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STRUCTURAL ANALSIS OF AGROFORESTRY PRACTICES ON FARMER FIELD IN JAUNPUR DISTRICT OF UTTAR PRADESH

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Abstract

The richness of various varieties of trees in an agro-ecosystem supports a wide variety of flora and fauna in that area. However, the more diversity, indicates the potential of site quality and ecosystem stability, the more it may lead to competition for available resources that result in the alteration of physico-chemical dynamics of soil of that particular area. In this study, a field survey was performed during 2022-2023 in Kerakat, Dobhi, Dharmapur, Jalalpur, Muftiganj, Sirkoni and Shahganj blocks of Jaunpur district (Uttar Pradesh) to understand the density of different trees, composition, species richness and structure of agroforestry on farmer's land, their growing pattern and agroforestry practices followed by the farmers of the selected blocks. A sample of 20% villages from each block was selected randomly for a composite representation of whole block is considered for this survey. The different aspect of surveyed trees in selected village and the total number of trees, crops, land use patterns, species count and number enumerated in a hectare land. It was observed that farmers had adopted block plantations, agrihorticulture, silvipasture, bund plantation, scattered trees, and home gardens. The major tree species existing bund plantation on farmer field in Jaunpur districts are *Tectona grandis, Eucalyptus tereticornis, Azadirachta indica, Mangifera indica, Dalbergia sissoo, Derris indica, Emblica officinalis, Madhuca longifolia, Terminalia arjuna* and *Acacia nilotica*. The contribution of these tree species varied from 0.15 to 22.6 per cent in the total tree population in top ten tree species. The tree density recorded in different block (Kerakat, Dobhi, Dharmapur, Jalalpur, Muftiganj, Sirkoni and Shahganj blocks of Jaunpur district (Uttar Pradesh)) varied from 11.54-21.86 trees ha^{-1}. Tree population and composition varied in different blocks in the same district.

Keywords: Agroforestry system, tree species, climate change, plantation pattern

Introduction

Agriculture is the main occupation of developing nations like India. It is evident from previous studies that agriculture is highly dependent upon the climatic conditions of a particular

region. In recent decades, the climatic situation of the whole Earth has changed drastically. And as per the findings of the IPCC, 2022 the Earth's global surface temperature was elevated by 1.09 degree centigrade from 2011 to 2020 due to global warming. It was also speculated that if the present situation continues, there will be a further increase in Earth's global surface temperature, ultimately posing a great threat to the survivability of many flora and fauna species. It was suggested by Verchat et al. (2007) that developing nations urgently need toformulate global warming mitigating techniques to improve their livelihood with respect to their rapid population growth. United Nations framework convention on climate change (UNFCC) suggested mitigation measures especially in agriculture and forestry areas. Around one-fourth of the world's greenhouse gases come due to deforestation (Lauren Bannett, 2017; Kushwaha et al., 2022). In same point of the state due to high temperature and low rainfall cultivation of crops become so different to meet the requirement of farmers' family. Under such situation the inclusion of woody perennial crops may reduce the risk of crop failure in Uttar Pradesh (Jaunpur, Prayagraj, etc.). Trees in ecosystem help to cope against climate change by sorting carbon, they buffer against weather related production losses enhancing resilience against climate impact and tree on farms provide addition income and diversity of food sources through tree based production (Ram Newaj et al., 2015). Trees have storage of CO_2 (the major greenhouse gas) more than what is present in the whole atmosphere and when deforestation occurs, these stored gases are plunged into the atmosphere which leads to changes in climatic conditions. Diversity in agroforestry practices differs across various climatic conditions and regions. As per the national forest policy laid in 1988, a minimum of $1/3^{rd}$ area of land should have forest cover. However, only 8.82% of the geographical area of Uttar Pradesh has forest and tree cover compared to the national average of 24.16% (Verma et al., 2017). It is a sad truth that with the progress of rapid population choke, industrialization and the need for more cultivable land has further reduced forest and tree cover on the geographical land of the nation. Some progressive farmers have started planting commercial trees like teak, eucalyptus, poplar, etc. However, it has been reported that some farmers do not take much interest in planting trees as it takes considerable time to repay and corresponding income from it. Most of the farmers belong to small and marginal category and prefers to plant cereal crops. Nonetheless, with 3 different agro- climatic zones, Uttar Pradesh has a large area, wood-based industries and different agriculture institutes which form great scope for improvement in agroforestry in the state (Verma et al., 2017). As per a report, the agroforestry model in the wasteland of Prayagraj, Uttar Pradesh (Allahabad; adjacent district to Jaunpur) was observed to have Jatropha plantation (Lal et al., 2004; Mehra and Lal, 2007; Biswarup and lal, 2009). In addition to this, eco-rehabilitation of degraded areas was reported with bamboo plantation in Prayagraj district (Lal et al., 2005). And as per the findings of (Singh et al., 2015), large scale mango orchards have been grown in groups in parts of eastern Uttar Pradesh.

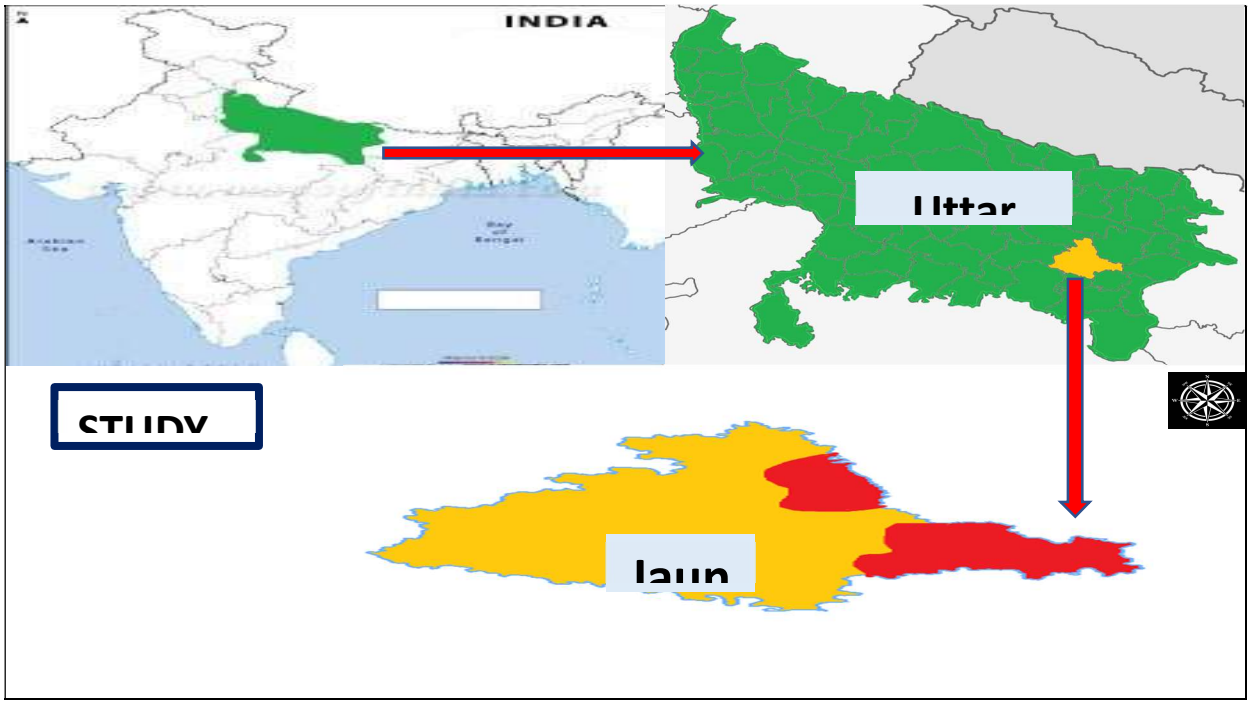
Agroforestry may be utilized as a set of practices that may enhance trees cover in and around agricultural area and thus, carbon sequestration through these trees may considerably contribute in the mitigation of climate change (Anil and Sihag, 2017; Ukey et al., 2019; Kumar et al., 2020). The climatic condition of Jaunpur district of Uttar Pradesh is similar to that of northern

plains, central highlands, hot semi-arid eco regions and hot dry eco-regions of India. The range of temperature and annual rainfall in Jaunpur is 4 to 44 degree centigrade and 1098mm. Longitudinal and latitudinal coordinates being 25.7464° N, 82.6837° E.

From the literature review, it has been observed that studies regarding agroforestry patterns in above stated areas are scanty and need urgent basis study in order to lay down various policies. Therefore, the aim of this study was to assess the agroforestry practices and tree population on farmer field in Jaunpur district of Uttar Pradesh.

Materials and methods

Study area map



The climatic condition of Jaunpur district of Uttar Pradesh is similar to that of northern plains, central highlands, hot semi-arid eco regions and hot dry ecoregions of India. Range of temperature and annual rainfall in Jaunpur is 4 to 44 degree centigrade and 1098mm. Jaunpur district is surrounded by Gazipur and Varanasi districts in the east, Pratapgarh and Sultanpur in the west, Azamgarh in the north-west, Prayagraj and Bhadohi in the south-west districts. In the coming sections, a brief description about survey methodology is provided.

The tree species commonly observed in this district include *Madhuca longifolia, Mangifera indica, Dalbergia sissoo, Derris indica, Azadirachta indica, Tectona grandis, Emblica officinalis, Eucalyptus tereticornis, Ziziphus mauritiana, Acacia nilotica* and *Terminalia arjuna*. Normally, the height and GBH (girth of breast height) of the trees are around 20 feet and 40cm, respectively. A wide variety of trees, birds and animals are found in this district. The soil type of the district is sandy loam and has five rivers (Gomti, Sai, Varuna, Basuhi and Pili nadi) which bear rich fertile tracts of Alluvial soil.

Field survey conducted in this study was aimed at understanding the agroforestry practices followed by the farmers in their existing fields. For this study, a total of 7 blocks namely Kerakat, Dobhi, Shahganj, Muftiganj, Dharmapur, Jalalpur and Sirkoni were selected to conduct this survey. These block contained large number of villages. It was not feasible to survey each and every village. Hence, a 20% sample size of the village from each block was selected. A completely randomized methodology was followed during the conduct of this survey so that it represented a clear picture of the whole block. The transect walk methodology (Ram Newaj et al., 2017) was followed during the survey of each village. Concerned farmer or local leader was associated in this survey to represent a clear profile of the village.

The sampling technique at the farmer's field involved the numbering of all trees, bunds, wasteland, scattered trees etc. The trees exceeding or equal to 15 feet in height and 5 cm in diameter was considered in this survey. The land area of a particular village was taken as decisive criteria for the number and distance for transect of the area. A 10 X 10 m quadrate was taken for trees and 5X5 and 1X1m for shrubs. The transect size was taken by 1 km transect at interval of 100 m to observe the tree species, density, girth of breast height, soil, crops, etc. but the number transect depended upon the area of survey village. Following this methodology, a survey was conducted in each village. Thus, per hectare tree species was determined in each village followed by its multiplication to give the total number of trees, species, density, girth of breast height , soil, crops, etc. in the block and consecutively for the whole district (Ram Newaj et al., 2020).

Results and discussion

In this survey report as showed in table 1, we included almost all the tree species those were enumerated and crossed more than 0.009% in the complete pool of tree species observed in different villages of the surveyed district. Fast growing, medium and slow growing trees species existing on farmer's field is shown in table 2. The tree species that were reported during this survey work included- *Acacia nilotica, Aegle marmelos, Ailanthus excels, Albizia odoratissima, Albizia procera, Anthocephalus kadamba, Artocarpus heterophyllus, Azadirachta indica, Bauhinia variegate, Bombax ceiba, Butea monosperma, Cassia fistula, Dalbergia sissoo, Delonix regia, Derris indica, Emblica officinalis, Eucalyptus tereticornis, Feronia elephantum, Ficus benghalensis, Ficus religiosa, Ficus virens, Ficus racemosa, Holoptelea integrifolia, Leucaena leucocephala, Madhuca longifolia, Mangifera indica, Melia azedarach, Morus alba, Moringa oleifera, Phoenix dactylifera, Pithecellobium dulce, Prosopis juliflora, Psidium guajava, Syzygium cumini, Swietenia macrophylla, Tectona grandis, Terminalia arjuna, Termindus indica, Ziziphus mauritiana,* among others. On considering overall constituent percentage share of five major tree species found across all seven blocks were *Tectona grandis* followed by *Eucalyptus tereticornis, Azadirachta indica, Mangifera indica* and *Dalbergia sissoo*, respectively.

On considering block wise report, top five tree species in Kerakat block included *Tectona grandis* (21%) followed by *Eucalyptus tereticornis* (15.6%), *Dalbergia sissoo* (11.42%), *Mangifera indica* (10.24%) and *Azadirachta indica* (9.8%), respectively. While, in Dobhi block, the top five tree species were *Tectona grandis* (21.84%), followed by *Eucalyptus tereticornis* (14.36%), *Dalbergia sissoo* (11.6%), *Mangifera indica* (11.4%) and *Azadirachta indica* (10.5%),

respectively. Whereas, in Muftiganj block major five tree species investigated in this survey included *Tectona grandis* (19.8%), followed by *Azadirachta indica* (17.3%), *Eucalyptus tereticornis* (12.48%), *Dalbergia sissoo* (10.4%), and *Mangifera indica* (8.62%), respectively. In case of Dharmapur block, five major contributing tree species were *Tectona grandis* (17.52%) followed by *Azadirachta indica* (16%), *Eucalyptus tereticornis* (13.64%), *Mangifera indica* (9.36%) and *Dalbergia sissoo* (8.7%), respectively. Further, in Sirkoni block, the top 5 contributing tree species were *Tectona grandis* (15.3%) followed by *Eucalyptus tereticornis* (14.82%), *Azadirachta indica* (14.8%), *Mangifera indica* (9.82%) and *Dalbergia sissoo* (5.65%), respectively. Again, in Jalalpur block, the five major contributing tree species were observed as *Eucalyptus tereticornis* (22.6%) followed by *Tectona grandis* (15.8%), *Mangifera indica* (8.6%), *Dalbergia sissoo* (7.24%) and *Azadirachta indica* (6.7%), respectively. Furthermore, Shahganj block showed that highest 5 contributing tree species were observed as *Azadirachta indica* (17.6%), followed by *Tectona grandis* (14.3%), *Eucalyptus tereticornis* (11.8%) *Mangifera indica* (11.4%) and *Dalbergia sissoo* (8.17%), respectively.

On analyzing individual top five contributors of tree species as shown in table 3, it was found that *Tectona grandis* was found most in Dobhi block followed by Kerakat, Muftiganj, Dharmapur, Jalalpur, Sirkoni and Shahganj blocks, respectively. Whereas, *Eucalyptus tereticornis* was found most in Jalalpur block followed by Kerakat, Muftiganj, Dharmapur, Dobhi , Sirkoni and Shahganj blocks, respectively. However, *Azadirachta indica* was found most in Muftiganj block followed by Kerakat, Dharmapur, Dobhi , Jalalpur, Sirkoni and Shahganj blocks, respectively. Furthermore, maximum enumeration of *Mangifera indica* was reported in Dobhi and Shahganj block followed by Kerakat, Dharmapur, Jalalpur, and Sirkoni blocks, respectively. And in case of *Dalbergia sissoo,* major contributing blocks included Dobhi block followed by Kerakat, Dharmapur, Jalalpur, Sirkoni and Shahganj blocks, respectively.

Table 1: Different agroforestry practices used by farmers in Jaunpur district of Uttar Pradesh

S. No.	Agroforestry systems	Tree Component	Crop/ vegetable component					
			Kharif		Rabi		Zaid	
			Crop	Vegetable	Crop	vegetable	Crop	Vegetable
1	**Block plantation**	*Dalbergia sissoo Leucaena leucocephala*	-	-	-	-	-	-

		Madhuca indica, Mangifera indica Swieteni a macrophylla, Tectona grandis Eucalyptus tereticornis						
2	**Agrihortisilviculture**	*Aegle marmelos Emblica officinalis, Mangifera indica Psidium guajava, Syzygium cumini, Ziziphus mauritiana.etc*	*Sesamum indicum Sorghum bicolor, Pennisetum glaucum, Cajanus cajan, Vigna radiata, Vigna mungo Zea mays*	*Amorphophallus paeoniifolius, curcuma spp., Solenum melongena, Solenum lycopersicum, Capsicum annum Trichosanthes dioica,*	*Triticum aestivum, Brassica spp., Cicer arietinum, Lens culinaris spp, Pisum sativum,*	*Raphanus sativus, Brassica spp.,Solenum tuberosum, Allium sativam, Allium cepa*	*Helianthus annus, Vigna radiata, Vigna mungo, Zea mays*	*Ablemoseh us esculenta, Cucumis sativus, Lagenaria siceraria, Momordica charantia, Luffa aegyptiaca,*

3	**Bund plantation**	*Tectona grandis, Mngifera indica Eucalyptus tereticornis, Acacia nilotica, Prosopis juliflora, Azadirachta indica, Ziziphus mauritiana, Madhuca indica, Dalbergia sissoo, Terminelia arjuna etc.*	*Sorghum bicolor, Oryza sativa, Pennisetum glaucum, Cajanus cajan, Vigna radiata, Vigna mungo, Sesamum indicum, Zia mays*	*Trichosanthes dioica, Trichosanthes cucumerina, Amorphophallus paeoniifolius, curcuma spp., Solenum melongena, Solenum lycopersicum, Capsicum annum*	*Triticum aestivum, Lens culinaris spp, , Cicer arietinum, Brassica spp., Pisum sativum, Linum usitatissimum,*	*Raphanus sativus, Brassica spp.,Solenum tuberosum, Allium sativam, Allium cepa*	*Vigna radiata, Vigna mungo, Zia mays*	*Ablemoschus esculenta, Cucumis sativus, Lagenaria siceraria, Momordica charantia, Luffa aegyptiaca, citrullus lanatus, Lagenaria siceraria*
4	**Scattered trees**	*Acacia nilotica, Azadirachta indica, ziziphus mauritiana, Dalbergia*	*Sorghum bicolor, Oryza sativa, Pennisetum glaucum,*	*Trichosanthes dioica, Trichosanthes cucumerina, Amorphophallus paeoniifo*	*Triticum aestivum, Lens culinaris spp, , Cicer arietinum, Brassic*	*Raphanus sativus, Brassica spp.,Solenum tuberosum, Allium sativam, Allium cepa*	*Vigna radiata, Vigna mungo, Zia mays*	*Ablemoschus esculenta, Cucumis sativus, Lagenaria siceraria, Momordica charantia, Luffa*

		sissoo, Madhuca indica, Mangifera indica, Leucaena leucocephala Terminelia arjuna ,Buetia monosperma, pongemia pinnata, Aegle marmelos, Artocarpus eterophyllus Etc	*Cajanus cajan, Vigna radiata, Vigna mungo , Sesamum indicum, Zia mays*	*lius, curcuma spp., Solenum melongena, Solenum lycopersicum, Capsicum annum*	*a spp., Pisum sativum, Linum usitatissimum,*			*aegyptiaca, citrullus lanatus, Lagenaria siceraria*
5	**Silvipasture**	*Acacia nilotica Azadirachta indica Ailanthus excelsa, Prosopis juliflora ,*	*Napier grass, Pannisetum glaucum, Sorghum bicolour, Pennisetum purpureum etc.*		*Avena sativa, Trifolium alexandrinum, Napier grass,*		*Cow pea, Sorghum vulgare, Napier grass,*	

		Ziziphus mauritiana, ficus spp., Leucaena leucocephala etc.			
6	**Home-gardens**	*Psidium guajava, Phyllanthus emblica, Aegle marmelos, Syzygium cumini, Ziziphus mauritiana, Citrus spp, Punica granatum, Carissa carandas Artocarpus eterophyllus, Mangifera indica,*	*Trichosanthes dioica, Amorphophallus paeoniifolius, curcuma spp., Solenum melongena, Solenum lycopersicum, Capsicum annum, Lagenaria siceraria, Lablab purureus, Momordica charantia, Luffa acutangula, Abelmoschus esculentus, Capsicum annum, etc.*		

		Moringa oliofera, etc.	

Table 2: Fast growing, medium and slow growing trees species existing on farmer's field in Jaunpur district of Uttar Pradesh

Fast growing tree species	Medium growing tree species	Slow growing tree species
❖ *Ailanthus excels* ❖ *Albizia procera* ❖ *Anthocephalus cadamba* ❖ *Eucalyptus tereticornis* ❖ *Jatropha curcas* ❖ *Leucaena leucocephala* ❖ *Moringa oleifera* ❖ *Morus alba*	❖ *Acacia nilotica* ❖ *Albizia odoratissima* ❖ *Anogeissus latifolia* ❖ *Artocarpus eterophyllus* ❖ *Azadirachta indica* ❖ *Bauhinia variegate* ❖ *Bombax ceiba* ❖ *Butea monosperma* ❖ *Cassia fistula* ❖ *Dalbergia sissoo* ❖ *Delonix regia* ❖ *Derris indica* ❖ *Dipterocarpus urbinatus* ❖ *Emblica officinalis* ❖ *Feronia elephantum* ❖ *Ficus virens* ❖ *Holoptelea integrifolia* ❖ *Mangifera indica* ❖ *Melia azedarach* ❖ *Mitragyna parvifolia* ❖ *Phoenix dactylifera* ❖ *Prosopis juliflora* ❖ *Psidium guajava* ❖ *Syzygium cumini* ❖ *Terminalia arjuna* ❖ *Vachellia leucophloea,*	❖ *Ficus benghalensis* ❖ *Ficus racemosa* ❖ *Ficus religiosa* ❖ *Ficus virens* ❖ *Madhuca longifolia* ❖ *Phoenix dactylifera* ❖ *Pithecellobium dulce* ❖ *Tamarindus indica* ❖ *Tectona grandis* ❖ *Ziziphus mauritiana*

Table 3: List of dominant trees along with their percentage share across different surveyed blocks of Jaunpur district

Dominant trees	Kerakat	Dobhi	Muftigunj	Dharmapur	Sirkoni	Jalalpur	Shahganj
Acacia nilotica	3.6	4.8	1.6	2.98	4.2	6.7	4.5
Aegle marmelos	0.95	0.86	0.9	0.4	0.82	0.61	0.66
Albizia odoratissima	0.01	0.03	0.14	0.06	0	0.02	0
Albizia procera	0.86	0.25	0.62	0.35	0	0.42	0.32
Ailanthus excels	1.26	0.46	0.16	1.2	0.11	0	0.28
Anthocephalus kadamba	0.02	0.06	0.01	0	0	0.45	0.48
Artocarpus heterophyllus	0.52	0.25	0.08	0.46	0.82	0.92	1.7
Azadirachta indica	9.8	10.5	17.3	16	14.8	11	17.6
Bauhinia variegate	0	0.01	0	0	0.01	0	0.02
Bombax ceiba	0.07	0.14	0	0.24	0	0	0
Butea monosperma	1.42	0	0.87	1.26	0.38	0	1.65
Cassia fistula	0.52	0.01	0.01	0.05	0	0.01	0
Dalbergia sissoo	11.42	11.6	10.4	8.7	5.65	7.24	8.17
Delonix regia	0.06	0.12	0	0.04	0.32	0.04	0.01
Derris indica (pinnata)	3.8	4.2	4.87	5.1	3.44	2.52	3.4
Emblica officinalis	2.4	2.12	3.12	2.82	3.46	3.12	3.4
Eucalyptus tereticornis	15.6	14.36	12.48	13.64	14.82	22.6	11.8
Feronia elephantum (kaetha)	0.02	0	0.03	0	0.11	0.05	0.06
Ficus benghalensis	0.04	0.02	0.02	0.12	0.05	0.03	0.02

Ficus religiosa	0.03	0.02	0.05	0.13	0.08	0.03	0.08
Ficus virens	0.16	0.07	0.32	0.12	1.44	0.07	0.04
Ficus racemosa	0	0.02	0	0.04	0.01	0.01	0
Holoptelea integrifolia	0.05	0.02	0.13	0.08	0.04	0.11	0.01
Leucaena leucocephala	3.4	1.8	2.4	3.5	2.1	0	1.2
Madhuca longifolia	2.65	3.52	3.26	4.68	4.78	2.62	1.89
Mangifera indica	10.24	11.4	8.62	9.36	9.82	8.6	11.4
Melia azedarach	0	0	0	0.42	1.46	1.84	1.98
Mulberry	0.04	0.01	0.05	0	0	1.42	0
Moringa oleifera	0.72	0.86	1.78	0.76	1.1	2.52	1.7
Phoenix dactylifera	0.02	0	0	0.03	1.32	0.09	0.98
Pithecellobium dulce	0.01	0.05	0.16	0.08	0.18	0.82	0.42
Prosopis juliflora,	0.15	0.18	1.72	2.89	3.82	1.24	0.96
Psidium guajava	3.2	1.32	2.12	1.42	1.56	0.04	0.36
Syzygium cumini	1.06	0.86	1.04	0.46	0.86	0	2.04
Swietenia macrophylla	0.34	0.65	0	0.23	0.04	0	1.2
Tectona grandis	21	21.84	19.8	17.52	15.3	15.8	14.3
Terminalia arjuna	1.65	3.58	2.12	2.44	3.62	4.68	2.15
Termindus indica	0.08	0.56	0.12	0.18	0.23	1.65	0.33
Ziziphus mauritiana	1.6	2.65	1.98	1.42	1.87	1.78	2.5
Others	1.23	0.8	1.72	0.82	1.38	0.95	2.39

Conclusion

The major tree species existing bund plantations on farmer field in Jaunpur districts are *Tectonagrandis, Eucalyptus tereticornis, Dalbergia sissoo, Derris indica, Azadirachta indica, Mangifera indica, Madhuca indica, Terminalia arjuna, Emblica officinalis,* and *Acacia nilotica*. The contribution of these tree species varied from 0.16 to 22.6 per cent in total tree population in most top ten tree species. The tree density recorded in different block (Kerakat, Dobhi, Dharmapur, Muftiganj, Sirkoni, Jalalpur, Shahganj) varied from 11.54-21.86 trees ha^{-1}. Tree population varied in different block in the same district.

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Author's contribution

AK and AKS conceived the idea, performed and drafted the manuscript. SK and SK helped in data collection and survey work. BSR and UK assisted in English editing and drafting of this manuscript. All the authors considerably contributed in this work and agreed for publication.

Declaration

Compliance to ethics.

Conflict of interest

Authors declare that there exists no conflict of interest.

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