ISSN 2319-6432 (Print)
ISSN 2349-6433 (Online)

J Krishi Vigyan 2024, 12(4) : 947-950

DOI : 10.5958/2349-4433.2024.00162.4

Soil Amelioration through Multipurpose Trees: An Insight from Agroforestry Systems in Jharkhand, India

Kushmita Dhan[1], Anil Kumar[1], Firoz Ahmad[1], Robin Kumar Ram[1] and Abhishek Kumar[2*]

Department of Silviculture &Agroforestry,
Birsa Agricultural University, Ranchi, Jharkhand

ABSTRACT

In Jharkhand, the tradition of tree planting is well-established, with farmers actively managing native multipurpose trees as a defining characteristic of agricultural landscapes. A prominent characteristic of perennial component based land management systems is their ability to enhance the physico-chemical properties of soil and hence the site's production potential.This study examined nine Multipurpose tree species (MPTs)planted at a spacing of 2×2 m in agroforestry systems at the College of Veterinary Science and Animal Husbandry, BAU, Ranchi, located in a subtropical humid climate in Northeast India. Species such as *Millettia pinnata, Pterocarpus marsupium, Swietenia macrophylla, Acacia auriculiformis* and *Dalbergia sissoo* depicted potential as live fences around farm boundaries, providing nitrogen-rich foliage for mulching and manure. The presence of MPTs significantly improved soil properties, including enhanced soil humus and available nutrients, reduced soil erodibility, improved surface soil moisture and water retention capacity (0–30 cm depth). Notably, plots with Karanj (*Millettia pinnata*) exhibited higher concentrations of organic carbon (2.02%), nitrogen (174.68 kg/ha), and potassium (227.36 kg/ha). The study also revealed that the available soil nutrients get reduced with increasing soil depth. Overall, the findings underscored the importance of MPTs in enhancing the physicochemical attributes of soils.

Key Words: Agroforestry, Amelioration, MPTs, Timber, Rainfed, Erodibility.

INTRODUCTION

The physiography of Jharkhand is highly undulating, with sloping hills leading to a higher rate of soil erosion, and areas without tree cover on hilly slopes are vulnerable to erosion and reduced fertility. Alarge portion of Jharkhand's soilis acidic in composition with sandy loam texture, good drainage, poor water holding capacity and low consistency (Oraon *et al*, 2014). Plantation of multipurpose tree species in aforesaid areas can be one of the influential land-use management practices that can halt land degradation and soil erosion. MPTs aims to amplify tribal income and enhance forest cover by planting trees through agroforestry and nurturing forested areas. The contributions will create spaces for wildlife, and agroforestry will empower tribals, providing them with fruits, bark, and medicine for consumption and sale. MPTs can play a crucial role in minimizing soil erosion along gullies and streamsby being planted at the medium to high water mark. Their roots anchor the soil and reduce the impact of stormwater.Agroforestry is a sustainable land use practice that combines trees with crops or livestock, fostering an agroecological succession (FAO, 2013). Recognized for its economic, social, and environmental benefits (Abrha, 2017), agroforestry is globally promoted as a potential means to diversify and improve production systems (Mbow *et al,* 2014).These species should be widely adopted in agroforestry, especially in boundary plantations, as they have the capacity to thrive and survive in rainfed conditions. MPTs can alter the physico-chemical characteristics of soil

Corresponding Author's Email - abhifcp@gmail.com
Department of Silviculture &Agroforestry, Birsa Agricultural University, Ranchi, Jharkhand
2ICAR-Research Complex for Eastern Region, Patna, Bihar

Table 1. Species Description of Multipurpose tree species (MPTs).

Species	Family	Leguminous/Non leguminous	Use	Distribution	Altitude (m)	Rainfall (mm)	Temperature (^{0}C)
Neem	Meliaceae	Non- Leguminous	Fuel wood, fodder, agricultural tools, for making ayurvedic medicines.	India, Bangladesh, Burma, Sri Lanka, Malaysia, Indonesia	Up to 1500.	450 to 1200	21-32
Bakain	Meliaceae	Non-Leguminous	Pole, fuel wood, fodder and also as medicinal/insecticidal purposes	India, China, Tropical South America, and Southern Europe	Up to 1800	600-2400	23-26
Karanj	Fabaceae	Leguminous	Oil, fuel wood, dyeing agent	Asian subcontinent	Up to 1200	500-2500	27-38
Kathal	Moraceae	Non-Leguminous	Pulp is eaten as fruit and vegetable, Wood is used for making furniture, poles.	Southeast Asia	1600	1000-2400	19-29
Bijasal	Fabaceae	Leguminous	Skin diseases, diabetes, elephantiasis, leucoderma, toothache and appetizing	India, Nepal and Sri Lanka	200-500	750-2000	22-32
Gamhar	Lamiaceae	Non-Leguminous	Boat building, papermaking and in the matchwood industry, furniture	India, Bangladesh, Sri Lanka, Myanmar	Up to 1500	1200-4500	20-45
Mahogany	Meliaceae	Leguminous	Construction materials, plywood furniture and cabinet making, boat construction	Southern Mexico	50-1400	1200-1500	23-28
Shisham	Fabaceae	Leguminous	Fuelwood, shade, shelter, soil stabilization	Cameroon, Ethiopia, Indonesia, Iraq	1500	500-1500	40-45
Acacia	Fabaceae	Leguminous	Fuelwood, gum, fodder, timber, dyestuff	Australia	Up to 400	700-2000	17-34

by means of nutrient recycling and litter dynamics.Keeping in multipurpose use, the species is required to propagate in situ and ex situ and also make people aware of its sustainable utilization.

MATERIALS AND METHODS

Experimental Site

The research was conducted at the Agroforestry field, College of Veterinary Science and Animal Husbandry, BAU, Ranchi, under subtropical humid climate in Northeast India during 2020-2021.The three years old, nine MPTs were planted at a spacing 2m × 2m in randomized block design. The research site is characterized by warm, humid weather, receiving an average of 312 mm of rainfall annually, primarily during the monsoon season (June to September). The average maximum temperature varies between 17.5°Cand30°C. The soil has a bulk density of 1.28 g/cm³ and is classified as sandy loam in texture.

Soil chemical properties

Using soil samples collected randomly from five locations within each plot (four corners and the centre), the chemical characteristics of the soil, including pH, organic carbon, and available nitrogen (N), phosphorus (P), and potassium (K) were carefully analysed. Soil samples were collected from 30 cm soil depth in all plots, then air-dried and ground to pass through a 2-mm sieve.The sieved soil was then thoroughly mixed before analysis and the composite samples were prepared to assess various soil chemical properties. The pH of the soil was measured using a digital pH meter with an aqueous soil solution prepared at a 1:2.5 soil-to-distilled water ratio. Soil organic carbon content was determined using the Walkley and Black method, while available nitrogen was quantified using the alkaline potassium permanganate method. Available phosphorus was measured using the ascorbic acid-reduced molybdophosphoric blue colour method, and available potassium was analysed using a flame photometer (Tondon, 1993).

Table 2. Chemical status of soil under study.

Treatments		Soil fertility status of 0 -30 cm soil				
		pH	O. C P. %	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O_5 (kg/ha)
Initial		5.1	0.63	123.94	12.45	68.76
Final		2020	2020	2020	2020	2020
T_1	Neem	5.66	1.18	148.62	4.783	123.94
T_2	Bakain	5.58	1.08	145.46	47.787	120.18
T_3	Karanj	6.69	2.02	174.68	45.851	227.36
T_4	Kathal	5.08	0.74	133.60	20.731	77.28
T_5	Bijasal	6.31	1.8	165.79	14.523	187.41
T_6	Gamhar	5.29	0.86	141.28	5.189	95.57
T_7	Mahogany	5.44	1.06	144.49	4.037	110.13
T_8	Shisham	5.77	1.18	151.46	3.709	132.90
T_9	Acacia	6.01	1.70	162.65	4.256	141.12

RESULTS AND DISCUSSION

Soil physical properties

The presence of MPTs caused a considerable change in the physical characteristics of soil. The potential of multipurpose tree species to ameliorate soil traits largely rely on accumulation of leaf litter and its pace of decomposition. Addition of organic matter through the decomposition of leaf litterhas increased the water retaining capacity of the soil and reducedthe bulk density especially through penetrating into deeper soil layers (Liyanage *et al*, 1997).

Soil chemical properties

Maximum soil pH(6.69) and organic carbon(2.02%) was recorded in Karanj, while least pH(5.08) and organic carbon (0.74%)was shown by Kathal. Litter fall, which generates weak organic acids during decomposition, may contribute to the decline in pH and organic carbon. As well, Karanj registered the highest available nitrogen (174.8 kg/ha)& available potassium(227.36 kg/ha), while Kathal recorded the least available nitrogen (133.60 kg/ha) & available potassium(77.28kg/ha). Available phosphorus (47.78 kg/ha) was recorded highest in Bakain plot(47.78 kg/ha), and the least was observed in Shisham (45.85 kg/ha). The presence of MPTS has been shown to improve soil fertility by enhancing the available N, P and K content, increasing organic matter, and playing a key ecological role in controlling erosion, mitigating climate change, and conserving biodiversity (Lelamo, 2021).

CONCLUSION

It can be concluded that after three years of plantation, soils under *Azadirachta indica*, *Melia azedarach*, *Millettia pinnata*, *Artocarpus heterophyllus*, *Pterocarpus marsupium*, *Gmelina arborea*, *Swietenia macrophylla*, *Dalbergia sissoo*, and *Acacia auriculiformis* exhibited a gradual improvement in key physico-chemical properties. Specifically, these plantations contributed to a notable increase in soil pH, which can enhance nutrient availability, as well as a significant enrichment in organic carbon levels. Furthermore, the presence of these multipurpose tree species led to an improvement in the soil's nutrient status, including the availability of essential nutrients such as nitrogen, phosphorus, and potassium, thus fostering better overall soil fertility. This progressive enhancement of soil quality highlights the potential of these MPTs in promoting sustainable soil health and fertility over time.

REFERENCES

Abrha F W (2017). Determination of Youth Migration the case of TsegedieWereda*. J Busi & Finan Affair* **5**(234): 2167-0234.

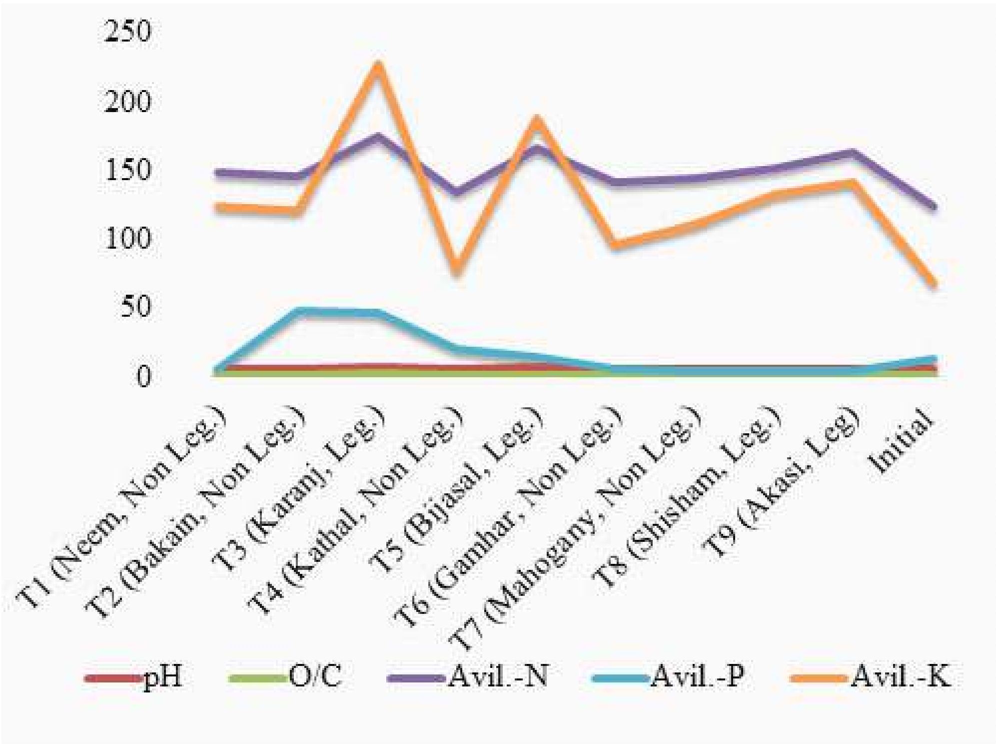

Fig 1. Chemical status of soil under study

FAO (2013). Advancing agroforestry on the policy agenda: a guide for decision-makers. FAO, Rome. Agroforestry Working Paper No. 1. http://www.fao.org/docrep/017/i3182e/i3182e00.pdf.

Mbow C, Smith P, Skole D, Duguma L and Bustamante M (2014). Achieving mitigation and adaptation to climate change through sustainable agroforestry practices in Africa. *Curr Opin in Environ Sustain* **6**: 8–14.

Lelamo L L (2021). A review on the indigenous multipurpose agroforestry tree species in Ethiopia: Management, their productive and service roles and constraints. *Heliyon* **7** (9) : 1-8.

Liyanage M D S, Liyanage V, Dassanayake K B and Abeysoma H A (1997). Role of multipurpose trees in rehabilitatory degraded coconut lands in Sri-Lanka. In Proceedings of *Int Workshop BIO-REFOR, Brisbane* 26-28.

Oraon B C, Malik M S and Bijalwan A (2014). Changes in soil properties under plantation of multipurpose trees species in different ecosystems of Jharkhand, India. *Sci and Edu* ***2***(5): 110-113.

Tandon H L S (1993). Method of analysis of Soils, Plants, Water and Fertilizers. *Fertilizer Development and Consultation Organization*, 204-204A Bhanot Corner, 1-2 Pamposh Enclave, New Delhi - 110 048, India 1-48.

Received on 29/10/2024 Accepted on 18/11/2024