

Gliricidia (*Gliricidia sepium*) as an aid for enhancing soil health and crop productivity

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Gliricidia (Gliricidia sepium) farming is of the most promising and climate friendly technology for improving soil health as well as crop productivity. Presence of high amount of nitrogen in leaves makes it suitable to use as an alternate source of nitrogen fertilizer in wide variety of soils. Being a legume tree, rhizobia present in the root nodules of gliricidia capable of performing N₂-fixation and make it available to non-legume plants when it plant as an intercrop. Gliricidia can also prevent soil degradation and maintain soil fertility through supplying plant nutrients. In addition, the plant has the potential to sequester carbon dioxide from the atmosphere through the accumulation in its biomass. Therefore, farmers need to be encouraged to grow gliricidia along the border of the farmland or field bunds and use it as a green manure in their lands. This will not only reduce their investment on fertilizer purchases but also benefits environment.

Key words: Biological nitrogen fixation, Carbon sequestration, Green leaf manuring, *Gliricidia sepium*

AS soil is the fundamental natural resource for agriculture, maintaining its viability for sustainable crop production under conditions like deteriorating soil health, depleting water resources, vulnerability of soil to degradation and desertification and loss of biodiversity is also pose another challenge. It is projected that about 36.5% of the total geographical area (~120.4 Mha) in India is affected by various kinds of land degradation comprising water erosion (82.6 Mha), wind erosion (12.0 Mha), chemical degradation (24.8 Mha) and physical degradation (1.0 Mha). Out of total degraded area, 104.2 Mha is arable land. Erosion induced loss in crop production in rainfed areas under major cereal, oilseed and pulse crops has been estimated as 13.4 million tonnes. Besides, over 5.3 billion tonnes of soil is lost annually through water erosion resulting in a loss of approximate 8 million tonnes of plant nutrients (NPK). Similarly, the crop production loss due to salinity and alkalinity at the national

level has been estimated to be 5.66 and 11.18 million tonnes, respectively. Quite a lot of management options are available to check land degradation and thus to improve the soil health for sustainable crop production such as conservation agriculture (CA), crop residue recycling, biofertilizers, inclusion of legumes in the cropping sequence or as intercrops, modified crop rotation, green manure crops, green leaf manuring, tank silt addition, farm yard manure, vermin-composting, poultry manure, urban compost along with chemical fertilizers. Green leaf manuring with *Gliricidia sepium* is the most promising and climate friendly technology for improving soil fertility. Growing *Gliricidia* plants on farm bunds serves dual purpose of producing green leaf manure rich in nitrogen content (2.4%), phosphorus (P) (0.1%), potassium (K) (1.8%), calcium (Ca) and magnesium (Mg) and also helps in conserving soil through reduced soil erosion.

Gliricidia scientifically known as

Gliricidia sepium originated from Central America, and spread to West Africa, West Indies, Southern Asia and tropical America. *Gliricidia sepium* is also known as mata raton (Spanish), cacao de nance, cacahnanance, madriado (Honduras), kakawate (Philippines), madre cacao (Guatemala). It is probably the most widely cultivated multipurpose agroforestry tree after Subabul (*Leuceana leucocephala*). It is widely known for its multipurpose use like to provide crop shade for cacao, coffee, and other shade loving crops, as live fence posts for pasture and property boundaries, and as a fellow tree to improve degraded land It is important source of green manure, fodder, timber, fuel wood, medicinal purpose, soil stabilization. *Gliricidia* (Leaf, twing, stem, etc.) is also used for preparation biochar (Pyrolyzed biomass), which is recalcitrant carbon material used as a soil amendment. *Gliricidia* leaves are also used as insecticide, repellent and rodenticide. Therefore, *Gliricidia* farming can play important role in improving the soils



and water regularly for maintaining proper moisture. Normally, 3-4 months old seedlings can be planted on bunds or nearby farm ponds at 50 cm spacing during rainy season. For close plantation on steep slopes, a spacing of <20 cm is recommended for better soil erosion control.

Pruning of green leaf manure

Harvesting can be done by lopping plants at 75 cm above the ground. Pruning can be done once the plants attain one year growth and leaves can be collected through pruning at least thrice in year. First, pruning can be done before sowing of *kharif* season crops (June), second just before sowing of *Rabi* season crops (November) and third before sowing of the summer crops (March).

Chopping for green leaf manure

After the pruning, lopping parts (stem, small twigs, and leaves) of *Gliricidia* plants should be cut into small pieces. These chopped plant material can be applied to the soil surface as mulch between rows in main crops or incorporated into the soil as green manure before crop planting or sowing. It is estimated that the annual leaf dry matter production of the *Gliricidia* plants range from about 2 to 20 tonne/ ha/ year.

Role of *Gliricidia* green leaf manure on soil health

Application of *Gliricidia* leaves in soil as mulch or soil incorporation improves the physical and chemical properties of soil in a variety of ways such as enhancing water infiltration by reducing the surface run off that in turn reduces soil erosion; increasing the water holding capacity of the soil and thus helps to improve the soil quality; enhancing the soil chemical properties through mobilizing native nutrients in the soil through the production of carbon dioxide and organic acids during the decomposition of the plant material along with the addition of nutrients like N, P, K, Ca, and Mg to the soil. It is an estimate that the application of 1 tonne *Gliricidia* leaf manure per ha provides about 21 kg N, 2.5 kg P, 18 kg K, 85 g Zn, 164 g Mn, 365 g Cu,

especially having low nitrogen content soils.

Growth and development

Gliricidia sepium is a small, thornless, semi-deciduous tree and grows up to a height of 3-15 m. The tree may have single or multiple stem and tends to have a diffuse, irregular spreading crown. The branching of this thornless tree is frequently from the base with basal diameters reaching 50-70 cm. The bark is smooth and can vary in color from whitish-grey to deep red-brown. Leaves are usually alternate pinnate, approximately 30 cm long with terminal leaflets. Flowers bright pink to lilac, tinged with white, usually five toothed calyx and a corolla of five-pink or light purple petals. Green coloured fruits sometimes tinged with reddish-purple when unripe contain 3-8 seeds. The seeds are circular and flat about 10 mm in diameter, shiny, light to dark brown.

Soil and climate adaptation

Gliricidia plant grows best in warm, dry climates with moderate mean annual rainfall to higher rainfall. It grows well with optimal temperature of 22-30° C. The plant tolerates seasonal drought and climate with mean annual low rainfall. The plant grows best in deep, medium textured, well drained fertile soils. It has been observed that plant flourishes well in neutral acidic soils and it also grows in light soils to heavy

soils right with high clay content.

Agro-techniques for cultivation

Propagation: *Gliricidia* can be propagated through seed and stem cuttings. In general, propagation through stem cuttings are easy than seed propagation. Also, *Gliricidia* plants from stem cuttings grow faster than those grown from seeds. However, use of stem cuttings are appropriate mostly in situations where only a few trees are to be planted and seed propagation is the most suitable method for large scale plantation of the *Gliricidia*.

Stem cuttings: Stem cutting for propagation should be taken from brownish green mature branches of at least one-year-old plants. Stem cutting should be of 2-6 cm diameter and 30-100 cm length. The stem cuttings are normally cut obliquely at both ends and younger tips of the stem should be removed. In general the cuttings are inserted 20-50 cm deep into the soil during rainy season. Stem cuttings are planted closely at 50 cm distance for the establishing hedges and can be pruned at specific intervals to collect green leaves, and firewood.

Seed propagation: For seed propagation, seeds collected from dry pods need to be soaked overnight in water for proper germination. The soaked seeds are sown in plastic sachets or polythene bags filled with potting mixture (mixture of soil, sand and farmyard manure in 1:1:1 ratio)

728 g Fe besides considerable quantities of S, Ca, Mg, B, Mo, etc. Similarly, application of green leaf manure in soil also improves the biological properties of soil through increasing the microbial population such as fungi, bacteria, actinomycetes, total microbial count, microbial biomass carbon and nitrogen. Besides the use of green leaf manure minimizes the use of chemical fertilizers especially nitrogenous fertilizers. The *Gliricidia* green leaf manure improves the soil organic carbon content in different depths through addition of large amount of organic matter, enhanced root activity and rhizodeposition. Moreover significantly lower amounts of CO₂ are released when *Gliricidia* leaves are incorporated into the soil compared to other crops like pigeon pea leaves. As *Gliricidia* residue is rich in N it decomposes rapidly with low concentrations of lignin and active polyphenol. Therefore, when used as a green manure or organic fertilizer, it contributes a large amount of N available to the other plants in a short time.

Biological nitrogen fixation (BNF)

Gliricidia is an important legume tree capable of forming a symbiotic association with N₂, fixing rhizobia due to its active root nodules. It may also act as an alternate nitrogenous fertilizer to non-legume plants by increasing soil nitrogen availability. The quantity of atmospheric nitrogen (N₂) fixation by *Gliricidia* varies considerably depending upon the method used to estimate BNF, age and population of trees, and management practices. Estimations through isotope dilution methods showed that *Gliricidia* contribute 86-309 kg N/ha/year in alley cropping and 70-274 kg N/ha/year in field monoculture.

Carbon sequestration

Gliricidia have the potential to sequester carbon dioxide from the atmosphere through the accumulation in biomass. Estimations show that *Gliricidia* based alley cropping system generally have the total biomass of about 32.99 tonne/ha that is equivalent to around

Table 1. Carbon sequestration and soil nutrient status in *gliricidia sepium* treated plot after 5 years experiment in maize based cropping sequence at ICAR-IISS, Bhopal.

Treatment		Soil organic carbon (SOC) (g kg ⁻¹)	SOC Stock (t ha ⁻¹)	Carbon sequestration (kg ha ⁻¹ year ⁻¹)
T1	Control	4.07	7.75	-54.9
T2	120-60-30 kg NPKha ⁻¹ (General recommended dose)	4.97	9.43	57.3
T3	135-55-50 kg NPKha ⁻¹ (STCR-dose)	5.07	9.62	70.0
T4	75% NPK of T3	4.90	9.42	56.7
T5	75% NPK of T3 + 5 Mg ha ⁻¹ Maize residue (MR)	5.17	9.73	77.0
T6	5 Mg ha ⁻¹ MR +1 Mg ha ⁻¹ PM + 2 Mg ha ⁻¹ <i>gliricidia sepium</i> lopping	5.27	9.82	83.0
T7	5 Mg ha ⁻¹ MR + 5 Mg ha ⁻¹ FYM + 2 Mg ha ⁻¹ <i>gliricidia sepium</i> lopping	5.90	10.89	154.4
Initial status		4.50	8.57	-

14.61 tonne carbon/ha stored. On the other hand, the general carbon sequestration rate is 0.91 tonne carbon/ha/year. This is due to greater input of organic material from tree pruning directly contributes to maintain the the soil organic carbon pool (SOC). Similarly, it has been reported that organic carbon in the soil significantly increased by the application of *Gliricidia lopping* (2 t/ha) along with sorghum stover as crop residues under minimum and conventional tillages in sorghum-castor rotation in rainfed condition. Therefore, the application of lopping material (green leaf manure) to the soil surface as mulch or soil incorporation (before crop sowing) can maintain levels of SOC pool and crop productivity. Similarly, *Gliricidia lopping* was used as soil application based on N equivalent at ICAR-IISS, Bhopal and noticed considerably improvement in carbon stock and carbon sequestration as compared generals recommended dose of chemical fertilizers (Table 1).

Enhancement in crop productivity

Several research findings conveyed that incorporation of lopping material of *Gliricidia* into soil surface as mulch or green leaf manure increased the yield of different agricultural crops such as maize, chickpea, finger millet, pearl millet, sorghum in many regions of India. This increase was attributed to the improved soil fertility and water retention by the above ground biomass incorporated into soil surface. AICRPDA reports showed that application of *Gliricidia* leaf manure equivalent to 20 kg N/ha

increased the maize yield from 1.7 to 2.1 t/ha in red and lateritic soils at Bhubaneswar. A research finding shows that integration of 2 t *Gliricidia* loppings along with 20 kg N/ha increased the sorghum yield by 84.6 % as compared to without application. Similar reports also available that the conjunctive use of urea and organic sources of nutrient such as loppings of *leucaena* and *Gliricidia* on nitrogen equivalent basis (1:1 ratio) had noticeably effect on sorghum grain yield. Besides, *Gliricidia* intercropping may play an important role in preventing or slowing soil degradation and in maintaining the supply of plant nutrients to any intensified cropping systems.

CONCLUSION

Gliricidia (*Gliricidia sepium*) can be raised in all type of soils and environment for cultivation and suitable for sole crop, intercrop, alley cropping or any other cropping system particularly in rainfed ecosystem. Hence, farmers should be encouraged to raise the *Gliricidia* on boarder of farm ponds, farm bunds, and borders of agricultural fields. Addition of *Gliricidia* as green leaf manure or mulch in crop production systems along with chemical fertilizers enhanced the crop yield along and soil health through improving soil physical, chemical and biological properties of soil.

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