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Adaptation Reasons for Agroforestry in the Study Area of Eastern Uttar Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

It is paramount to assess the social and economic status of the farmers in the adaptation of any agroecosystem. Studies on the impact of socio-economic factors specifically in the agroforestry system adaption are meager in Uttar Pradesh. The present research was carried out in the villages of the three selected districts (Kaushambi, Pratapgarh, and Allahabad) of Eastern Uttar Pradesh with 750 respondents in 2020. The investigation aimed to assess the reasons in the study area to adopt the agroforestry models. A simple random sampling technique was employed to select the respondents and primary, as well as secondary data, were used for qualitative and quantitative analysis by using an appropriate statistical design. Results showed that socio-economic factors, like family size, education, and age of the farmers greatly impacted the adaptation and difference in combinations of agroforestry systems. The land area under Agroforestry in Kaushambi with 54% followed by Pratapgarh (52%) and Allahabad (50%). the majority of the farmers adopted trees on their farmland for traditional purposes in the Kaushambi district (72%) and in Pratapgarh and

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Allahabad districts 72% and 70% respectively. The adoption of agroforestry systems for commercial purposes was observed highest in Allahabad (18%) followed by Kaushambi (16%) and Pratapgarh (12%). The Agrisilviculture system is practiced in the three districts and there were different combinations recorded in Pratapgarh (Teak+paddy: 96%); Allahabad (Eucalyptus+mustard: 96%) and Kaushambi (Teak+ mustard: 95.6%) districts. Conclusively, this study would be an asset and provide an idea for the policymakers in implementing or promoting agroforestry system practices in Uttar Pradesh.

Keywords: Agroforestry; social background; farmers decision; survey study.

1. INTRODUCTION

Agroforestry is a dynamic, ecologically oriented integrated strategy for managing natural resources that enable greater social, economic, and environmental advantages [1]. During the last 20 years, efforts have been undertaken by farmers, business personnel, and researchers to introduce tree-based agricultural techniques in the U.P. green belt. Every sixth Indian resides in Uttar Pradesh and the state contributes almost 20.37% of the nation's agricultural output [2].

Uttar Pradesh is the most important agricultural state of India, not only that it has the highest cropped area of 25,785 thousand hectares, but it has the highest number of over 21 million farm holdings as well. This state is the largest food grain-producing state in the country. Agroforestry in the Eastern Plain region of Uttar Pradesh is in the early stages of development. Agroforestry practices vary by agro-climatic zone, land capabilities, and farmer socio-economic condition in Uttar Pradesh. The diversity in agroforestry systems reflects heterogeneity, and comparative advantage has sparked renewed interest in harnessing the vibrant potential [3]. According to the Forest Survey of India report in 2019, forest cover, including tree cover, accounts for 3.05% of the total area in Uttar Pradesh is 7342 sq km. Instead of monocropping, the state's Eastern Plains and North Eastern Tarai zones should implement proper agroforestry systems such as Agri-silviculture, Silvi-horticulture, Agri-Silvi-horticulture, and silvopastoral systems. To succeed in Indian agriculture, this state must become more competitive holistically and particularly in crop diversification. Agroforestry plays a pivotal role in achieving the desired level of sustainability and stable livelihood of the people as compared to traditional cropping systems. Similarly, that should be linked to the industrial sector to safeguard the people who are involving all these sectors by mutually upholding each other [4].

Socioeconomic factors have frequently been linked to the adoption of agro-based technologies such as agroforestry practices [5,1,6]. Additionally, it is crucial to comprehend the underlying elements that might affect farmers' adoption choice processes to successfully assist the adoption of improved agricultural methods among smallholder farmers. With a focus on the integration of on-farm trees, this study investigates the socioeconomic determinants that affect smallholder farmers' adoption of agroforestry methods. It aims to give relevant information to extension services on smallholder farmers' planning and adoption strategies for established agro-based technology [5,6].

Therefore, the key objective of the study was to characterize and identify the factors that led farmers to promote agroforestry systems and later assess the systems' effects.

2. METHODOLOGY

2.1 Selection of the Study Area

Different varieties of agroforestry have been pushed throughout the nation, including in eastern Uttar Pradesh, southern Karnataka, and sections of Andhra Pradesh. Eastern Uttar Pradesh has been chosen for the different adoption of trees and crops on the farm fields for various advantages including water conservation, windbreaks, and microclimate conditions in the region. Additionally, Uttar Pradesh was divided into two regions: Intensive (commercial) and traditional agroforestry region. The UP state is located between 25.31° N latitude and 77.84° E longitude. The State is split into the Western, Central, Eastern, and Bundelkhand areas. The tropical monsoon type of climate that prevails in Uttar Pradesh is characterized by warm temperatures.

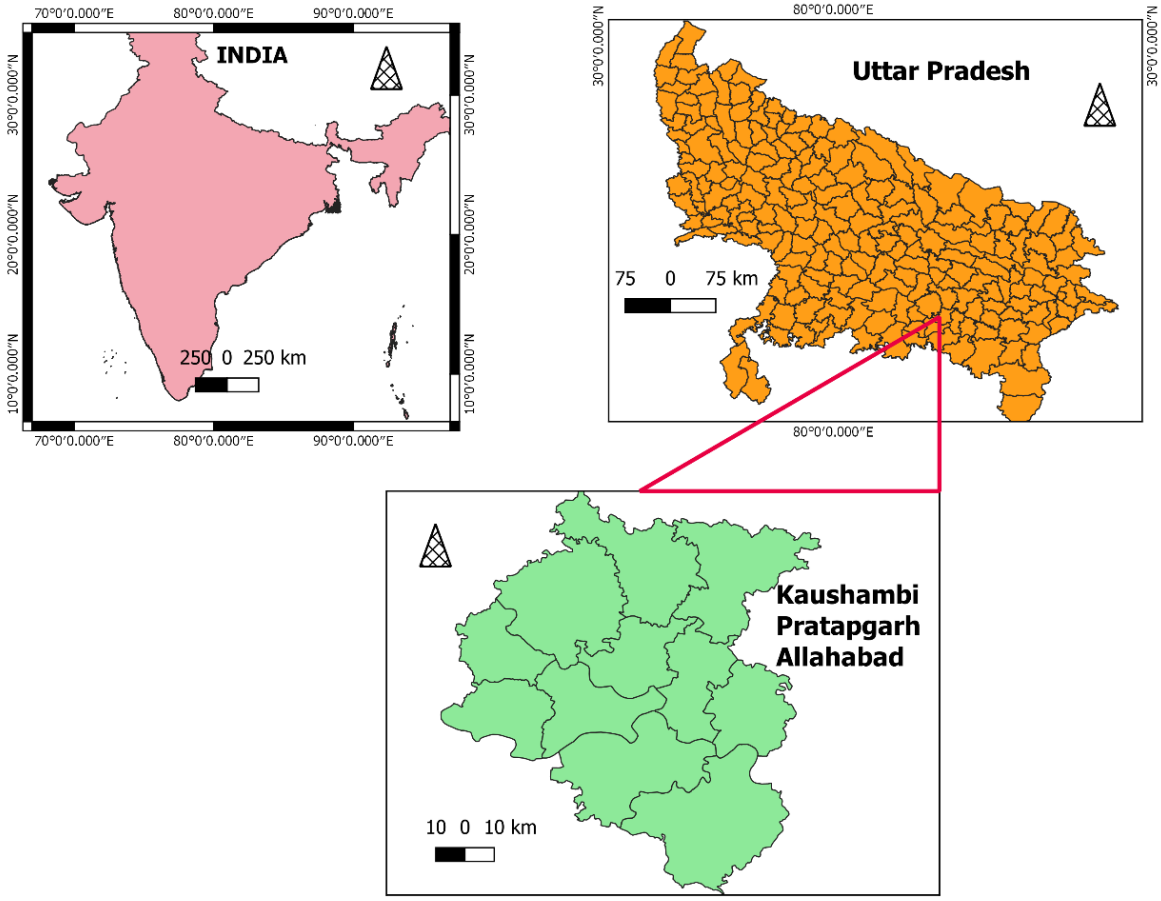

Fig. 1. Map of the study area

The investigation was conducted in 3 districts (Kashumbi, Pratapgarh, and Allahabad) of the multi-stage random sampling (Fig. 1), from each of these areas, three blocks with 15 villages each 5 villages were chosen. These villages have wide range agroforestry adaptation area. The sample units for the study total of 750 farmers were chosen based on the goal of the research on agroforestry systems and intensive farming systems as well as categories representing various, ages, education family size holdings of land, reasons for agroforestry adoption, farmer challenges, and various socioeconomic categories.

2.2 Data Collection

From each village, about 50 farmers (as per the statistical design and fulfillment of the objective) were selected that making total respondents of 750 randomly to participate in the survey. Face-to-face interviews, farm visits, and structured questionnaires were used to collect the data. Information was obtained on agroforestry adoption, socio-demographics of farmers, and desires of farmers for integration trees on farms.

2.3 Statistical Analysis

Statistics are employed based on percentages; comparisons are made with the help of the Z-test. All of the data were taken into account for the statistical analysis to the best possible inference for each parameter in the context of the study's goals.

3. RESULTS AND DISCUSSION

3.1 Age

The results of the socio-economic studies in villages of three districts (Kaushambi, Allahabad, and Pratapgarh) revealed that the Age of the majority respondents (Table 1) were in the middle age group with a high percentage of 68% in Pratapgarh district and the lowest was in Allahabad with 46%. Similarly, the least percentage of young-aged farmers are involved in agricultural operations in the study area with 2 to 4% in the identified districts of the study.

Table 1. Age of the respondents in survey districts

Age of the respondents	Kaushambi		Pratapgarh		Allahabad	
	Frequency	%	Frequency	%	Frequency	%
Young (<30years)	5	2	5	2	10	4
Middle (Between 30-55)	130	52	170	68	115	46
Old (>55)	115	46	75	30	85	34
Total	**250**	**100**	**250**	**100**	**250**	**100**

3.2 Education

Based on a survey of the findings in (Table 2), the education of the respondents was categorized into five categories as Illiterate, Primary school, Middle school, High school, and Graduate. Based on a survey in the Kaushambi district, about 50% of respondents graduated followed by the high school category (34%). But the Primary school and Illiterate categories were very meager in the surveyed area of the study. In Allahabad district majority of the respondents had a high school education and graduated. Less number of respondents studied up to middle and primary school education. In the Pratapgarh district, more graduated and high school-educated respondents. Primary school-level educated respondents were the least in number. According to [7] education is an important variable that influences the knowledge of different farmers based on their ability to read and write. The present study also concluded that education is an important variable for farmers to know about their farming operations, level of technical knowledge on agricultural programs, and knowledge about tree and crop adaptation.

3.3 Family Size

Every family is one of the integral parts of human beings. Every human is incomplete without family. All the members of the family share equal parts while sharing [8] the responsibilities within the family. Then it will make the family complete. The family members influence the decision-making process and the final decision on farming operations related to farming. Usually in the agriculture-related decision-making by the head of the family particularly regarding farming operations and other personal activities in the family. Table 3 showed that the majority of the family size is seen in four members size and 38% in Kaushmabi and Pratapgarh. While in Allahabad it was 32%. Fewer are family members who have at least two members with 2% in the survey districts.

Table 2. Education of the respondents in three survey districts

Education of the respondents	Kaushambi		Pratapgarh		Allahabad	
	Frequency	%	Frequency	%	Frequency	%
Illiterate	15	6	15	6	35	14
Primary	10	4	5	2	25	10
Middle	15	6	20	8	10	4
High school	85	34	75	30	110	44
Graduate	125	50	135	54	70	28
Total	**250**	**100**	**250**	**100**	**250**	**100**

Table 3. Family size of the respondents in the survey area

Family size in numbers	Kaushambi		Pratapgarh		Allahabad	
	Frequency	%	Frequency	%	Frequency	%
2	10	4	5	2	5	2
3	5	2	55	22	15	6
4	95	38	95	38	80	32
5	75	30	60	24	70	28
6	30	12	25	10	40	16
7	25	10	5	2	30	12
8	10	4	5	2	10	4
Total	**250**	**100**	**250**	**100**	**250**	**100**

3.4 Land under the Agroforestry System

The land is used for agroforestry systems for the cultivation of different crops, like (wheat, mustard, paddy, and chickpea) trees (Poplar, Eucalyptus, Teak, Mango, Neem, and also guava, etc.,) and pastures on the land by the farmers is a parameter to segregate the land into three different categories viz., small, medium and large as given by [9]. It is depending on the availability of total land and awareness of the farmer about agroforestry and also its significance in making sustainability of farmer and productivity of soil to assign the part of available land for agroforestry. Results in Table 4 revealed that the land under Agroforestry in three districts having high percent of the land is in a large group and it was present in Kaushambi with 54% followed by Pratapgarh (52%) and Allahabad (50%). The least land-holding farmers were mainly present in the medium category in Kaushambi and Pratapgarh with percent of 2%.

3.5 Reason for the Adaptation of Agroforestry

Combining crops, trees, and cattle is a typical method among farmers to deal with the problem of a severe lack of fuel, fodder, and other supplies [10]. The farmers have few options to choose the tree species, so they settle with whatever is there on their property [10]. As stated by [11], agroforestry is the driving force behind this system's advantages for farmers. While the availability of fuel wood was the main factor in traditional agroforestry systems, commercial agroforestry in Eastern Uttar Pradesh was based on huge revenue. As presented in Table 5, the majority of the farmers adopted trees on their farmland for traditional purposes in Kaushambi district (72%) and in Pratapgarh and Allahabad districts 72% and 70% respectively. The adoption of agroforestry systems for commercial purposes was observed highest in Allahabad (18%) followed by Kaushambi (16%) and Pratapgarh (12%).

3.6 Agrisilviculture System Followed by the Farmers

During the survey, a question regarding the preference of the trees for future adoption was also asked from the respondents and the resultant data have been presented in Table 6. It was evident that agri-silviculture is the most widely practiced agroforestry type in the area, while silvi-pastrol is the least widely practiced agroforestry type. The study conducted by Kumar et al., [9] identified that agri-silviculture, silvopastoral, and agri-silvopastoral are the most common agroforestry types in Uttarpradesh, India. The combination of trees and crops is known as the Agrisilviculture system and the farmers are mostly cultivating crops like paddy, mustard, and wheat in combination with the trees like Teak, Eucalyptus on their same piece of land. The results mentioned that the Agrisilviculture system is practiced in the three districts and there were different combinations recorded in Pratapgarh (Teak+paddy: 96%); Allahabad (Eucalyptus+mustard: 96%) and Kaushambi (Teak+ mustard: 95.6%) districts.

Table 4. Land under Agroforestry system in survey area

Land under Agroforestry	Kaushambi		Pratapgarh		Allahabad	
	Frequency	%	Frequency	%	Frequency	%
Small (1-2)	110	44	115	46	95	38
Medium(2-3)	5	2	5	2	30	12
Large(>3)	135	54	130	52	125	50
Total	**250**	**100**	**250**	**100**	**250**	**100**

Table 5. Reason for adaptation of agroforestry by respondents in the survey area

Reason for Adaptation of AGF	Kaushambi		Pratapgarh		Allahabad	
	Frequency	%	Frequency	%	Frequency	%
Traditional	185	72	180	72	175	70
Trial	25	10	40	16	30	12
Commercial	40	16	30	12	45	18
Total	**250**	**100**	**250**	**100**	**250**	**100**

Table 6. Agrisilviculture system followed by respondents in survey districts

Agrisilviculture system	Kaushambi		Pratapgarh		Allahabad	
	Frequency	%	Frequency	%	Frequency	%
Teak+ Paddy	237	94.8	240	96	239	95.6
Teak+ Mustard	239	95.6	235	94	237	94.8
Teak+wheat	234	93.6	238	95.2	234	93.6
Eucalyptus +Paddy	235	94	235	94	238	95.2
Eucalyptus + Mustard	238	95.2	240	96	240	96
Eucalyptus + Wheat	236	94.4	237	94.8	239	95.6

Family farming and forestry systems have demonstrated, over many years, great efficiency in the management and use of resources and are defined by their ecological characteristics, making them desirable from a social, economic, and environmental point of view, as reported by research. de Olivares et al. [12,13]; Olivares et al. [14]; Montenegro et al. [15]. In a very broad sense, these traits are based on a holistic knowledge based on facts and beliefs, highly flexible, and on the worldview of sometimes indigenous producers, where nature is a living entity and even sacred in some cultures [16-20].

It could be affirmed that, in these systems, agriculture and forestry have been considered by many families as constitutive parts of their culture, where agricultural work and culture form a unit. Through this activity, the peoples relate to each other through nature and based on this relationship, the landscape is configured, social relationships are structured and a series of cultural activities are generated that affirm identity, evident in the work of forestry [21-23].

Studies in Latin American indigenous tropical territories establish that in agroforestry, natural succession processes are used as management tools and enrichment of environmental conditions, through productive practices of protection and conservation [24,25]. Secondary succession, instead of constituting a problem for the producer, is a natural subsidy for soil improvement, obtaining resources, and for reducing pest risks [26,27].

Orchards or family gardens are strategies developed by some agricultural communities in Latin American territories, these agroforestry systems are located around the peasant home, where fruit trees are grown [28,29], food plants [30,18-20], ornamental, medicinal, magical-religious [31,32], represent the fundamental basis for livelihoods. Within these small systems, different management patterns are located and it is here where the producer maintains cultivars and experiments with new varieties [33].

4. CONCLUSION

Agroforestry is a sustainable land use system that maintains and increases crop yields by combining different crops with trees on the same plot of land. Farmers in the eastern highlands have been employing the agroforestry method for many years for traditional purposes, and they have accepted trees on wide stretches of land. It also enhances the productivity of the products and preserves soil fertility, which decreases crop failure rates. In the present investigation, it was noticed that paddy, mustard, and wheat are the main crops grown in the agrisilviculture system, which also includes the tree species *Tectona gradins, Eucalyptus globulus,* and *populus spp*. These trees play a significant role in all types of terrestrial ecosystems and offer a variety of services and goods to both urban and rural communities. Nevertheless, the socio-economic background of the farmers strongly influences the adaption of agroforestry. However, the site specific and appropriate policies are critical to promote the adoption of agroforestry at local, state and national scale.in this context, t role of stakeholders such as farmers, government and non-government organizations, scientists, researchers, and policymakers' collaborative approach helps in promoting the agroforestry system in Uttar Prsadesh.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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