Topic- Green Manuring

Manures, Fertilizers and Soil Fertility Management (SAC-311)

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What is green manuring?

Green manuring is the practice of growing lush plants on the site into which you want to incorporate organic matter, then turning into the soil while it is still fresh. The plant material used in this way is called a green manure (GM). Generally the practice of green manuring is adopted in two ways:

a) *In-situ* green manuring

b) Green leaf manuring

In-situ green manuring

In this system the short duration legume crops are grown and buried in the same site when they attain the age of 60-80 days after sowing. This system of on-site nutrient resource generation is most prevalent in northern and southern parts of India where rice is the major crop in the existing cropping systems.

In-situ

Green Manuring

Common legume crops for *in-situ* green manuring

S. No.	Common name	Botanical name	Growing season
1.	Dhaincha	*Sesbania aculeata*	Zaid/Kharif
		Sesbania rostrata	Zaid/Kharif
2.	Sunhemp	*Crotalaria juncea*	Zaid/Kharif
3.	Mung	*Vigna radiata*	Zaid/Kharif
4.	Cowpea	*Vigna unguiculata*	Kharif
5.	Guar	*Cyamopsis tetragonoloba*	Kharif
6.	Senji	*Melilotus alba*	Rabi
7.	Berseem	*Trifolium alexandrium*	Rabi
8.	Khesari	*Lathyrus sativus*	Rabi

[Source : Singh *et al*., 1992]

Green leaf manuring

Green leaves and tender plant parts of the plants are collected from shrubs and trees growing on bunds, degraded lands or nearby forest and they are turned down or mixed into the soil 15-30 days before sowing of the Crops depending on the tenderness of the foliage or plant parts.

Green leaf manuring

The most common shrubs/trees used for green leaf manuring are given below :-

S. No	Common name	Botanical name
1.	Subabool	*Leucaena leucocephala*
2.	Glyricidia	*Glyricidia maculeata*
3.	Wild dhaincha	*Sesbania speciosa*
4.	Karanj	*Pongamia glabra*

How green manuring works

- Timing? Which species to grow?
- Avoid competition to the main crops.
- Ensure good growing conditions.

1. Sow the green manure

2. Wait until maximum biomass is developed

- Cut before flowering.

3. Cut and incorporate the plant material in the soil

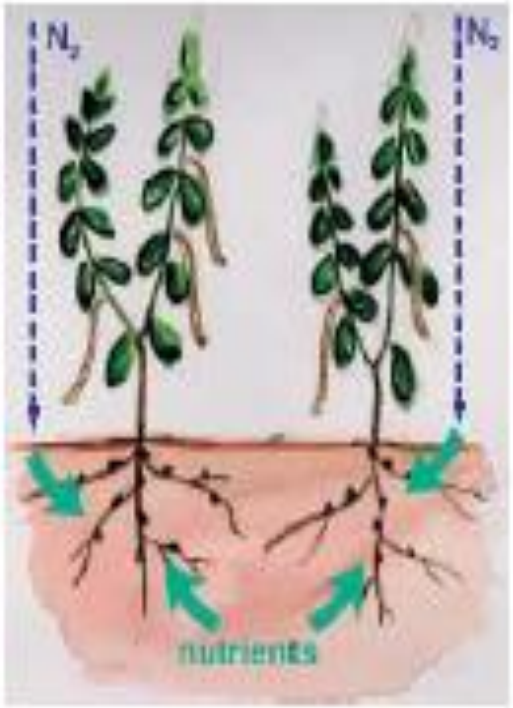
- Crush the material into pieces.
- Incorporate it superficially.

4. Sow or plant a crop with a high nutrient demand

- Sow or plant the next crop within two weeks to avoid nutrient losses.

What makes an ideal green manure plant

- It is easy to cultivate
- It fixes nitrogen from the air
- It provides good animal fodder
- It produces a lot of biomass in short time
- It effectively suppresses weeds..



- It is not sensitive to pest and diseases
- It is easily worked in

- It develops deep roots
- It takes up soil minerals in large quantities
- It does not compete with the main crop if grown in association.

Status of GM crops in India

At present only **6.7** million hectares are in green manure which accounts for **4.5** per cent of net sown area (**142** million ha) of the country (*Agril. Statistics at a Glance*, 2005). The practice of green manuring is most common in rice growing states like **A.P., U.P., Karnataka, Punjab and Orissa** which contribute **41**, 16, 11, 6 and 5 per cent to the total area under green manuring in India respectively. Whereas, the share of Gujarat (3%), M.P. (3%), Himachal Pradesh (**2%**) and Haryana (1.7%) is not very encouraging and concerted efforts are to be made out at all levels to bring more area under green manuring that too in irrigated area if nutritional need of organic farming is to be made.

[Source : Bisen *et al*., 2008]

Nutrient compositions of common green manures

S. No.	Crop/Weed	Nutrient content						
		Major nutrients (%)*			Total micro nutrients (mg/kg)**			
		N	P_2O_5	K_2O	Zn	Fe	Cu	Mn
1.	*Sesbania rostrata*	2.62	0.37	1.25	40	1968	36	210
2.	*Sesbania speciosa*	3.98	0.24	1.30	50	480	44	110
3.	*Crotalaria juncea*	2.86	0.34	1.27	30	1190	24	110
4.	*Eichhornia crassipes*	2.83	0.93	1.79	50	470	19	420
5.	*Trianthema* Spp.	2.34	0.30	1.15	30	1992	19	200
6.	*Parthenium hysterophorus*	2.66	0.8	1.29	70	470	19	160
7.	*Glyricidia maculeata*	3.49	0.22	1.30	30	550	19	150
8.	*Cowpea residue*	1.70	0.28	1.25	-	-	-	-
9.	*Mungbean residue*	2.21	0.26	1.26	-	-	-	-

[Source : *Singh *et al*., 1992; **Gupta, 2000 and Savitri *et al*., 1999]

Nutrient potential of GM crops

Almost all GM crops which are used for *in-situ* or *ex-situ* green manuring contain all the plant nutrients which are essential for completing the life cycle of any plant grown in community. Among the different GM crops, *dhaincha (Sesbania aculeata)* and Sunhemp (*Crotalaria juncea*) have higher accumulation of major and micro nutrients on account of more biomass production and better nutrient composition compared to food legumes which are inferior due to low contents of nutrients coupled with less dry matter production. **Water hyacinth has great nutrient potentials and it could contribute 198 kg N, 63.0 kg P_2 O5, 125.3 kg K_2O and 350 g Zn, 3290 g Fe, 133 g Cu and 2940 g Mn when about 70 q/ha dry matter is added in the soil and could serve as better source of plant nutrients through *ex-situ* green manuring .**

Biomass and nutrient potentials of different green manures and weeds

S. No.	Crop	Dry matter in 45-60 DAS (q/ha)	Nutrient accumulation						
			Major nutrients (kg)			Total micro nutrients (g)			
			N	P_2O_5	K_2O	Zn	Fe	Cu	Mn
1.	*Sesbania rostrata*	**50.0**	**131.0**	**18.5**	**62.5**	**200**	**9840**	**180**	**1050**
2.	*Sesbania speciosa*	30.0	119.4	07.2	39.0	150	1440	132	330
3.	*Crotalaria juncea*	**52.5**	**150.2**	**47.3**	**93.9**	**262**	**2467**	**100**	**2205**
4.	Eichhornia crassipes	**70.0**	**198.1**	**63.0**	**125.3**	**350**	**3290**	**133**	**2940**
5.	Trianthema Spp.	25.0	58.5	07.5	28.7	75	4980	47	500
6.	P. hysterophorus	40.0	106.4	35.2	51.6	280	1880	76	640
7.	*Glyricidia maculeata*	36.0	125.6	7.9	46.8	108	1980	68	540

[Source : Palaniappan, 1992; Singh *et al*., 1992]

Techniques for good benefits from GM Crops

The maximum benefit from green manuring can be obtained through

- Better knowledge of suitable sowing time of GM crops.
- Age or stage of GM crop for burial.
- Time interval between burial and sowings of next crop.

Stage of GM crop at burial

Knowledge of time of burial of GM crops is of most importance for deriving maximum benefits. The chemical composition of most plants changes identically during growing season. During early period of crop growth its content of N, protein and water soluble constituents are maximum, while the amount of fibre, cellulose, hemicelluloses, lignin and the C: N ratio are also less. Therefore, tissues of immature plants usually decompose more rapidly as compared to those of matured plants. Singh *et al*. (1992) reported that the GM crops are to be buried in the soil when they are 2 months old and two weeks delay in the incorporation reduced their N content and increased the C: N ratio, cellulose, hemicelluloses and lignin contents.

Time interval between burial of GM sowing of next crop

Knowledge of time interval between burial of GM crops and sowing of next food crop for just to facilitate the complete decomposition of the turned in green matter is essential. Ghose *et al*. (1960) reported that the time interval was not so important when succulent green manure crop of eight weeks age was buried because transplanting of paddy immediately after burying of green manure crop was as good as any other treatment. But it was necessary to give time interval of 4-6 weeks before planting paddy when the GM was 12 weeks of age.

Criteria for selection of green manures plants

Various nitrogen fixing leguminous and non-leguminous species particularly tree, creepers and bushes can be used as green manures

The criteria for selection of plants as GM crops

Criteria	Effects
High biomass production	Mobilization of nutrients from soil into vegetation; suppression of weeds
Deep rooting system	Pumping up of weathered and/or leached nutrients from soil layers not occupied by roots of main crop
Fast initial growth	Quick soil cover for effective soil protection suppression of weeds
More leaf than wood	Easy decomposition of organic matter
Low C/N ratio	Leading to enhanced availability of nutrients for succeeding crops; easy to handle during cutting and/or incorporation in to the soil
Nitrogen fixing	Increased nitrogen availability
Good affinity with mycorrhiza	Mobilization of phosphorus leading to improved availability for crops
Efficient water use	Possibility to grow after main cropping season on residual soil moisture or with less rainfall
Non-host for crop related pests and diseases	Decrease in pest and disease populations
No rhizomes	Controllable growth
Easy and abundant seed formation	Propagation in farmers fields
Useful by-products (e.g. fodder, wood)	Integration of animal husbandry and forestry

[Source : Prased and Power, 1991]

Sesbania germinating in rice field

Benefits of using green manures

Green manuring offers an inexpensive way of improving crop yields and it takes little extra effort. Green manures are especially important on farms where there is not enough animal manure available, and when it is not possible to bring in natural fertilizers from elsewhere. Although the use of green manures may seem to create extra work, they provide following benefits :

Nitrogen fixation

The main benefit of using a legume as a green manure is that legumes fix nitrogen from the atmosphere and convert it into a form that is available to other plants. Legumes from a symbiotic association with soil bacteria called rhizobium. These bacteria colonize the root hairs of the legumes and multiply causing swellings, which become nodules. The bacteria benefit from the relationship by obtaining carbohydrates (plant sugars) from the legume. The growing legume benefits from the nitrogen that is captured from the air and converted into ammonium legume benefits from the nitrogen that is captured from the air and converted into ammonium within the nodules.

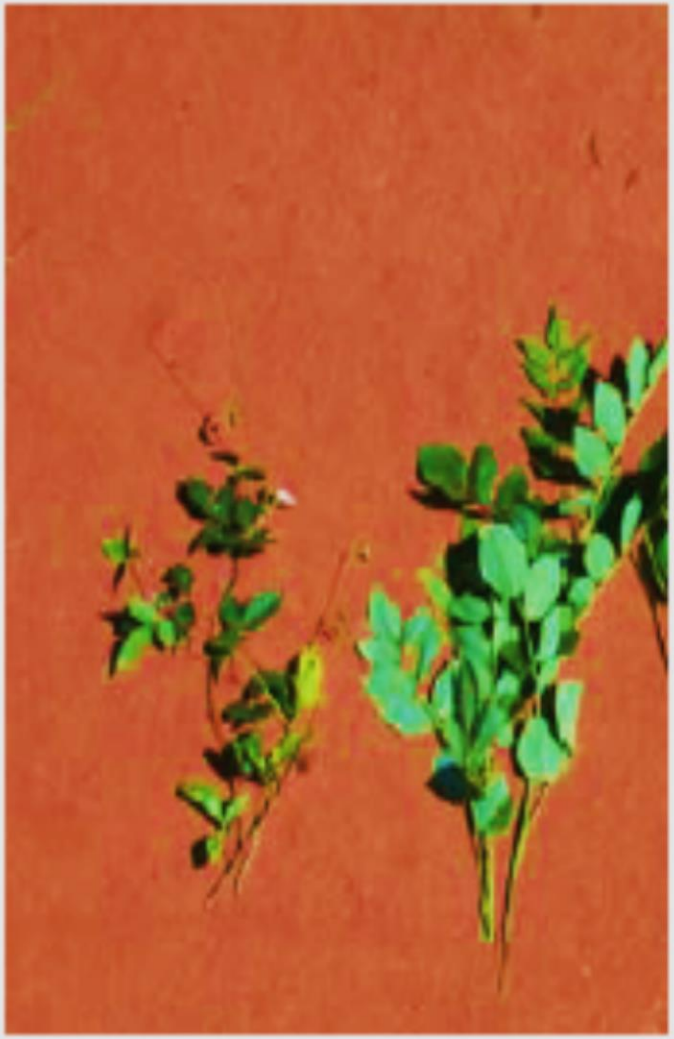
How to improve nitrogen fixation

- Avoid strong shading of the legumes.
- Improve availability of phosphorus.
- Avoid nitrogen deficiency of the legumes in an early stage.
- Ensure a good supply with potassium (strengthens the legumes).
- Avoid sulphur deficiency.
- Avoid water logging and water stress.

Did you know?

High inputs of manures or fertilizers stop the nitrogen fixation process.

Benefits from nitrogen fixing trees



- They help to increase the levels of nitrogen and organic matter in the soil.
- They produce fuel wood and timber.
- They offer shade and support for crops.
- They can be used as a living fence.
- They produce material for green manuring and mulching.
- Some can be used as fodder or bedding material for domestic animals.
- Some produce food for human consumption.
- They can serve as shelterbelts and windbreaks.
- They are hosts for birds and beneficial insects.

How to integrate green manures into the rotation?

Between two crops (for a short period)

As a cover crop into an annual crop

Between two crops (for a long period)

Effect of green manuring on soil productivity

The physico-chemical properties of soils are affected significantly due to addition of organic matter in the form of green manures particularly in plots receiving green manuring through *Sesbania rostrata* and *Crotalaria juncia*. Consequently, marked improvement in soil structures, infiltration rate, bulk density and water holding capacity of soil.

Enhances soil fertility

Green manures recycle nutrients and add organic matter to the soil. They help prevent nutrients being washed out of the soil. The nutrients are taken up by the green manure and held inside the plant. When the nutrients are needed for the next crop, the plants are dug into the soil or used as mulch on top of the soil. This helps to increase crop yields. Legumes and other nitrogen fixing plants, which take nitrogen from the air to the soil are particularly beneficial.

Supplement for nutrients

Different green manures and grain-legumes are used to increase the nitrogen content and texture of the soil. Among the green manures *Sesbania aculeata* accumulated the largest amount of biomass and nitrogen contribution and among the grain legumes, cowpea ranks first both in terms of grain yield and biomass addition. The available green manure crops and utilization pattern are as follows :

Nutrient potential of green manures

Green manure	Biomass (tonnes)	N accumulobase (kg/ha)
Sesbania aculeata	22.50	145.00
S. rostrata,	20.06	146.00
Crotalaria juncea,	18.40	113.00
Tephrosia perpurea	6.80	6.00
Green gram	6.50	60.20
Black gram	5.12	51.20
Cowpea	7.17	63.30

[Source : Sharma, 2004]

Improved soil structure

Green manures improve soil structure, letting more air into the soil and improving drainage. Green manures help sandy soil hold more water and not drain so quickly.

Prevention of soil erosion

Green manures help to stop the soil being carried away by wind and rain. The roots penetrate the soil and hold it in place.

Weed control

Green manures help to control weeds. Bare soil can become quickly overgrown with weeds, which can be difficult to remove. Green manures cover the ground well and stop weeds growing beneath them, by competing for nutrients, space and light.

Place in farming system

Green manures in rotation : Growing green manures as part of a crop rotation is an important part of an organic farming system. These help to build soil fertility and are particularly useful when grown before crops, which need a lot of nutrients. Green manures can be used in rotation :

1. Whenever there is no crop in the ground, rather than leaving the land bare and allowing weeds to grow and nutrients to leach out of the soil.

2. As break crops, when these is only a short time between main crops.

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Green manures as mulch

Green manure plants can be cut and left on the soil surface as a mulch. Mulching releases nutrients slowly but has some advantages :

1. Mulching helps to prevent weed growth

2. Mulching protects the soil from erosion

3. Mulching keeps the soil moist by reducing evaporation

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Green manures in agroforestry

Agroforestry is the practice of growing trees and/or shrubs together, with crops and/or animals. The trees/shrubs act as long term green manures and the leaves can be used to digging in or as a mulch.

The regular pruning of agroforestry trees such as Leucaena (*Leucaena leucoephata*), Mother of cocoa (*Glyricidia sepium*) and Calliandra (*Calliandra calothyrsus*) during the crop growing period provides large amounts of green material for digging into the soil and reduces competition with the main crop. The material can also be used as a mulch. It is spread on the top soil, usually between crop rows or before a crop has been planted.

As well as improving the soil in the ways described above, trees and shrubs also provide food, fodder, fuel wood, erosion control and other benefits.

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Sustainability

For more than a decade it has been accepted that green manures and cover crops would only be accepted by small farmers if they could be grown on land that had no opportunity cost, could be intercropped with other produce, grown under tree crops or on fallow land and be cultivated in periods of expected drought or extreme cold. They would also be favoured if they involved no extra labour or out of pocket cash expense.

Essential precautions

- Broadcast or sow the seeds after the harvest of main crop, preferably in the water sign/zodiac of the ascending period of the month.
- Slash the green manure crops shoots and incorporate them into the soil.
- Slashing and incorporation of green manure crop should be done while the soil has adequate moisture. If there is no moisture an irrigation is essential. Without moisture incorporation is difficult and if done, it will not be effective. Meanwhile moisture is a critical factor for the microbes to act over the incorporate material.
- sow or transplant the next crops 1-2 weeks after the incorporation of the green manure, since in the initial stage of decomposition there will be a release heat of decomposition that is very unfavorable for germination and the growth of young plants.
- Use disc harrow to incorporate the green manure crop. Discs harrow have become the implement of choice for incorporating all the heaviest perennial stands. Disc harrow implements adequately mix the legume residues into the soil, promoting even decomposition and nutrient release near to the soil surface.

Conclusions

A number of conclusions can be drawn from the examples given above :

- ✓ The variety of sustainable green manure and crop cover systems already established in traditional as well as more recently introduced agricultural system is remarkably diverse.

- ✓ Green manures and cover crops have been adopted on a wide scale despite the seemingly prohibitive conditions. The fact that virtually every system referred to has some elements of these conditions confirms their predictive value. Thus, programmes to introduce new green manure and cover crop systems should teach farmers not only how these species can be used to improve their soil but that they have other uses as well.

- ✓ Tremendous potential still exists for the development of new green manure and cover crop system.

- ✓ Scope of potential systems for using green manure and cover crops still need to be investigated, most notably the major possibilities of using them for animal feed; the potential latent in new as yet untried species, including trees and non-legumes, and the value of combining of green manures and cover crops rather than using individual species. Experience leads us to believe that, with the possible exception of very intensive farming systems such as irrigated vegetable and rice, green manure and cover crop systems can probably be introduced into many, if not most of the world’s small scale farming systems.


Thanks