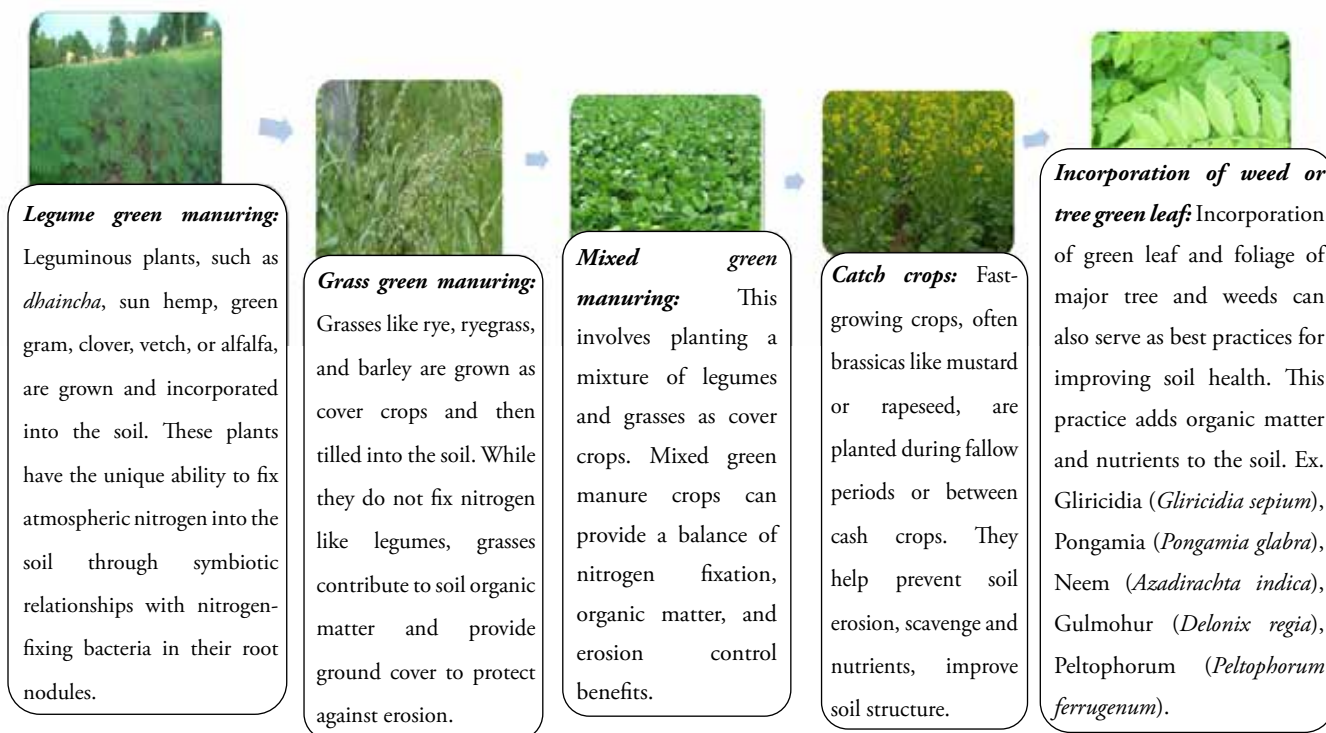
Every year, India loses 16.5 t/ha of fertile soils due to erosion. Most nutrients utilized by farmers exhibit poor recovery rates: nitrogen (30-40%), phosphorus (15-20%), potassium (50-80%), sulphur (10-15%), and micronutrients (1-5%). This is due to imbalanced fertilization practices and soil degradation from intensive agriculture and tillage. India loses 8-10 million tonnes of nutrients annually due to these factors. While the Green Revolution tripled yields in the past, current yields have plateaued. In this context, it is imperative to adopt innovative technologies to address these challenges while improving soil health, optimizing productivity, and conserving soil for future generations. Green manuring, an ancient agricultural practice, offers hope in addressing these issues at minimal cost. Green manuring involves planting and incorporating



Dhaincha as green manure

certain green plants or cover crops into the soil while they are still alive and green. Instead of leaving fields

fallow or relying solely on synthetic fertilizers, green manuring enriches the soil with organic matter,



Types of green manuring practices

nutrients, and nitrogen. Farmers plant specific crops like legumes (such as *Dhaincha*, sunn hemp, green gram, clover, vetch, or alfalfa) or grasses (like rye or ryegrass) that have the ability to fix nitrogen from the atmosphere into the soil through their roots. These plants are grown for a certain period and then tilled back into the soil while still green and actively growing, typically at the flowering stage or before they reach maturity and set seed. As the green manure crops decompose, they release nutrients and organic matter into the soil, improving its fertility, structure, and moisture retention. This practice helps to maintain soil health, reduce erosion, suppress weeds, and enhance crop yields in subsequent plantings.

Types of green manuring practices

There are several types of green manuring practices viz. Legume green manuring, Grass green manuring, Mixed green manuring, Catch crops, Incorporation of weed/tree green leaf, each with its own benefits and suitability for different agricultural systems.

Agronomic practices for green manure crop

By following these steps, farmers

can effectively establish and manage green manure crops to improve soil quality, enhance crop yields, and promote sustainable agricultural practices.

Select suitable green manure crops: Choose green manure crops based on factors such as soil type, climate, cropping system, yield potential, cost-effectiveness, and compatibility with crop rotation and intended benefits. Popular options include legumes like *Dhaincha*, sunn hemp, green gram and cowpea for nitrogen fixation, as well as grasses like ryegrass and oats for biomass production.

Prepare the land: Clear the field of existing vegetation and perform any necessary soil preparation, such as tilling or soil amendment. Ensure that the soil is well-drained and free from compaction for optimal root growth.

Seed sowing: Plant green manure seeds according to the recommended seeding rate and depth for the chosen crop. This may involve broadcasting seeds evenly across the field or using precision seeding equipment for more controlled placement.

Seedbed preparation: After sowing, lightly rake or roll the soil to ensure good seed-to-soil contact and promote germination. Irrigate



Green manure incorporation

the field if necessary to provide moisture for seedling establishment.

Crop growth and development: Monitor the growth of the green manure crop throughout the growing season, providing supplemental irrigation and nutrients as needed to support healthy development. Weed control may also be necessary to prevent competition with the green manure crop.

Incorporation into soil: Depending on the growth stage of the green manure crop and the timing of subsequent cash crops, determine the optimal time for incorporation into the soil. This is typically done when the crop



Green manure incorporation (*Dhaincha*) at IARI, RS, Pusa

reaches peak biomass but before it matures and sets seed.

Incorporation methods:

Incorporate the green manure crop at the flowering stage (generally 50 days after sowing) into the soil using mechanical tillage equipment such as plows, discs, or rotary tillers. Aim to bury the green manure residues sufficiently to facilitate decomposition and nutrient release into the soil. Effective incorporation of green manure crops is crucial for realizing their full benefits.

Allow decomposition: After incorporation, allow sufficient time for the green manure residues to decompose and integrate into the soil. This process may take several weeks to months, depending on factors such as temperature, moisture, and microbial activity.

Crop rotation: Incorporate green manure crops into a systematic crop rotation plan to maximize their benefits and prevent build-up of pests, diseases, or nutrient imbalances. Rotate between different types of green manure crops and cash crops to optimize soil health and productivity.

Benefits of green manuring for soil health

Increased soil fertility: Green manure crops enhance soil fertility by adding organic matter, promoting nutrient cycling, and improving soil structure. They recycle nutrients stored in their tissues upon decomposition, enriching the soil. Additionally, certain crops, like legumes, host nitrogen-fixing bacteria, boosting soil nitrogen levels. Their root systems create channels for water infiltration, reducing compaction, and aiding

Table 1. Fixation and release of nitrogen into the soil under various pulses

Crop	Nitrogen fixation (kg/ha)	Nitrogen release into soil (kg/ha)
Chickpea	26-63	-
Cowpea	53-85	50.3
Lentil	35-100	32.8
Mungbean	50-55	34.5
Pigeon pea	68-100	-
Field pea	46	59.4
Urdbean	50-60	38.3
Green gram	30-60	-
Soybean	20-260	-
Black gram	80-140	-

Source: Brahmprakash *et al.* (2004)



Soil health under green manure crop

root penetration. Green manure fosters microbial communities, vital for organic matter decomposition and nutrient release. Moreover, some crops regulate soil pH, optimizing nutrient availability. Overall, green manure plays a multifaceted role in sustaining soil fertility, crucial for productive and sustainable agriculture.

Increased nutrient solubility: Green manuring boosts nutrient solubility by acidification, chelation, microbial activity, root exudation, and soil structure enhancement. Organic acids from decomposition lower pH, aiding phosphorus solubility. Chelates from green manure crops maintain nutrients in soluble forms. Microbes break down organic matter, releasing soluble nutrients, while root exudates mobilize soil nutrients. Enhanced soil structure facilitates nutrient movement, supporting plant growth.

Improved soil structure: Green manure crops improve soil structure by adding organic matter,

penetrating soil with deep roots to reduce compaction, cycling nutrients upon decomposition, preventing erosion with dense root systems, enhancing water infiltration and retention, and promoting soil aggregation through beneficial organisms.

Increased organic matter: Green manure enriches soil organic matter by incorporating organic residues, root exudates, fostering microbial activity, sequestering carbon, and enhancing soil structure through aggregation. This accumulation enhances soil fertility and productivity, underpinning sustainable agricultural practices and ecosystem health.



Weed/Pest suppression: Green manure crops reduce weed and pest populations through competition for resources, allelopathic effects inhibiting weed growth, habitat disruption for pests, biofumigation releasing pesticidal compounds,



Weed suppression effect by mungbean at IARI, RS, Pusa

trap cropping to divert pests, and attracting beneficial predators, thereby fostering ecological balance and reducing reliance on synthetic pesticides.

Prevention of nutrient leaching and erosion: Green manuring prevents nutrient leaching and erosion by providing soil cover, root binding, enhanced water infiltration, improved nutrient retention, and microbial activity support. This sustainable practice reduces soil loss, prevents nutrient runoff, and maintains soil fertility, ultimately safeguarding water quality and ecosystem health.

Table 2. Increase in crop productivity and profitability

Crop	Green manure crop	Yield Increase (%)	References
Maize	Sunnhemp	26.4	Pasha <i>et al.</i> (2019)
Rice	Dhaincha	7.8	Ahmed <i>et al.</i> (2020)
	Mung bean	14.8	Irin <i>et al.</i> (2021)
Wheat	Dhaincha	23	Gautam <i>et al.</i> (2021)
	Sunnhemp	31	
	Cowpea	19	
	Mung bean	30	
Sugar-cane	Dhaincha	12-22	Yadav and Yaduvanshi (2001)
	Cowpea	10	White <i>et al.</i> (2020)

Table 3. Challenges and considerations in green manuring

Challenge	Consideration
Timing of incorporation	When adding green manure, make sure to strike a balance between releasing nutrients and producing the most biomass possible
Nitrogen immobilization	The temporary tying up of nitrogen in the soil by certain green manures—particularly those with high carbon content—needs cautious handling
Weed seed contamination	To prevent adding new weed species to the soil, make sure the green manure crop is free of weeds
Water availability	In dry areas, take into account the amount of water needed by the green manure crop to maintain proper growth and biomass output

Support of beneficial microbes and other soil organisms: Green manuring enriches soil by supplying organic matter, fostering microbial growth and biodiversity. Root systems create habitats for beneficial microbes, supporting nutrient cycling and nitrogen fixation. They also suppress pathogens naturally, while improving soil structure for microbial activity.

Increase in crop productivity and profitability

Green manuring may improve the physical, chemical, and biological properties of the soil, which could lead to higher crop yields in later crops.

Challenges and considerations in green manuring

While green manuring offers numerous benefits, there are also some challenges and considerations to keep in mind as listed in Table 3.

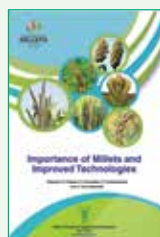
SUMMARY

Green manuring is a sustainable agricultural practice that involves incorporating green plants into the soil to enhance fertility, structure, and health. This method reduces erosion, suppresses weeds, and improves nutrient cycling, thus minimizing reliance on synthetic fertilizers. Despite challenges like timing and water availability, green manuring significantly boosts crop yields and soil resilience, especially under changing climate conditions. Integrating green manure with other fertilization practices is essential for optimizing crop production and ensuring long-term soil health, making it a cost-effective strategy for sustainable agriculture and global food security.

*Corresponding author email: mhasanain1794@gmail.com



Importance of Millets and Improved Technologies



“Importance of Millets and Improved Technologies” This book is an excellent compilation of knowledge of importance of Millets and improved production technologies which is essential to create awareness among the end users for their promotion. Millets are being utilized for various purposes such as food, feed, fodder and more recently, as bio-fuel.

For this information, importance of different millet crops in our livelihood and their technological advancement has been compiled in this monogram. This will be of immense value to the researchers, academicians, end-users and policymakers alike to promote millets farming.

TECHNICAL ASPECTS

Pages: v + 183; Price: ₹ 700.00, US\$ 90.00; Postage: ₹50

ISBN No.: 978-81-7164-272-4

For obtaining copies, please contact:

Business Unit

ICAR- Directorate of Knowledge Management in Agriculture
Krishi Anusandhan Bhawan – I, Pusa, New Delhi 110012

Tel: 011-25843657; email: bmicar@icar.org.in, businessuniticar@gmail.com
website: www.icar.gov.in

SCAN QR Code to Purchase Online

