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**Recycling resources in
agroecological farms**

Bhoomi Sudha

Recycling biomass for enhanced soil fertility

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Farmers in Khunti and Ranchi districts in Jharkhand are benefitting from including biomass yielding plants in their fruit orchards. Mulching of biomass in the plant basins was found to result in significant increase in soil moisture, soil nutrients and organic matter content which is reflected in terms of increased plant vigour and yield.

Mulching with biomass increases soil moisture, soil nutrients and organic matter



The eastern plateau and hill region of India offers suitable climatic conditions for successful cultivation of a wide range of fruit crops. Although the region receives ample rainfall, constraints arising out of low soil organic carbon, poor water holding capacity, soil acidity, and deficiency of nutrients like phosphorus, boron and zinc contribute towards poor growth and low productivity of different fruit crops, particularly under rain-fed conditions. The soils in most of these tropical environments have high acidity and aluminum toxicity, and are rich in oxides and poor in nutrients. Therefore, use of lime and fertilizers accounts for a large part of the agricultural production cost.

Any effort on increasing the productivity of fruit crops in this region must primarily address towards increasing the soil organic carbon content. Maintaining or improving soil organic matter in soils cultivated in tropical humid and sub-humid regions is a major challenge because of the high rates of decomposition. Agricultural systems that combine low soil tillage and high input of plant residues have been pointed as efficient alternatives to mitigate soil organic matter losses and to increase overall soil quality. The increasing cost of organic manure in the recent years has led to gradual decrease in their application rate in the agricultural fields. The farmers of the eastern plateau region of India always have the inclination for application of the available organic manure in their field crops and rarely apply any organic manure in their fruit orchards. Although options on green manuring crops like *Sesbania* are available, their annual production cycle is a major deterrent for their adoption in the fruit orchards grown under rainfed conditions. Similarly, increasing costs of inorganic fertilizers limit their use in sufficient quantities by most smallholder farmers and this has led to increased interest in

development of integrated soil fertility management systems.

Biomass yielding plants in cropping systems

Inclusion of biomass yielding plants into the crop production system has been found to be effective in improving soil fertility through addition of leafy biomass to the main crop. The presence of biomass yielding species in the alley cropping production system has been shown to contribute to nutrient recycling, reduction in soil nutrient leaching, stimulation of higher soil faunal activities, soil erosion control, soil fertility improvement

Mulching bael trees with Bhoomi sudha



Tephrosia candida (Roxb.) is native to the tropical foothills of the Himalayas in India which has been naturalised and is cultivated throughout South–East Asia for varying uses. It also has medicinal uses. The species holds promise for agroforestry in the tropics due to its high biomass yield, dense vegetative cover, deep root system, non-invasive nature as well as its nitrogen fixation ability. *Tephrosia vogelii* and *T. candida* are some of the shrubs that are already being used as fertilizer trees in African continent. The trees are suitable for rehabilitating degraded land, and raising soil N, P and K levels in proportion to increased levels of organic matter.

and sustained levels of crop production. The success of alley cropping based nutrient recycling system is related *inter alia* to the quantity and quality of the pruned material from trees, the amount of nutrients released from residues during the decomposition process, and the synchronicity between nutrient release and crop requirements. Planting of leguminous plants with deep root systems to enhance the nutrient uptake from deeper soil layers, combined with N inputs from N fixation, is considered to be one of the most effective ways of improving nutrient cycling on-farm. Many agroforestry systems accumulate Phosphorus in their biomass and return it to the soil when the litter decomposes. Through cycling, some less available inorganic forms of P in the soil are converted into potentially available forms.

Bhoomi Sudha: A potential biomass yielding plant

A number of biomass yielding perennial plants have been reported for their effectiveness in recycling of soil nutrients. *Leucaena leucocephala* (Common name-Subabul) is a commonly used plant for alley cropping system under the sub-humid subtropics. However, the difficulties arising out of invasive nature of the species warrant for identification of effective substitute for Subabul for integration in alley cropping system.

To identify a substitute to Subabul, from 2014 onwards, a number of farmer participatory studies has been carried out by ICAR RCER, Research Centre, Ranchi. These studies have been conducted in experiment-cum-demonstration mode, on-farm as well as at farmers' fields scattered over several districts viz., Ranchi, Khunti and Ramgarh. Based on the observations, Bhoomi Sudha (*Tephrosia candida*) has been identified to be an effective

substitute to Subabul for nutrient recycling in fruit orchards through recycling of biomass.

Model on nutrient recycling in fruit crops

Drawing upon data from five years of experimentation, a model was developed on sustainable bael (*Aegle marmelos*) based production system for the eastern plateau and hill region of India. The approach was of enriching the plant basin through nutrient recycling with biomass obtained from Bhoomi Sudha plants growing in the alley area.

In this model, bael plants are planted at a spacing of 2.5 m x 5.0 m and in between the rows, plants of Bhoomi Sudha are grown from seeds in strips of 3.0 m width. The seeds are sown during July at a spacing of 15 cm x 30 cm in the strips. Loppings from Boomi Sudha can be obtained at least twice a year (September and March) which can be used for mulching of bael plants. A comparison between Bhoomi Sudha and Subabul shows that Bhoomisudha is better in terms of yield and nutrient content. (Table 1)

Based on the nutrient content in tissue, the amount of nutrients that can be recycled during the initial three years through Bhoomi Sudha plants to the root zone of Bael plants are 1.17 t/ha nitrogen, 0.06 t/ha phosphorus and 0.42 t/ha potassium. In case of subabul, a total of 0.41 t/ha of nitrogen, 0.03 t/ha of phosphorus and 0.16 t/ha of potassium can be recycled through the biomass. In monetary terms, the cost of N, P and K that can be recycled through the biomass of Bhoomi Sudha during the initial three years is estimated at Rs 23400/-, Rs 23600/- and Rs 25200/- per ha.

Table 1: Comparison between Bhoomi Sudha and Subabul

S.No	Parameter	Bhoomi sudha	Subabul
1	Dry biomass yield (t/ha)	12.8	10.2
2	Nutrient Content (%)		
	N	2.94	2.94
	P	0.24	0.24
	K	1.06	1.16
3	Micro nutrients (ppm)		
	Zinc	35.35	39.97
	Copper	19.18	14.07
	Manganese	177.60	79.54
	Iron	203.20	159.07

Effects of mulching

Mulching of biomass of Bhoomi Sudha in the plant basin of bael was found to result in significant increase in the soil content of available Potassium, organic carbon and reduction of soil bulk density after three years. The decrease in the soil bulk density can be ascribed to increase in the soil moisture and organic matter content which helps in creating cogeniality for root penetration. Mango orchards in Khunti and Ranchi districts are similarly benefitting from *Tephrosia* leaf shedding and loppings. In the Guphoo village of Torpa block in Khunti district, Bimla Devi was the earliest adopter in 2014. The technology has now spread out to more than 20 orchards in Torpa block and a few more in adjacent Murhu block with the help of PRADAN (an NGO) functionaries.

Mulching of Bhoomi Shudha biomass also resulted in increase in the plant growth parameters like trunk diameter, height, canopy spread and yield of five years old bael plants. In an orchard of mango, with Amrapali variety, mulching with biomass of Bhoomi Shudha for a period of two years could result in marked improvement in the plant vigour of 10 year old mango plants. Although villagers do not have methods to evaluate the impact empirically, they go by the visible effects on foliage as well as quality and yield of fruits. One obvious measure is spontaneous demand for seeds from neighbouring farmers and nearby areas. No wonder that they have locally christened it as '*maind gachh*' meaning 'manure tree'. Adoption is palpably convenient and the way PRADAN has taken up the task of its wide application, it is hoped that it would become a standard practice in the region.

Land reclamation through *Tephrosia* in coal mining affected areas

Vast stretches of land left barren after mines had been spent, asked for efforts to rehabilitate and reclaim. Forestry and fruit trees are being planted and farmers are being encouraged to plant *Tephrosia* in alleys and boundaries. It was planted initially during 2014 at the boundary of one-hectare farm of Mr Sunil Murmu at Phusri village in Ramgarh district. Now, other farmers have also started multiplying them in the alleys. They also use it as supplement in feed for cattle and goats.

Conclusion

Integration of biomass yielding plants like Bhoomi Sudha (*Tephrosia candida*) in the alley area fruit orchards has found to be an effective method for improving the plant growth and yield of fruit trees. However, studies at ICAR RCER, RC, Ranchi indicated mortality of Bhoomi Sudha plants after five years, which warrants resowing of the seeds after every five years. It is an effective substitute to Subabul due to the ease in eradication of the plants when needed. At the ICAR RCER, RC, Ranchi seeds of Bhoomi Sudha are being produced for distribution to the farmers and large number of farmers in Jharkhand have already planted Bhoomi Sudha plants in their orchards. With proper advocacy through the extension agencies, the plant can be utilized in large scale for improving the productivity of fruit orchards.



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