



Assessment of agroforestry systems existing in farmers field of Narsinghpur district (Madhya Pradesh)

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ABSTRACT: Agroforestry systems become popular among farmers due to their multiple products besides improving soil productivity and income. Various agroforestry systems were adopted by the farmers in their field/field bunds. The present study deals to assess the adoption level of existing agroforestry systems by the farmers. A total of 135 farmers from three blocks of Narsinghpur district (Central Narmada Valley Agroclimatic Zone of M.P.) were selected by adopting a multistage random sampling method. An extensive survey was carried out to record tree and crop preference, reasons for adoption, problems associated with agroforestry, and awareness of tree farming from the farmers by using a pretested questionnaire and recorded data from the small, medium, and large farmers of Narsinghpur district. Data revealed that the majority of small farmers practiced Horti-Agri System (10.37%), while medium (8.15%) and large (8.89%) farmers practiced the Silvi-Agri System. The primary motive for adopting agroforestry systems was to obtain multiple products (20.74%) to better their livelihood, and after adopting fourteen different types of agroforestry systems, the majority of farmers noticed shade effects (25.19%) on yield of agricultural crops was a major constraint among the farmer communities. As per landholdings, small, medium, and large farmers adopted bund plantation (30.37%, 14.07%, 16.30%) and block plantation (2.96%, 1.132%, 1.71%), respectively. The present study reported that farmers are now proclivity towards the adoption of different agroforestry systems.

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1. INTRODUCTION

Agroforestry is a longstanding tradition that has been practiced in India for thousands of years (Puri and Nair, 2004). Agroforestry is a versatile practice employed in both irrigated and rain-fed conditions, providing multiple benefits like food, wood, fuel, fodder, fiber, and green fiber. It plays a vital role in ensuring food security, improving nutrition, and maintaining ecological balance, while also supporting livelihoods and reducing poverty. Agroforestry contributes to the resilience and productivity of agricultural systems by fostering environments conducive to sustainable crop and farm management and also contributes to ecosystem services by storing carbon, reducing deforestation, conserving biodiversity, promoting soil and water conservation, and enhancing the resilience of agricultural lands against extreme weather events like floods, droughts, and the impacts of climate change (National Agroforestry Policy, 2014).

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According to the Indian State of Forest Report (ISFR), 2021, the country's forest cover is 21.71% of its geographical area but the country's is less than the actual target *i.e.* up to 33% as per National Forest Policy, 1988. India was the first country to adopt an agroforestry policy in the year 2014 with one of the objectives of expanding tree plantation through agroforestry, as this land use practice is the only way to achieve 33% forest cover. Few preliminary studies have been done to estimate agroforestry areas in 13 agroclimatic zones and recorded areas of 23.25M. ha. (Rizvi *et al.*, 2019) currently, India has about 28.42 million hectares of area under agroforestry and has achieved the milestone of being the first nation to systematically demarcate the entirety of its agroforestry expanse across the country (Arunachalam *et al.*, 2022).

The present study aims to assess the adoption level of agroforestry by the farmers, tree and crop preferences, reasons for adoption, constraints in farming practices, and level of awareness of tree farming. Various researchers worked on agroforestry systems prevailing in different agroclimatic regions of India *viz.* Paddy + *Acacia nilotica* Agroforestry system in Chhatisgarh region of Madhya Pradesh (Viswanath *et al.*, 1994), *Dendrocalamus strictus* + sesame-chickpea in semi-arid tropics of central India (Dev *et*

al., 2020), *Cajanus cajan*+ *Psidium guajava* + *Pterocarpus marsupium* (Berry *et al.*, 2021), *G. arborea*+*C. longa*+*Z. officinale* + *P. betle* (Berry *et al.*, 2022). Few studies were conducted on the adoption level of agroforestry systems by the farmers in Sub Temperate to Temperate (Pali village, Paiuri district, Garwal Himalaya) (Nautiyal *et al.*, 1998), Kymore Plateau and Satpura Hills Agro Climatic Zone (Jabalpur district) of Madhya Pradesh (Sharma *et al.*, 2005), Vindhyan area (Sonbhadra district) of Uttar Pradesh (Anand *et al.*, 2016) Southern Hills of Navsari district of Gujrat (Singh *et al.*, 2017), Central narmada valley agroclimatic zone (Hoshangabad district) of Madhya Pradesh (Berry *et al.*, 2021) and Kymore plateau and Satpura Hills agro-climatic zone (Seoni district) of Madhya Pradesh (Berry *et al.*, 2023).

2. MATERIALS AND METHODS:

2.1 Study site description

Narsinghpur (Fig.1), is a part of the Central Narmada Valley Agroclimatic zone of Madhya Pradesh. The district is flourishing with its cultural heritage, economic sustenance, and agricultural productivity with rich irrigation facilitated by the Narmada River to make it fertile land. This district is characterized by its rich black soil, renowned for its fertility, and agricultural landscape further diversified by various soil types, including Black loamy, smooth, rocky, loamy, and sandy compositions. Agricultural practices in Narsinghpur are complexly tied to seasonal cycles, with Rabi crops such as Wheat, Pulses, Peas, Flaxseeds, and Lentils cultivated during the winter season, and Kharif crops including Paddy, pulses like Moong, Urad, fodder crops Sorghum, Pearl millet, Maize, Sugarcane. Soybeans and sugarcane are particularly important commercial crops, as they are grown for oil extraction and sugar/gud (jaggery) production. The district has a 9-10 sugar mills, earning it the name "Sugar Bowl of Madhya Pradesh," highlighting its importance in the state's agro-economy. (<https://narsinghpur.nic.in>)

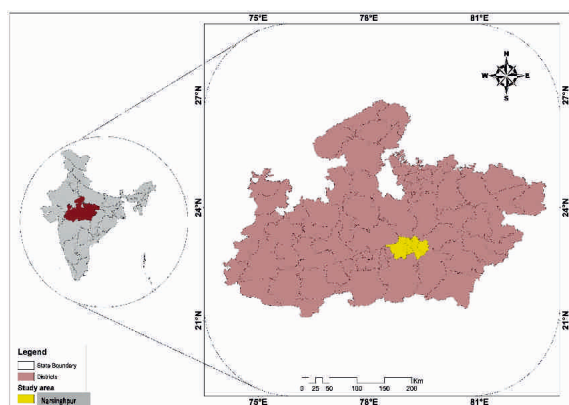


Fig. 1. Map of the study area

2.2 Sampling technique and selection of farmers

A multistage random sampling method was used for the selection of farmers. Three blocks namely Shridham, Narsinghpur, and Kareli were selected in Narsinghpur district. In each block, 15 villages and 3 landholding categories, and 15 farmers in each landholding category were selected. (Fig 2.). A total of 135 farmers were selected, a face-to-face interview and field visit were conducted with the heads of the family members and collected information on agroforestry practice, tree, and crop preference, reasons for adoption, problems associated with agroforestry and awareness of tree farming with the pre-tested questionnaire during 2021-2024 (Berry *et al.*, 2021 and Berry *et al.*, 2023)



Fig 2. A multistage sampling of farmers

3. RESULTS AND DISCUSSION

Data revealed that out of 3 blocks, 45 villages and 135 farmers of Narsinghpur district adopted 14 different types of agroforestry systems (Fig 3.) on their farms. Maximum farmers adopted Silvi-Agri system (25.19%) followed by Horti-Agri system (24.44%), Silvi-Agri-Horti system (20.00%), few farmers adopted a complex system having more than two components like Silvi and horti tree, fodder crop, vegetable crops, medicinal crops, flower species and fish culture with forestry and horti species. Other researchers also conducted the study on different agro-eco regions such as Sharma *et al.*, 2005, who documented the adoption of agroforestry systems in Kymore Plateau and Satpura Hills Agro Climatic Zone (Jabalpur district), Behera *et al.*, 2013 noticed six agroforestry systems in Western Central table land (Boudh district) of Odisha, Bodega *et al.*, 2022 documented Agri-Silvi system was most adopted system in Central plain zone (Allahabad district) of U.P, Berry *et al.*, 2023 reported various systems viz Silvi-Agri-Horti (48.85%), Silvi-Agri (28.85%), Horti-Agri system (20%) in Kymore plateau and Satpura Hills (Seoni district).

Maximum small farmers have adopted Hort-Agri system (10.37%) followed by Silvi-Agri-Horti system (8.89%), Silvi-Agri system (8.15%), while maximum medium and large farmers adopted Silvi-Agri system (8.15% and 8.89%), followed by Horti-Agri system (7.41% and 6.67%) and Silvi-Agri-Horti system (5.19% and 5.93%), respectively.

In case of Medium and Large farmers are interested in adopting innovation in tree farming systems like woodlot (3.70% and 4.44%), Horti-Medicinal system (1.48% and 2.22%), Silvi-Horti System (1.48% and

During the field visit, a few farmers are facing constraints (Fig 7.) by adopting agroforestry systems. The majority of farmers faced shade effect (25.19%) grain yield reduction, followed by Bird and Monkey attack and losses (15.56%), availability of Quality planting material (14.07%), non-availability of the market (11.85%), and rigid rule of felling (10.37%) are major constraints in Narsinghpur district. Similar problems were also reported by, Berry *et al.*, 2021, Berry *et al.*, 2023, Verma *et al.*, 2017 and Chauhan and Chauhan, 2011.

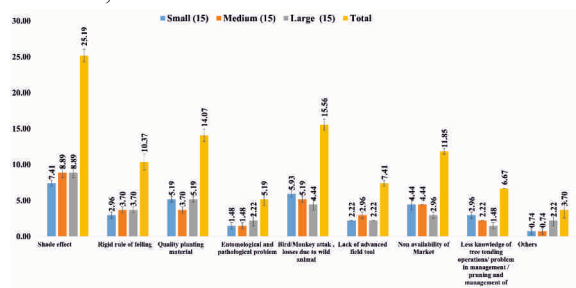


Fig 7. Constraints faced by farmers after adoption of agroforestry systems in Narsinghpur District (M.P.)

Another important aspect is to right selection of species, which is very important for the success of any plantation. Nowadays farmers are generally aware of the right species for agroforestry systems.

According to different agroforestry systems, there are eleven systems (n=88) (Fig 8.) based on Silvi components and nine systems based on Horticulture components (n=83) (Fig 9.). Several species were documented according to the system and components used in the agroforestry systems and reported that the maximum number of farmers adopted *Tectona grandis* (25.8%) in both bund and block patterns in the Silvi-Agri system, Silvi-Agri-Horti system, Silvi-Medicinal system, Woodlots and other Silvi based agroforestry systems followed by *Eucalyptus* spp.(20.2%), adopted by maximum farmers in Shridham and Narsinghpur block in the woodlot, Silvi-Oleri system, Silvi-Pasture system, and Silvi-Agri system, *Leucaena leucocephala* (12.4%) used by farmers to fulfill the dietary need of livestock, *Gmelina arborea* (11.2%) is now adopted by farmers of Narsinghpur and Kareli blocks in Silvi-Agri system, Silvi-Medicinal system, and Silvi-Oleri system.

As acceptance of agroforestry and the uses of fast-growing species helps to increase the social status of farmers, farmers of Kartaj village of Narsinghpur block and Chitapar, Linga, Barman khurd, Badiya ghat villages, of Kareli blocks widely adopted *G. arborea* on bunds and block, few combinations are reported during survey *G. arborea*+ *Curcuma longa* in Silvi-Medicinal system, *G. arborea*+ *Allium sativum*, *G.*

arborea +*Lagenaria siceraria*, *G. arborea* + *Luffa cylindrica* in Silvi-Oleri system, *G. arborea* with *Oryza sativa*, *Triticum aestivum*, *Saccharum officinarum* based Silvi-Agri system is being popularized among the farmers community day by day.

In Shridham, and Narsinghpur woodlot of *Eucalyptus* spp. is very common among the large farmers planted for commercial purposes. *Eucalyptus*+ *Abelmoschus esculentus*, *Eucalyptus*+ *Capsicum frutescens*, *Eucalyptus*+ *Brassica oleracea* based Silvi-Oleri system adopted by farmers in both the blocks. In the Narsinghpur block Horti-Medicinal system *Psidium guajava*+*Cucuma longa*, and *Citrus lemon* + *Curcuma longa* is practiced by farmers. Table 1 and Figure 10 – 15 depict different agroforestry systems with tree-crop combinations in Narsinghpur District. It was also documented that after facing the COVID pandemic few farmers planted Neem on their farm bunds, and few farmers adopted a medicinal plant-based intercrop and increased the uses of medicinal plants in their daily lives. Farmers also adopted fruit-yielding species, the majority of farmers adopted *Mangifera indica* (32.5%) followed by *Psidium guajava* (26.5%) in different Horti-Agri system, Horti-Medicinal system, Silvi-Agri-Horti system, and other Horti based agroforestry systems, farmers also preferred *Musa paradisiaca* (10.8%), *Phyllanthus emblica* (8.4%) and *Carica papaya* (7.2%), in block and bund planting pattern.

Other researchers are also documented species used in agroforestry, Behera *et al.*, 2013 that the majority of farmers planted Teak, *Eucalyptus*, bamboo, and *Acacia mangium* in a block pattern in the Western Central table land (Boudh district) of Odisha. Parihaar *et al.*, 2015 documented that *Mangifera indica* and *Tectona grandis* were the most preferred species by the farmers of the Kumaon Himalayan region, Berry *et al.*, 2021 and Berry *et al.*, 2023 also documented that *Mangifera indica* and *Tectona grandis* was most dominant species in Central Narmada Valley agroclimatic zone (Hoshangabad district) and Kymore plateau and Satpura Hills agro climatic zone (Seoni district), respectively. Bijlwan *et al.*, 2019 also studied and recorded various tree species, and tree-crop combinations used by farmers in different agroclimatic zones of Madhya Pradesh.

It was also observed that some Multipurpose tree species (MPTs) like *Buchanania lanzan*, *Aegle marmelos*, *Madhuca longifolia*, *Terminalia arjuna*, *Holoptelea integrifolia*, *Dalbergia sissoo*, *Sapindus mukorossi*, *Saraca asoca*, *Santalum album* and *Acacia catechu* found on bund and scattered in the farm fields. Medicinal plants like *Tinospora cordifolia*, *Aloe vera*,

Datura metel, *Datura stramonium*, and *Hedychium coronarium*, are also planted due to their medicinal uses but commercially *Curcuma longa* and *Zingiber officinale* cultivated in farm fields in Silvi-Medicinal and Horti-Medicinal system.

They also collected fruits, bark, and flowers and used them for their livelihood upliftment. Few farmers adopted fruit-yielding species suitable to other regions like *Passiflora edulis*, *Prunus amygdalus*, and *Ficus carica*, on a trial basis on a small scale on their farm. On the farm, other fruit-yielding species were also planted like *Artocarpus heterophyllus*, *Manilkara zapota*, *Cocos nucifera*, *Carissa carandas* and *Manilkara hexandra* etc. Farmers who take training from Government organizations and private firms now plant *Buchnanania lanzan*, *Eucalyptus spp.*, and *Swietenia mahagoni* respectively.

Preference of Tree species under different agroforestry system by the farmers, of Narsinghpur district (M.P.) (n=88)

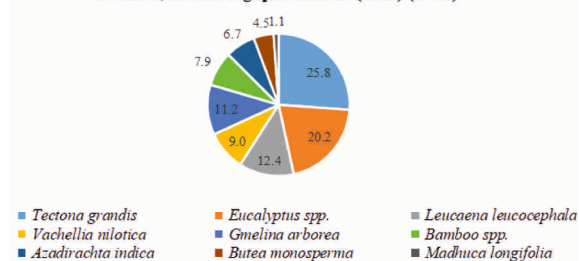


Fig 8. Preference of Tree species under different agroforestry systems used by the farmers, of Narsinghpur district (M.P.)

Preference of Fruit yielding species under different agroforestry systems used by the farmers, of Narsinghpur district (M.P.) (n=83)

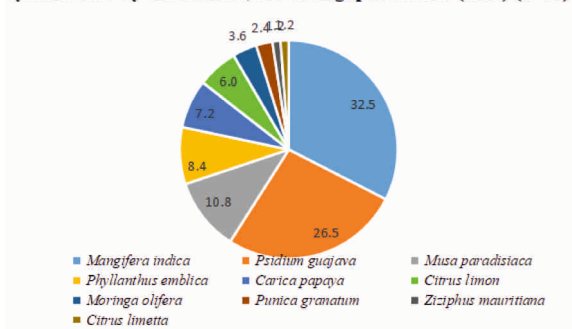


Fig 9. Preference of Fruit yielding species under different agroforestry systems used by the farmers, of Narsinghpur district (M.P.)



Fig 10. *Gmelina arborea* + *Saccharum officinarum* based Silvi-Agri System at Narsinghpur Block of Narsinghpur District



Fig 11. *Citrus lemon* + *Lycopersicon esculentum* based Horti-Oleri system with Mulching sheet at Narsinghpur Block of Narsinghpur District



Fig 12. *Eucalyptus spp.* + paddy-based Sivi-Agri System at Shridham Block of Narsinghpur District

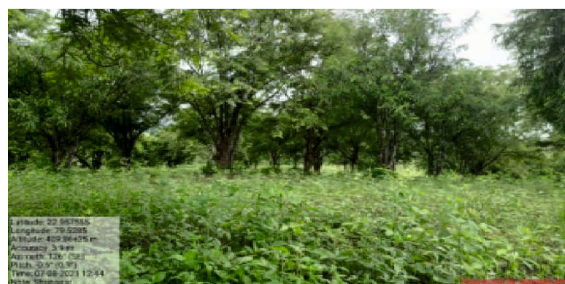


Fig 13. *Phyllanthus emblica* + *C.cajan* based Horti-Agri System at Shridham Block of Narsinghpur District



Fig 14. *G. arborea* + *Curcuma longa* based Silvi-Medicinal system at Kareli block of Narsinghpur District

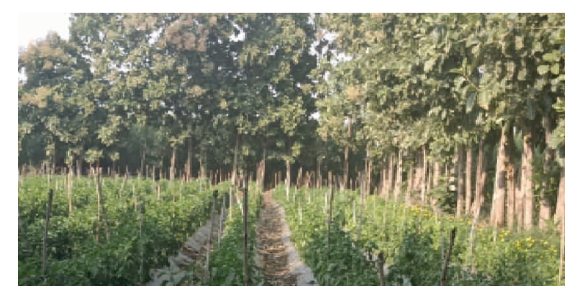


Fig 15. *Tectona grandis* + *Capsicum annuum* based Silvi-Horti System at Kareli block of Narsinghpur District

Table-1 Tree-crop combination used by farmers in Narsinghpur district, M.P.

Agroforestry systems		Tree-crop Combinations		
S.No.	Forest Tree	Horticulture Crop	Crops (Agricultural, Fodder, Vegetables)	
1	<i>Eucalyptus</i> spp., <i>Tectona grandis</i> (Sagon), <i>Leucaena leucocephala</i> (Subabul), <i>Vachellia nilotica</i> , <i>Gmelina arborea</i> (khamer), <i>Butea monosperma</i> (palash), Bamboo spp. (Bans), <i>Azadirachta indica</i> , <i>Madhuca longifolia</i> (near to forest areas), <i>V. nilotica</i> (Babul)	-	<i>Saccharum officinarum</i> (Sugarcane), <i>Vigna radiate</i> (Mung), <i>Vigna mungo</i> (Urad), <i>Triticum aestivum</i> (Wheat), <i>Lens culinaris</i> (Masoor), <i>Glycine max</i> (Soyabean), <i>Oryza sativa</i> (Paddy), <i>Zea mays</i> (Maize), <i>Cicer arietinum</i> , <i>Cajanus cajan</i> (Pigeon pea), <i>Brassica nigra</i> (Mustard), <i>Sesamum indicum</i> (Sesame)	
2	-	<i>Mangifera indica</i> (Mango), <i>Psidium guajava</i> (Guava), <i>Musa Paradisiaca</i> (Banana), <i>Carica papaya</i> (Papaya), <i>Phyllanthus emblica</i> (Amla)	<i>T. aestivum</i> , <i>C. arietinum</i> , <i>S. officinarum</i> , <i>V. radiate</i> , <i>V. mungo</i> , <i>L. culinaris</i> , <i>C. cajan</i> , <i>Z. mays</i> , <i>B. nigra</i> , <i>G. max</i> , <i>S. indicum</i>	
3	<i>T. grandis</i> , <i>Eucalyptus</i> spp., <i>L. leucocephala</i> , <i>G. arborea</i> , <i>V. nilotica</i>	<i>M. indica</i> , <i>P. guajava</i> , <i>M. paradisiaca</i> , <i>C. papaya</i> , <i>Ziziphus mauritiana</i> (Bet), <i>P. emblica</i> ,	<i>Triticum aestivum</i> , <i>Cicer arietinum</i> , <i>Saccharum officinarum</i> , <i>Vigna radiate</i> , <i>Vigna mungo</i> , <i>B. nigra</i>	
4	-	<i>M. indica</i> , <i>P. guajava</i> , <i>P. emblica</i> , <i>M. paradisiaca</i> , <i>Punica granatum</i> (Pomegranate), <i>Citrus limon</i> (Lemon), <i>Citrus limetta</i> (Mosambi)	<i>Abelmoschus esculentus</i> (Okra), <i>Vigna unguiculata</i> (cowpea), <i>Capsicum annuum</i> (Green chilly), <i>Solanum melongena</i> (Brinjal), <i>Lagenaria siceraria</i> (Bottle gourd), <i>Luffa cylindrica</i> (Sponge gourd), <i>Lycopersicon esculentum</i> (Tomato), <i>Brassica oleracea</i> (Cabbage)	
5	<i>Eucalyptus</i> spp., <i>G. arborea</i> , <i>T. grandis</i>	-		
6	-	<i>P. guajava</i> , <i>M. indica</i> , <i>C. limon</i> , <i>M. paradisiac</i>	<i>Zingiber officinale</i> (Zinger), <i>Curcuma longa</i> (Turmeric)	
7	<i>Eucalyptus</i> spp., <i>T. grandis</i> , <i>G. arborea</i> , <i>L. leucocephala</i>	-	<i>A. esculentus</i> , <i>V. unguiculata</i> , <i>Lablab purpureus</i> , <i>Allium sativum</i> , <i>L. siceraria</i> , <i>L. cylindrical</i> , <i>L. esculentum</i> , <i>Capsicum frutescens</i> (Shimla mirch), <i>B. oleracea</i>	
8	<i>Eucalyptus</i> spp., <i>T. grandis</i>	<i>M. indica</i> , <i>P. guajava</i>	-	
9	<i>Eucalyptus</i> spp., <i>L. leucocephala</i> , <i>T. grandis</i>	<i>M. indica</i> , <i>P. guajava</i> ,	<i>Sorghum bicolor</i> (Guinea corn), <i>Trifolium alexandrinum</i> (Barseem)	
10	<i>T. grandis</i> , <i>Eucalyptus</i> spp.	<i>M. indica</i> , <i>C. papaya</i> , <i>P. guajava</i>	<i>A. esculentus</i> , <i>C. frutescens</i>	
11	<i>T. grandis</i>	<i>P. guajava</i> , <i>C. papaya</i>	<i>Tagetes</i> spp. (Marigolds)	
12	<i>T. grandis</i> , Bamboo spp.	<i>M. indica</i> , <i>P. guajava</i>	-	
13	<i>Eucalyptus</i> spp.,	-	<i>Sorghum bicolor</i> , <i>Trifolium alexandrinum</i>	
14	<i>T. grandis</i> , <i>G. arborea</i>	-	<i>C. longa</i> , <i>Z. officinale</i>	

During the study, steps of tree planting and awareness of management practices were also recorded and documented and results indicate the farmers' levels of awareness regarding various aspects shown in (Fig 16). Selection of site (91.9%), Soil working (97%), time of planting (76.3%), planting material (93.3%), method of irrigation (94.1%), causality replacement (90.4%), weeding (94.1%), fertilizers (97%), Integrated Pest Management (91.9%), method of planting (82.2%), pit digging, filling, and size (87.4%), number of plants per hectare (87.4%), selection of intercropping (86.7%), mulching (84.4%), manures (87.5%), pruning practices (76.3%) and thinning (63.7%). Need to train them about the management practices of the trees that face the shade effect as a major problem.

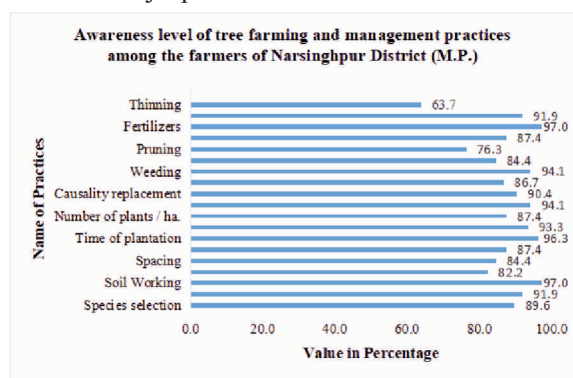


Fig 16. Awareness level of tree farming and management practices among the farmers of Narsinghpur District (M.P.)

4. CONCLUSION

In Narsinghpur district, farmers are increasingly recognizing the multiple benefits of agroforestry systems. They have integrated timber-yielding species, fast-growing tree species, and fruit-yielding species to enhance farm profitability and contribute to mitigating global warming. The adoption of diverse agroforestry systems is growing among the farmers. Common crops grown in Silvi-Agri Systems include *Saccharum officinarum* (sugarcane), *Zea mays* (maize), *Triticum aestivum* (wheat), *Oryza sativa* (rice), *Vigna radiata* (mung bean), and *Vigna mungo* (black gram), reflecting the critical role of agriculture in the Indian economy. Despite these progresses, farmers still face challenges such as the allelopathic effects of Eucalyptus species and difficulties in harvesting *Tectona grandis* (teak). Farmers are adopting more complex systems involving multiple components. Skill development and on site training will help to popularize agroforestry. Moreover, many farmers of the study area are now more familiar with new tools and techniques, with some registering as certified organic farmers through the use of preparations like neemstra, beejamrut, Panchgavya, jeevamrut,

vermicompost and farmyard manure (FYM). The adoption of 14 different types of agroforestry systems is steering farmers towards sustainability, as agroforestry holds significant potential to achieve sustainable development goals.

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