Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; SP1: 1970-1972

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Documentation of existing agroforestry system in Angara block, Ranchi, Jharkhand and its impact on soil organic carbon

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Abstract
The present study entitled "Documentation of existing agroforestry system in Angara block, Ranchi, Jharkhand and its impact in soil organic carbon" was conducted by adopting multi-stage random sampling. A total of four panchayat namely; Getalsud, Nawagarh, Haratuand and Bisa was selected for study. From four panchayat, eight villages and total 120 households were selected for data collection related to agroforestry practice. The data were collected by personal interview of the respondents through a structured interview schedule and soil sample was collected from the field and soil organic carbon analyzed. Few farmers were knowledge about various agroforestry models though few excellent agroforestry models of intercropping were found. Majority of farmers, i.e. 51% of them had adopted Homestead agroforestry followed by Agrisilviculture system 20% and Agrihorticulture system by 19% of the selected population. Apart from this silvipastoral was adopted by 8.5% of population. Silvihorticultre model was adopted very few farmers in the selected village. The soil organic carbon ranged from 0.49 - 0.75. It was gathered by questionnaire that large sample size farmers were practicing organic farming and there was significant use or organic manure over chemical fertilizers in the field. Agricultural crop field had carbon range from 0.49-0.70 whereas in fields where agroforestry was practiced in scientific organized manner had organic content to the maximum of 0.75.

Keywords: Agroforestry, Homestead, Agrisilviculture, Agrihorticulture, agroforestry model

Introduction
Rural economy of our country has deteriorated considerably in the past few years. Degradation of forest land has created shortage of fuel, fodder, food, and timber for the rural community dependent on it. According to Singh *et al.*, (1994) [15] more than 175 million hectares of arable land is facing degradation. Since availability of land is limited, there is need to adopt the practice of agroforestry to meet demands of people. Thus, agroforestry can be implemented not only to meet the demands such as, fuel, food, and fodder for people but also to minimize the pressure on forests. Obsolete and traditional ways of farming and over-exploitation of forest has led to depletion of forest cover and loss of fertility. For example, traditional way of mono-cropping has resulted in loss of soil fertility thereby reducing the productivity. The soil organic carbon (SOC) pool is the only terrestrial pool storing some carbon (C) for millennia which can be deliberately enhanced by agroforestry practices. Agroforestry uses the natural woodland ecosystem as a model to create "a dynamic, ecologically-based, natural resources management system". Agroforestry is an intensive land-management system that optimizes the benefits from the biological interactions created when trees and/or shrubs are deliberately combined with crops and/or livestock (Garrett *et al.*, 1994) [4]. In agroforestry literature, the words ''systems' 'and ''practices'' are often used as synonyms. In real sense agroforestry system is a specific local example of a practice, characterized by environment, plant species, and their arrangement, management, and socio-economic functioning. Agroforestry practice in turn denotes a distinctive arrangement of components in space and time (Nair, 1993). Although hundreds of agroforestry systems have been recorded, they all consist of about 20 distinct agroforestry practices. In other words, the same or similar practices are found in various systems in different situations.

India has many agroforestry systems and practices of various forms and types so it is very difficult to assess or estimate the extent of the area under agroforestry in the country. FSI, 2011 has reported that 25.31 M ha area in the country (8.2 % of the total reported geographical area of the country) is under agroforestry in both irrigated and rain fed agriculture. Land-use management such as, agroforestry systems or the combination of production of trees with agricultural crops plays a very important role in climate change mitigation by absorbing excess carbon dioxide, which is used in the process of photosynthesis by the trees.

Tree-based farm practices such as agroforestry systems are a viable C sequestering option. The incorporation of trees improves soil properties and can result in greater net C sequestration (Young, 1997) [17]. Further, higher species richness and tree density can result in higher SOC contents in Agroforestry systems (Saha *et al.*, 2009) [14]. Compared to monocultures, agroforestry systems are more efficient in capturing the resources available at the site for biomass growth and the increased growth may result in higher C inputs to the soil. In India, carbon sequestration potential ranges from 1.5 to 3.5 Mg C per hectare in small holding Agroforestry systems (Dwivedi *et al.*, 2009) [2].

The topographical features as well as the biophysical challenges collectively generate the risk leading to degradation in the water and land use efficiencies. The entire land forms of Jharkhand state for best management require multiple land use concept implementation, which endorses implementation of agroforestry on priority. Though there are a few agroforestry models which are being practiced in Ranchi and nearby areas which are successful in Angara block of Ranchi is being implemented and monitored by few reputed NGOs (JSLPS, Pradan, and Udyogini) and still there is a lot of scope in growth and adoption of agroforestry systems in Jharkhand. Though there is lack of literature regarding agroforestry system practiced in Jharkhand still some of the agroforestry practices of Jharkhand are agrisilviculture which is being practiced by using fast growing in rows or on the boundaries with the upland crops, Horti agrisilviculture using fruit trees like along with vegetables and cereal crops, Silvipastoral system is being practiced and entomoforestry is also quiet prevalent in Jharkhand as farmers grow tasar and lac on the host plants. But the most prevalent agroforestry model practiced in Jharkhand is Homestead garden where the farmers grow multipurpose trees along with vegetables and rhizome crops to fetch their daily needs of fuel, food and timber. The efforts by the government are still going to popularize the practice of agroforestry, which can meet the demand of people and reduce the pressure from the natural forest resources which are being degraded and exploited. Hence, there is need to study existing agroforestry system in the region and understand the tree performance of agroforestry systemin soil organic carbon improvement.

Materials and Methods

The nature of the problem and the practices selected for the study made a definite demand for the field investigation in the villages. Angara block was selected to carry out this study in Ranchi District of Jharkhand State, India. Farmers practicing agroforestry practice constitute the population of the study. Since the study was to analyze the various agroforestry systems in Angara block by adopting multi-stage random sampling was done and a total of four panchayats, eight villages and 120 households were selected for data collection related to agroforestry practice consultation with JSLPS. The questionnaire for interview schedule was modified according to requirement in the field. Development of interview schedule was made considering the objectives of study which was adjusted on ground according to the requirements. Soil organic carbon analysis was done in laboratory after collection of soil sample from various plots using Walkley-Black method. Once the organic content of sample was calculated, comparison of soil was done according to soil organic content to compare the plots were agroforestry was practiced has higher organic content or lesser than fallow and agricultural land.

Results and discussion

There were various kinds of agroforestry systems found in the selected villages of the block. Majority of farmers had adopted Homestead agroforestry 51%. Agrisilviculture was adopted by 20% of selected population. Agrihorticulture was adopted by 19% of the selected population. Apart from this silvipastoral was adopted by 8.5% of population. Silvihorticultre model was seen negligible in the selected villages. The details of planting pattern of tree species planted by farmers in presented in **Error! Reference source not found.** 2 reveals that most farmers had adopted random planting like in bari and at corners of field. Bund plantation was also adopted by farmers in large numbers. Intercropping was done mainly for horticultural crops like mango, litch, guava, papaya and banana with agricultural crops like chillies, green leaves like spinach, tomaotes and peas. Field plantation was dominated by sisso and ber tree. 82% of farmers had planted trees in scattered form.

Table 1: Agro-forestry model adopted by farmers

Sl. No	Model	Percent (%)
1	Agri-silviculture	20
2	Agri-horticulture	19
3	Silvi-pastoral	8.5
4	Silvi-horticulture	1.5
5.	Homestead	51

It can be concluded from the table- 2 that 82% of farmers had adopted scattered/ random planting patern followed by 65% planting along field borders. Least practiced pattern of plannting was silvipasture practices. This was also supported by Lakra and Sah (2008) [10] reported that in Jharkhand, Ranchi, Gumla and West Singhbhum district there was prevalence of homestead and tree crop mix along field and farm boundaries. Bijalwan *et al.,* (2011) [1] reported that traditional agroforestry system was found in Garhwal Himalaya, India. The predominant traditional agroforestry system reported in the area was agrisilviculture (AS), Agrihortisilviculture (AHS) and agrihorticultre (AH). Oraon *et al*., (2005) [12] studied on comparative performance of Agroforestry system in Kumharia village of Ranchi district and found that the various land use system and stated that agrisilviculture was the most accepted agroforestry system.

Table 2: Planting pattern adopted by farmers.

Sl. No.	Model	% of pattern planting adopted
1	Intercropping/Alley cropping	42
2	Block planting	-
3	Planting along field borders	65
4	Planting along bunds	55
5	Scattered/Random planting	82
6	Silvipasture practices	17

Anand *et al.,* (2016) [6] stated that in study on adoption of traditional Agroforestry among the Farmers in District Sonbhadra, Uttar Pradesh that Farmer prefer boundary planting and scattered planting pattern to grow tree species in their farmland under agroforestry system.

It was observed that the soil organic content was high in the study area. Not very significant but soil organic carbon was high in plots were agroforestry was practiced to agricultural field. The soil organic carbon ranged from 0.49 - 0.75. It was gathered by questionnaire that large farmers were practicing organic farming and there was significant use or organic manure over chemical fertilizers in the field. Carbon content range was higher in comparison to sole agriculture where agroforestry was practiced in scientific organized manner. There was prevalence of practice of organic farming using natural manures. Bio-pesticide and bio-herbicide was also used by farmers. There was lack of organized agroforestry practice which also affected the soil quality.

Table 3: Soil Organic carbon in Angara Block

Serial no.	Organic carbon range	Frequency
1.	0.49-.0.55	33
2.	0.55-0.60	52
3.	0.60-0.75	35

From the table 3 concluded that the range of 0.55-0.60 had highest frequency which indicate that soil organic content over the entire region was good. It was also observed that the highest range of carbon sequestration was found in the agroforestry intercropping model, which was 0.73-0.75. There was use of organic manures over chemical fertilizer and still productivity of the system was good. This study was supported by Lorenz *et al.,* (2014) [11] that the soil organic carbon (SOC) pool, in particular, is the only terrestrial pool storing some carbon (C) for millennia which can be deliberately enhanced by agroforestry practices. Hombegowda *et al.,* (2016) [5] stated that the establishment of home garden and coffee AFSs on agriculture land caused SOC stocks to rebound to near forest levels, while in mango and. Thus it can be concluded that if organized scientific agroforestry is adopted by farmers the net soil organic carbon sequestrated would increase.

Conclusion

Immense potential of agroforestry in the Angara block as large fallow land is available which can be used for agroforestry practices. It will not only help in providing fuel, food and timber but also help in increasing soil fertility and soil organic content as found in this studied as well. Farmer prefers intercropping, boundary planting and Planting along field borders to grow tree species in their farmland under agroforestry system. The main constraints in growing and further expansion of agroforestry models on farm land were shading effect, lack of market facility and long gestation period of tree in the study area.

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