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Tanu Shree Lakra
Department of Silviculture & Agroforestry, Birsa Agricultural University, Kanke, Ranchi, Jharkhand, India

MS Malik
Department of Silviculture & Agroforestry, Birsa Agricultural University, Kanke, Ranchi, Jharkhand, Indi

PR Oraon
Department of Silviculture & Agroforestry, Birsa Agricultural University, Kanke, Ranchi, Jharkhand, Indi

BC Oraon
Department of Silviculture & Agroforestry, Birsa Agricultural University, Kanke, Ranchi, Jharkhand, India

Jai Kumar
Department of Forest Products & Utilization, Birsa Agricultural University, Kanke, Ranchi, Jharkhand, India

SS Das
Department of Agricultural Statistics, Birsa Agricultural University, Kanke, Ranchi, Jharkhand, India

Corresponding Author
Tanu Shree Lakra
Department of Silviculture & Agroforestry, Birsa Agricultural University, Kanke, Ranchi, Jharkhand, India

Tree culture of farmers practicing agroforestry in the eastern region of West Singhbhum district, Jharkhand, India

Tanu Shree Lakra, MS Malik, PR Oraon, BC Oraon, Jai Kumar and SS Das

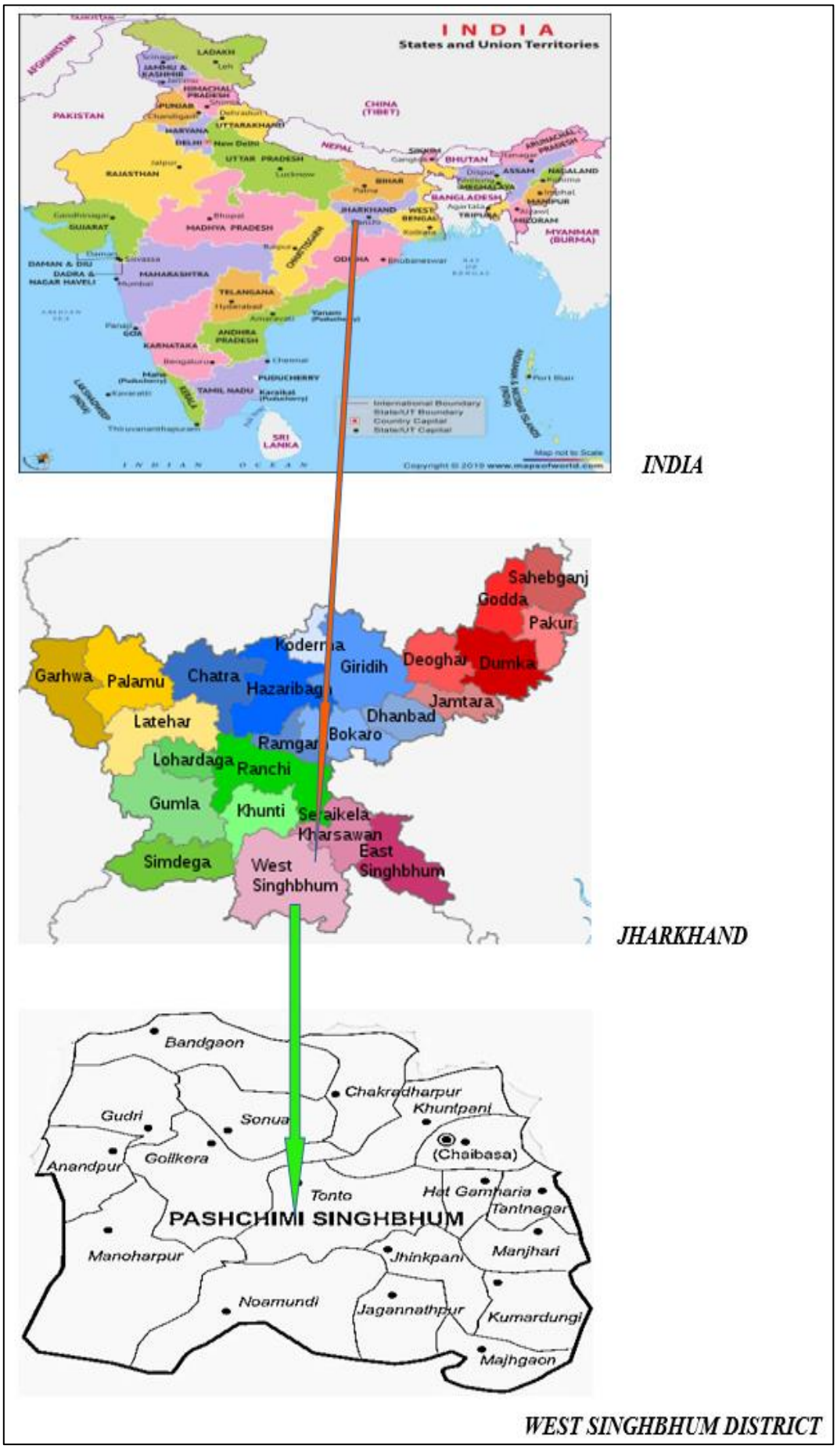
Abstract
This research paper investigates the types of agroforestry system that exist in the four selected blocks of Eastern region of West Singhbhum district Jharkhand. The data were collected through multistage random sampling, field observation and focus groups, followed by household survey of a sample of 320 farmers. The main agroforestry systems homegardens, fruit tree system, timber tree system and mixed fruit–timber system existing the study area. All of them exhibit a noticeable diversity in terms of both species composition, utilization and practices. The observed agroforestry systems include a form of forest dominated by 'cultivated trees'. In land-use classifications agroforestry systems are not recognized as forestry, but like forests they provide tree products and services.

Keywords: Agroforestry, cultivated trees, homgarden, land-use

Introduction
The important and historic relationship of local people and forests is widely reported. The romanticism that external observers often associate with indigenous forest people is strong. Trees are significant in many of the world's mythologies and religions and have been given deep and sacred meanings throughout the ages. In India, large numbers of herbs, shrubs and trees are traditionally worshiped and most of them are known for their uses in worship of several lords. India is a country showing diversity in religion and it is believed, that there are more than 33 million Gods and Goddesses worshiped in various traditional ways throughout the year. The people in India believe that life cannot exist without trees.
This paper investigates the types of agroforestry system that exist in the Eastern part of West Singhbhum district and the basic structural differences between them. Understanding such locally-developed systems can help inform improvements to policies to make them more compatible with local land-use practices. In addition, the history of agroforestry and the complex relationships between agriculture and forestry explain some misunderstandings about the concepts and classification of agroforestry. Contrary to common perception, the development of agroforestry practices has often been more closely related to agriculture than to forestry.

Materials and Methods
Study area
According to the 2011 census, West Singhbhum district has a population of 1,502,338. The district has a population density of 209 inhabitants per square kilometre (540/sq.m). Its population growth rate over the decade 2001-2011 was 21.69%. The West Singhbhum has a sex ratio of 1004 females for every 1000 males and a literacy rate of 59.54%. Scheduled Castes and Scheduled Tribes make up 3.8% and 67.3% of the population respectively. According to the 2011 census, 28.22% of the population was made up of Hindus, 5.83% Christians and 2.54% Muslims. Other religions (mainly Sarna) made up 62.96% of the population. At the time of the 2011 Census of India, the population in the district has different tribal communities ie., Ho (54.37%), Odia (18.74%), Mundari (9.16%), Hindi (4.64%), Santhali (3.35%), Sadhri (2.53%), Urdu (1.96%), Bengali (1.80%) and Kurukh (1.15%) as their first language. The majority of the population of West Singhbhum consists of Ho tribals. The district is covered with hills alternating with valleys, steep mountains, and deep forests on the mountain slopes.

It contains some of the best Sal (*Shorea robusta*) tree forests and the famous Saranda forest. There are plenty of waterfalls and a large variety of wild life like elephants, tigers, leopard, wild dogs and wild boars.



The map of the study area is shown below

Data Collection

In the present study data have been collected from eight villages of West Singhbhum district of Jharkhand State. Four blocks were selected from West Singhbhum district and from each block four villages and from each village twenty households were selected. In this way from each village 20 households were related for study with total no. of respondents ie., 320 as per following details:

1	x	4	x	4	x	20	=	320
District		Block		Village		Household		Total no. of respondents

Table 1: List of selected Blocks and Villages

Sl. No.	Name of selected blocks	Name of selected villages
1	Khuntpani	Matkobeda
		Pandrasali
		Uparlota
		Kendulota
2	Jagganathpur	Badananda
		Jintugara
		Mongra
		Todanghatu
3	Manjhari	Roladih
		Gitilpi
		Dokata
		Lomjori
4	Tonto	Nmdih
		Sankuchiya
		Rampusi
		Chalgi

The study is based on survey of 20 randomly selected household practicing agroforestry from each village with the help of a questionnaire specially designed and pretested for the interviewing the socio-economic survey. Multi-stage random sampling technique was used to select four blocks namely Khuntpani, Jagganathpur, Manjhari and Tonto and from each block four villages and from each villages 20 respondents or households were selected for the observation. The data related to agroforestry practices were derived from 20 farmers.

Results

The agroforestry systems are used mainly to provide products to support livelihoods, and are based on traditional knowledge and mainly developed from farmers' own trials. Various types of agroforestry system were found in the study area, and all conform to the hortus model described above.

Tree Culture of Farmers Practicing Agroforestry

Homegarden

Tree growing in the home compound is a long-standing tradition, consisting of an assemblage of plants which includes trees, shrubs and herbaceous plants. Contrary to a superficial appearance of a random assemblage, the gardens were usually carefully structured and purposefully managed. The ground layer is usually partitioned into two, with the lower-most (1 m height) dominated by a range of vegetable and medicinal plants, and the second layer (1–3 m height) composed of food plants e.g. banana. Various fruit trees, including guava (*Psidium guajava*), pomegranate (*Punica grantum*), mango (*Mangifera indica*), some of which would continue to grow taller, dominate the intermediate layer of 3–10 m height. The upper tree layer consisted of timber and fruit trees, with 35–70% of tree cover being 10–20 m in height and the remainder being taller upper canopy and emergent tree crowns.

Hortisilvicultural System (Fruit Tree System)

These have been established on farmer agriculture fields, through the planting of fruit trees and understory crops (Table 2). This is generally a permanent system, as the fruit trees, including mangoes (*Mangifera indica*), guava (*Psidium guajava*), jamun (*Syzygium cumini*), kathal (*Artocarpus heterophyllus*) etc. are productive for a long time period. The individual fruit trees are established and maintained as integrated components of the system continuously over time with over-mature trees being individually replaced whenever needed. This maintains a high, closed canopy of trees with dense undergrowth and high levels of agro-biodiversity. Some of them have been converted into mixed tree gardens (fruit and timber), a focus on fruit production has resulted from the recent increase in demand from markets. It was observed that fruit trees represent the main permanent structure of the system, comprising 25–60% of the canopy cover which is more than 15 m in height.

Silvicultural system (Timber Tree System)

The timber tree system is rotational, based on planting of a selected important timber species, e.g. teak (*Tectona grandis*) that makes up 30–70% of the canopy tree cover, above various types of understory crop. This system is also generally established on other agriculture fields. In principle, stands of timber trees are harvested at a time when their diameter reaches a size to yield useful timber, after which they are either immediately replaced through natural regeneration or planting, or the land use is reverted to seasonal crops for a few years before being planted to trees again,.

Mixed Fruit-Timber System

This system is generally practiced on land where the farmers previously planted seasonal cash crops, including cultivation fields. It is characterized by high species diversity and usually three to four vertical canopy strata of intimately mixed plant species leading to a total tree canopy cover of 35–70%. The selection of crops for cultivation based on their shade tolerance and these crops are established while tree species grow up over the years with gradual canopy coverage. After harvesting of timber, they are usually not replaced by planting new timber trees. In contrast fruit trees are maintained to continue fruit production for a longer period of time.

Table 2: Harvested agroforestry products observed

Local or English name	Scientific name
Vegetables	
Bean	*Dolichos lablab*
Cassava	*Manihot utilissima*
Chilli	*Capsicum annuum*
Cowpea	*Vigna sinensis*
Cucumber	*Cucumis sativus*
Okra	*Abelmoschus esculentus*
Pumpkin	*Cucurbita pepo*
Spinach	*Spinacia oleracea*
Sweet potato	*Ipomoea batatas*
Kacchhu	*Colocasia esculenta*
Tomato	*Lycopersicon esculentum*
Cereals/oil seed crops	
Maize	*Zea mays*
Rice	*Oryza javanica*
Sunflower	*Helianthus annuus*
Peanut	*Arachis hypogaea*
Onion	*Allium cepa*
Spices	
Ginger	*Zingiber officinale*
Garlic	*Allium sativum*
Chilli	*Capsicum annum*
Lemongrass	*Cymbopogon citratus*
Fruits and Nuts	
Bel	*Aegle marmelos*
Banana	*Musa spp.*
Coconut	*Cocos nucifera*
Guava	*Psidium guajava*
Jackfruit	*Artocarpus heterophyllus*
Lemon	*Citrus limonum*
Mango	*Mangifera indica*
Papaya	*Carica papaya*
Ber	*Ziziphus mauritiana*
pomegranate	*Punica grantum*
Timber	
Teak	*Tectona grandis*
Babool	*Acacia nilotica*
Khair	*Acacia catechu*
Shisham	*Dalbergia sissoo*
Kadam	*Anthocephalus cadamba*

Discussion

In the eastern region of West Singhbhum district, agroforestry practices can be classified into various systems which belong to the horticulture based model on the diversity of species cultivated, and structural as well as functional diversity. These systems are characterized by the establishment of a high, closed canopy with dense undergrowth and high levels of agro-biodiversity; a close integration of trees with local crops, and utilization of the principle of multi functionality in their management. Although these systems are designed for production, they are all characterized by high ecological diversity in terms of species composition and economically in terms of their range of products and patterns of utilization (Rahman *et al.* 2013; Manurung *et al.* 2008) [2].

The canopy cover of observed trees on agroforestry land ranged between 30 and 70%. However, this still lies outside the definition of forest FAO (2000) [1]. While it does have a tree canopy cover (10% and often exists in patches) 0.5 ha, it does not meet the criterion of being ‘‘not primarily under agricultural land use’’. The FAO definition specifically excludes stands of trees established primarily for agricultural production, for example fruit tree plantations. However, the FAO definition of forest is not a matter of function as both forests and agroforestry systems provide tree products and services. Rather it is an arbitrary distinction of perception. Therefore, Roshetko *et al.* (2008) [5] have argued for the recognition of agroforestry that surpasses the minimum thresholds of tree canopy cover and area as ‘‘forests’’.

The agroforestry systems documented in this study are not only a form of forest like ‘cultivated trees’, but also of ‘anthropogenic vegetation’. Growing trees is a traditional practice in the research site which has been derived from agricultural antecedents, e.g. through farmers’ long experience of trials of new practices and has mainly been used to produce livelihood necessities.

Agroforestry farmers in the research site own small areas of land (0.98 ha) but allocate a high proportion to agroforestry (0.85 ha). It was surprising that the farmers reported annual income from agroforestry to be much lower per land area (IDR 3.25 million/0.85 ha) than income from remaining agricultural land (IDR 1.66 million/0.11 ha). The income from products harvested from both systems was based on farmers’ reports of their income during the one most recent production year. However, for most of the farmers the timber trees in their agroforests had yet to reach harvestable maturity and in some cases fruit trees had yet to grow to maturity and

achieve maximum yield. Since tree species have a longer juvenile period compared with agricultural crops e.g. rice, income from agroforestry systems will be much lower during the years of the establishment phase (Rahman *et al.* 2008) [3]. While the landholdings per family were small, high yields of agricultural crops can be obtained per area of land provided that there is sufficient input of labour. Given the importance of off-farm income (equating to 76% of total income) available labour, rather than available farmland, is the most economically limiting resource for most of the households. Most do not have the available labour to intensively cultivate agricultural crops in all arable lands. Therefore, practicing more permanent agroforestry systems is appropriate for them. These systems require less labour input, while still increasing (or maintaining) their natural capital value. These factors are all likely to contribute to the spontaneous tree product diversification through smallholder agroforestry, as has been observed elsewhere in Indonesia and tropical Asia (Snelder and Lasco 2008; Manurung *et al.* 2008) [6, 2].

Conclusions

The agroforestry systems in the eastern region of West Singhbhum district share the properties of forests, yet economically and culturally they are an important component of farming systems. In areas where agroforestry is less well established the introduction of tree culture into subsistence monocropping cycles can represent a viable strategy for agricultural diversification. Such a strategy needs to be informed by the local productive activities, especially existing farming systems and livelihood strategies. Of particular importance for government agencies is to improve the dissemination of information about successful management practices and the availability of any necessary materials not currently available to farmers, e.g. loans (Rahman *et al.* 2012) [4]. Given the properties that agroforestry shares with both agricultural and forest systems, their classification will always be problematic if a binary system is applied. Therefore a more sophisticated approach should be adopted that incorporates the economic and environmental characteristics of a wider range of systems.

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