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Nikita Kumari
Department of Silviculture and Agroforestry, Faculty of Forestry, BAU, Ranchi, Jharkhand, India

MS Malik
Department of Silviculture and Agroforestry, Faculty of Forestry, BAU, Ranchi, Jharkhand, India

Jai Kumar
Department of Forest Products and Utilization, Faculty of Forestry, BAU, Ranchi, Jharkhand, India

Jyoti Kumari
Department of Forest Products and Utilization, Faculty of Forestry, BAU, Ranchi, Jharkhand, India

Comparative assessment of tree growth parameters grown under different Agroforestry systems

Nikita Kumari, MS Malik, Jai Kumar and Jyoti Kumari

Abstract
The traditional land use practice in major parts of Jharkhand has a plenty of resembling factors to associate it with modern day agroforestry. The rational behind such practice has been to gain more economic benefit from the small and fragmented land. To bridge the gap between the existing practice and scientific agroforestry, a close study of various growth parameters such as height and girth of various species existing in different agroforestry systems seems very crucial. In this respect a random sample survey was done in eight villages of four different panchayats of Namkum block in Ranchi. The survey revealed a number of agroforestry practices like agrisilviculture, agrihorticulture and silvipasture system. The respondent were found to be growing various agriculture crops in combination with tree crops such as *Melia azaderach, Leucaena luecocephala, Tectona grandis, Gmelina arborea, Pongamia pinnata, Dalbergia sissoo* etc. Therefore the average girth and average diameter of all the species present in the study area has been calculated and also the approximate volume of the important species has been calculated.

Keywords: tree growth parameters, Agroforestry systems

Introduction
Agroforestry, like multifunctional agriculture, has the objective of promoting economically, socially, and environmentally sustainable rural development (Leakey, 2012). Agroforestry provides opportunities to increase the value of total production through marketing of multiple products from a given unit of land (Feldhake *et al.,* 2008). Agroforestry practices offer many advantages such as crop and livestock protection, soil and stream conservation and protection, diversification of agricultural revenues through the production of timber and non-timber forest products, promotion of biodiversity, landscape enhancement and carbon sequestration (Cole, 2010).

The traditional land use practice in major parts of Jharkhand has a plenty of resembling factors to associate it with modern day agroforestry. The rational behind such practice has been to gain more economic benefit from the small and fragmented land. To bridge the gap between the existing practice and scientific agroforestry, a close study of various growth parameters such as height and girth of various species existing in different agroforestry systems seems very crucial. In this respect a random sample survey was done in eight villages of four different panchayats of Namkum block in Ranchi. The survey revealed a number of agroforestry practices like agrisilviculture, agrihorticulture and silvipasture system. The respondent were found to be growing various agriculture crops in combination with tree crops such as *Melia azaderach, Leucaena luecocephala, Tectona grandis, Gmelina arborea, Pongamia pinnata, Dalbergia sissoo* etc. Therefore the average girth and average diameter of all the species present in the study area has been calculated and also the approximate volume of the important species has been calculated. At present there is a need for closer study of the prevailing agroforestry practices and their socio-economic impact on people's life. So it is necessary to identify the existing agroforestry practice of the farmers, performance of tree as well as agricultural crops and impacts of these agroforestry practices with the objective to study the tree growth parameters of agroforestry trees.

Materials and Methods
Location
The experiment was conducted at different sites of Namkum block of Ranchi district (Jharkhand) which lies between 85°22'E longitude and 23°21'N latitude in agro climatic zone IV. The site is situated 25 km away from the Birsa Agricultural University on Kanke-Ranchi-Namkum Road. The experimental sites are undulated and steep sloped. Namkum is one of the 20 administrative blocks of Ranchi district in the state of Jharkhand. It belongs to Khijri

Correspondence
Nikita Kumari
Department of Silviculture and Agroforestry, Faculty of Forestry, BAU, Ranchi, Jharkhand, India

Assembly Constituency. It is spread over an area of 415.57 square kilometers. There are 23 Panchayats and a total of 109 villages. Geologically, it belongs to the archean age of granite gneissic formation. Other rocks are amphibolites, khondalite, mica schist, etc. Most parts of the total area are considered rural since it is in the outskirts of the city situated in the eastern end of Ranchi.

Preparation of interview schedule
Interview schedule for respondents was prepared on the basis of literature referred, reconnaissance survey and discussion with subject matter specialist to collect information from them regarding their socio economic status, land use characteristics general awareness with respect to various agroforestry activities, participation in various agroforestry activities. Selection of respondents was done by multi stage random sampling technique. Household heads were treated as respondents engaged in agroforestry activities and were selected as target group for the data collection.

Collection of Data
The data were collected by personal interviews of the respondents through a structured interview schedule. A part from this qualitative analysis was done on the basis of observation and interaction with the respondents. Interview was conducted preferably in isolation and the information was further cross checked by Focus Group discussion and personal observations wherever possible.
All the sites selected for study was thoroughly surveyed and all the available tree species present in the sites was listed. The species, height and diameter were measured as per the

standard method. While surveying, number of trees present in each species were identified, counted and accordingly they are listed. Only those individual trees of each species are enumerated which appear to have been attained the pole stage or appear to have been established in the site. The height of individual tree from ground level to the top of crown was considered as height, which was measured with a graduated bamboo marked in cm and meter. The height is expressed in meter. The girth of individual trees at breast height level i.e. at the height of 1.37 m from ground on tree trunk was measured with the help of tape and expressed in terms of cm. The volume production of tree species listed by the above methods was calculated and listed and volume of timber tree species was calculated by using Quarter Girth Formula.

$$V= (g/4)^2 \text{x } l$$

Where, g = girth at mid pt., l = length of the log

Result and Discussion
Growth parameters of tree species under various Agroforestry Systems
The Growth parameter of diameter and height and volume production of tree species of Namkum Block under various agroforestry systems is presented in Table 1. The tree species like *Melia azaderach, Leucaena leucocephala, Gmelina arborea, Tectona grandis* were commonly found in Namkum Block. Perusal of data indicated that in Agrisilviculture system *Tectonagrandis* had maximum height of 15.00m followed by *Gmelina arborea* i.e.13.97m.

Table 1: Growth parameters of tree species under Agrisilviculture Systems

| Sl. No.	Name of species	Common Name	Avg. Ht (m)±S.E$_M$	Av. girth (m) at mid pt. ±S.E$_M$	Avg. vol (cu.m) ±S.E$_M$
1.	*Melia azaderach*	Bakain	9.11±1.27	0.44±0.04	0.110±0.007
2.	*Leucaena leucocephala*	Subabul	10.69±1.39	0.51±0.07	0.173±0.002
3.	*Gmelina arborea*	Gamhar	13.97±1.11	0.64±0.06	0.360±0.009
4.	*Tectona grandis*	Sagwan	15.00±0.01	0.68±0.50	0.440±0.01
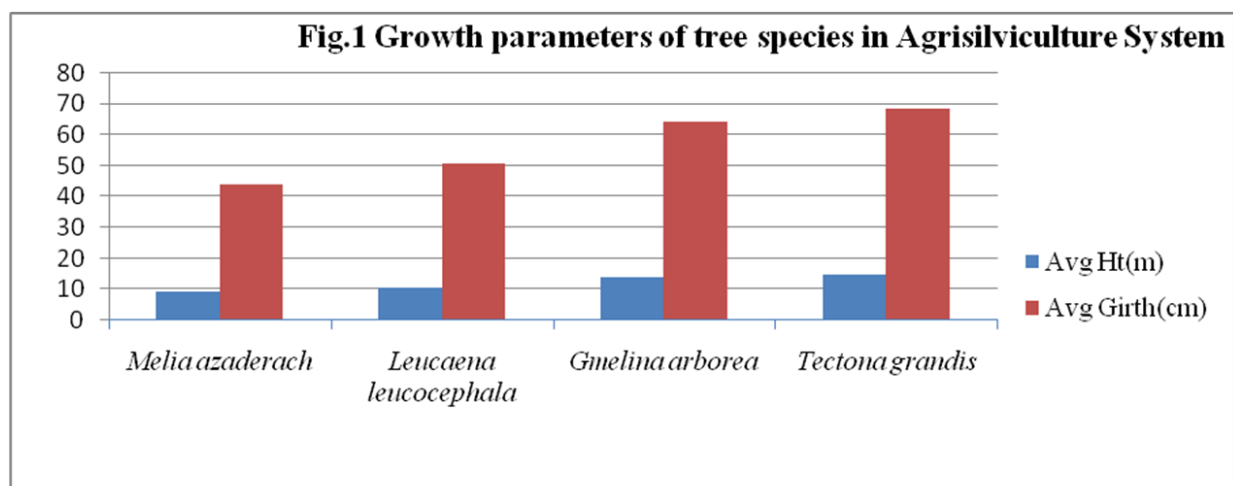
Growth parameters of tree species under Agrihorticulture System

In agrihorticulture system the tree species such as *Artrocarpus heterophyllus* and *Sygzium cumini* with average height

17.01m and 12.49m were present in the study area. The average girth was maximum in *Sygzium cumini* 0.91m.

Table 2: Growth parameters of tree species under Agrihorticulture System

Sr.No.	Name of species	Common Name	Avg. Ht (m)±S.E$_M$	Av.Girth (m) at midpt. ±S.E$_M$	Avg. Vol (cu.m) ±S.E$_M$
1	*Artocarpusheterophyllus*	Jackfruit	17.01±0.97	0.78±0.05	0.646±0.001
2	*Sygyziumcumini*	Jamun	12.49±0.83	0.91±0.05	0.646±0.001

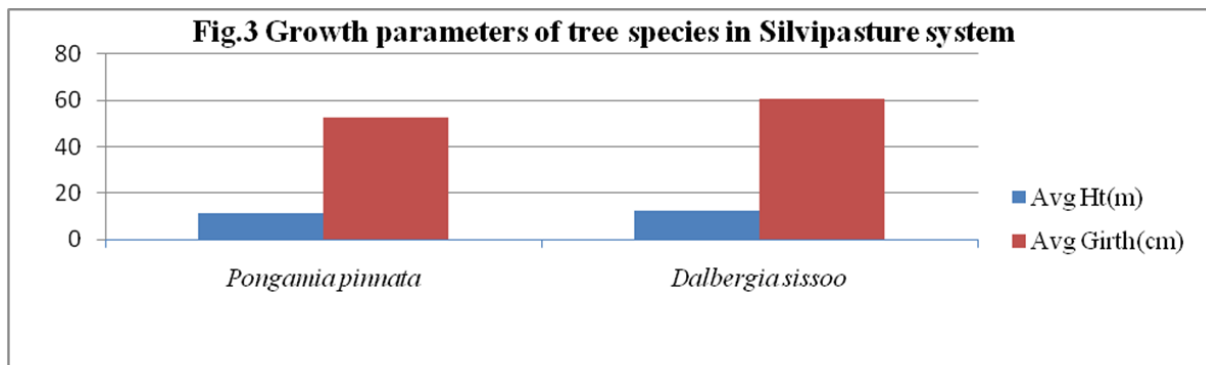Fig.2 Growth parameters of tree species in Agrihorticulture system
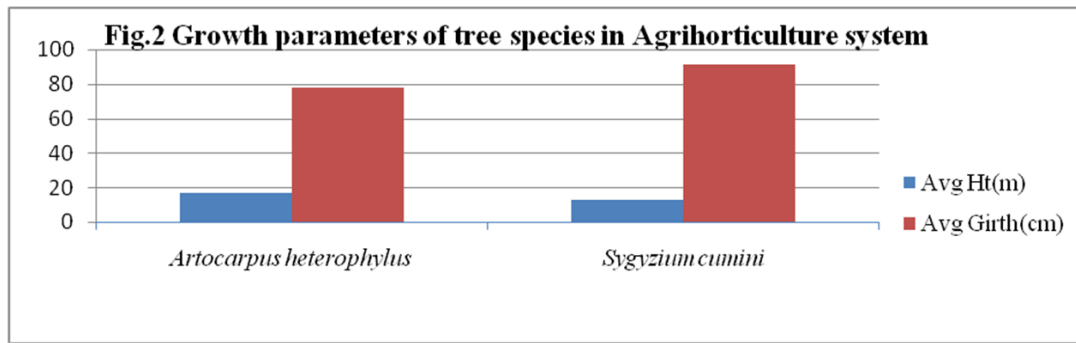
Growth parameters of tree species under Silvipasture System

In silvipasture system the tree species found in namkum block were *Pongamia pinnata* and *Dalbergia sissoo* with average height of 11.09m and 12.59m whereas the average girth was 0.52 and 0.61m respectively.

Table 3: Growth parameters of tree species under Silvipasture System

Sr. No.	Name of species	Common Name	Avg. Ht (m)±S.E$_M$	Av.Girth (m) at midpt. ±S.E$_M$	Avg. Vol (cu.m) ±S.E$_M$
1.	*Pongamia pinnata*	Karanj	11.09±0.75	0.52±0.05	0.187±0.002
2.	*Dalbergia sissoo*	Shisham	12.59±1.72	0.61±0.07	0.291±0.001

Fig.3 Growth parameters of tree species in Silvipasture system

Conclusion
The growth parameters in agrisilviculturesystem included tree species like *Melia azaderach*, *Leucaena leucocephala, Gmelina arborea and Tectona grandis* in which *Tectonagrandis* showed most favourable result in terms of average height (15.00m), girth (0.68m) and volume (0.44cu.m). Similarly in agrihorticulture system the combination of *Sygzium cumini* showed better results in terms of average girth (0.91m) and volume (0.646cu.m). The findings for silvipasture system suggested that the combination of *Dalbergia sissoo* with other pasture crops proved to be most economic in terms of average height (12.59m), girth (0.61m) and volume (0.291cu.m).

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