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RESEARCH ARTICLE

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Status of agroforestry practices in Varanasi district of Eastern plain region of Uttar Pradesh, India

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ABSTRACT : The study was conducted in selected villages (1%) of Varanasi district of Eastern plain region of Uttar Pradesh in India during the year 2018 to record the crop combinations with tree species and their stratified arrangement to identify agroforestry practices. The socio-economic studies based on general village profile, land holding, land use pattern and tree species planting pattern were performed in 12 villages representing eight blocks to collect the data with structured questionnaire and participatory rural appraisal (PRA) tools. The results demonstrated that a total of nine different agroforestry practices, silvi-horticulture, agri-silviculture, agri-horticulture, aqua-silviculture, agri-silvi-horticulture, agri-silvi-pastoral, silvi-pastoral, silvi-medicinal and homestead existed in different villages. Out of different categories, timber, fruits, medicinal, agriculture, flower and other plant species were recorded. It was recorded that out of existing agroforestry practices, scattered near farms and around homestead was found most common (about 47.0 %). The benefits from agro forestry practices in the villages was also assessed and ranked in their order of preferences in respective blocks of district. The different benefits as shade, fruits/vegetables, timber, protection, firewood, soil erosion, medicinal and fodder were scored from 1 to 8. The status of tree plantation in different area was also studied and found trees of mango were most abundant (33.1%), it was noticed that old mango trees were of deshi variety but new trees were mostly of kalmi variety for fruits. The *Neem* trees were recorded (25.5 %) followed by shisham (9.5 %) and teak (14.0 %). It was concluded from the results that status of agro forestry in the studied zonal area of the region is in developing stage and needs to be improved by imparting technical knowledge about planting material, methods and sale of end produces of trees to the farmers and tree growers.

KEY WORDS : Socio-economic studies, Agroforestry practices, Species diversity, Homestead system, Trees benefit scoring

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Agroforestry is a shining approach which merges century's old knowledge with modern science in a system and the concept of thinking small scale to achieve potentially big and transformative outcomes (Steiner, 2012). Today, Indian agriculture faces diverse challenges and constraint due to growing demographic

pressure, increasing food, feed and fodder needs, natural resource degradation and climate change (Dhyani *et al.*, 2013). Therefore, a management system needs to be devised that is capable of producing food from marginal agricultural land and is also capable of maintaining and improving quality of producing environment (Dobriyal, 2014). Agroforestry system is one of the best known traditional practices and has an important role in reducing vulnerability, increasing resilience of farming systems and buffering households against climate related risks (CAFRI, 2015), but there are several challenges that reap the benefits of agroforestry in India. There is shortage of superior planting material and improved seed varieties (Verma *et al.*,2017). In India, just as there is a great diversity in climate similarly there exists a large number of agroforestry systems of various forms and types (Dagar *et al*., 2014) .The current area under agroforestry in India is estimated as 25.31 million hectares or 8.2 percent of the total reporting geographical area of the country by Dhyani *et al.* (2013); Dagar *et al*. (2014) and CAFRI (2015). As the population of India is increasing at a very fast rate; the land-holding size of farmers shrink at a very fast rate and agroforestry is the only way to optimize the farm productivity (National Agroforestry Policy, 2014).It is generally well known that status of agroforestry in districts of Eastern plain region of Uttar radish is in developing stage. From Forest survey of India report (2017), it was recorded that forest cover including tree cover is only 1.11 per cent in the district of Varanasi. Therefore, a study has been conducted in selected villages (1%) of Varanasi district of Eastern plain region of Uttar Pradesh in India during the year 2018 to assess the socio-economic profile of villages for land use pattern, general information about villages, status of tree plantations, crop combinations with tree species and their stratified arrangement to identify agroforestry practices with a view to study existing tree species in different agro forestry systems in the villages and their benefits in day- to- day life of rural livelihood. The choice of species in agroforestry models were also recorded on the basis of their preferences in plantations.

EXPERIMENTAL METHODS

Study area: Varanasi district:

Varanasi is situated in the agro- climatic zone of eastern plain region of Uttar Pradesh, bordering the districts of Jaunpur in the North, Ghazipur in the North East, Chandauli in the East, Mairzapur in the South and Sant Ravidasnagar in the West. The total area of the district is 1535 sq. km, supporting of population of 31.48 lakh persons. This district is densely populated, with 2063 persons per sq. km, as against the state average of 689 persons per sq. km. The urban agglomeration is stretched between 82° 56'E – 83° 03'E and 25° 14'N – 25° 23.5'N. It is located in the middle Ganges valley of North India, along the left crescent-shaped bank of the river Ganges. The river system consists of the mighty Ganga highly revered by Hindus since ages and Gomti, Varuna, Assi, Banganga, Chandra Prabha and Karmnasa are tributaries of the Ganga, that drain the area. Being located in the Indo-gangetic plains of North India, the land is very fertile because low level floods in the Ganges continually replenish the soil. There are three main tahsil in Varanasi district. First one is Varanasi, second one is Pindra and another is Rajatalab. As per censes 2011, there are 1327 revenue villages in Varanasi district. Out of this, consists 1258 inhibited villages and 69 non-inhibited villages. There are eight block in Varanasi district. Out of these, 03 blocks in Varanasi tahsil namely Chiraigaon, Cholapur and Kashi Vidyapeeth and partially Harhuan and 03 blocks are in Rajatalab tahsil namely Sewapuri, Arajiline and partially Kashi Vidyapeeth and 03 blocks in Pindra tahsil namely Baragaon, Pindra and partially Harhuan exists.

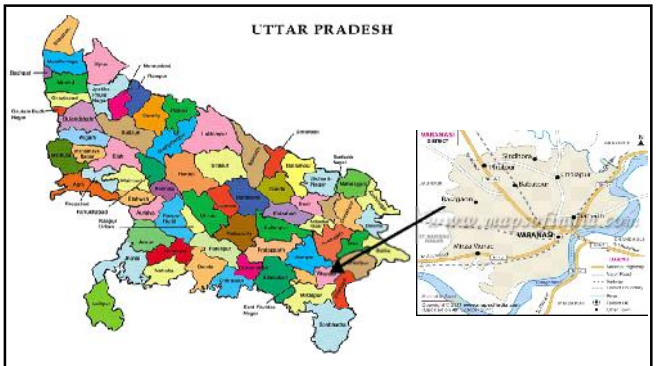

Fig. A: Map of Uttar Pradesh and Varanasi district

Socio-economic study:

The study was carried out in Varanasi district of eastern plain region of UP region. The socio-economic survey with structured questionnaire and Participatory Rural Appraisal (PRA) technique was used to study the general information of villages, land use pattern, existing

status of agroforestry through appraisal of existing farming systems and agroforestry practices and farmers' preference for management practices of agroforestry systems such as agri-silviculture, boundary plantation, silvi-pasture, silvi-horticulture, agri-silvi-horticulture, multi-storey, homestead etc. In the region, one representative village in each developmental block was selected to cover the area. Out of 1200 villages existing in the Varanasi, 17 (1%) villages were taken for study through stratified random sampling method. A total of 10 per cent households were involved in the survey including farmers of small, medium, large and marginal category, males and females covering age and caste of all groups in selected villages. In each selected village, a random sampling technique was used to select farmers. The primary and secondary data was collected from the selected study area. A semi–structured questionnaire was developed. The pre-test work of questionnaire was done by interviewing farmers in selected villages. Thus, the final questionnaire was prepared on the basis of valid suggestions. Before going to make interview, each respondent was given a brief introduction about the nature and purpose of the study.The collected data was verified through surveying the villages and personal interview with the sample respondents. Interviews were normally conducted in a common place of villages where people of all categories including women may sit collectively.

Data processing and analysis:

After completion of collecting data from all the interview schedules were compiled, tabulated and analysed in accordance with objectives of the study. The responses to the questions in the interview schedules were transferred to master sheet to facilitate tabulation for describing the different characteristics and their constraint facing, the respondents were classified into several categories. The MS Excel was used for data processing and analysis.

EXPERIMENTAL RESULTS AND ANALYSIS

The results of socio-economic studies in villages of Varanasi district reveal that land holding area (Table 1) for majority of farmers are under marginal category (84.81%) with small, medium and large in 9.93, 3.68 and 1.56 per cent, respectively. The land use pattern (Table 2) showed that agriculture was major land use (73.62%) followed by horticulture (10.06%) and agroforestry (8.56%). The diversity of trees, crops and vegetables in the study area was studied reflecting different combination of tree and crops in the study area (Table

Table 1 : Land holding pattern in Varanasi district

Sr. No.	Land holding area (ha)	Land holding pattern in developmental blocks (%)								Status in Varanasi district (%)
		Pindra	Harhua	Sevapuri	Arajiline	Badagaon	Cholapur	Chiraigaon	Kashi Vidyapith	
1.	Marginal (<1ha)	95.5	95	75	60	90	90	88	85	84.81
2.	Small (1-2 ha)	2.5	3.5	12.5	30	6	8	7	10	9.93
3.	Medium (2-3 ha)	1.5	1.5	9	6	2	2	5	2.5	3.68
4.	Large (>3ha)	0.5	0	3.5	4	2	0	0	2.5	1.56

Table 2 : Land use pattern in Varanasi

Sr. No.	Land use pattern	Status in developmental blocks (%)								Status in Varanasi district (%)
		Pindra	Harhua	Sevapuri	Arajiline	Badagaon	Cholapur	Chiraigaon	Kashi Vidyapith	
1.	Agriculture	65	80	81.5	72.5	80	80	50	80	73.62
2.	Agroforestry	5	11	12.5	10	5	5	5	15	8.56
3.	Horticulture	17.5	3	2.5	7.5	2	10	35	3	10.06
4.	Wasteland	6.5	3.5	1.5	3.5	4	3	3	1	3.25
5.	Others	6	2.5	2	6.5	9	2	7	1	4.5

3). The results demonstrated that a total of 09 different agroforestry practices, silvi-horticulture, agri-silviculture, agri-horticulture, aqua-silviculture, agri-silvi-horticulture, agri-silvi-pastoral, silvi-pastoral, silvi-medicinal and homestead existed in different villages. Out of different categories, timber, fruits, medicinal, agriculture, flower

Table 3 : Existing tree crop combinations in agroforestry systems in Varanasi

Sr. No.	Developmental block	Existing tree crop combinations	Agroforestry system
1.	Pindra	Mango – Marigold	Silvi-horticulture
		Eucalyptus – Wheat/ Mustard	Agrisilviculture
		Teak – Cabbage/ Potato	Silvihorticulture
		Eucalyptus – Pigeonpea	Agrosilviculture
2.	Harhua	Mango – Wheat/ Mustard	Agrohorticulture
		Teak – Potato/ Cauliflower	Silvihorticulture
		Eucalyptus – Potato /Pea	Silvihorticulture
		Eucalyptus -Brinjal/Tomato	Silvihorticulture
		Eucalyptus – Mango	
3.	Sevapuri	Teak – Mustard	Agrisilviculture
		Mango – Wheat	Agrihorticulture
		Eucalyptus – Pigeonpea	Agrisilviculture
		Eucalyptus – Pea/Cabbage/Chilli	Silvihorticulture
4.	Arajiline	Mango – Mustard	Agrisilviculture
		Eucalyptus – Pea	Silvihorticulture
		Teak – Aquaculture	Aquasilviculture
		Eucalyptus– Wheat/ Mustard	Agrosilviculture
5.	Badagaon	Teak – Wheat/ Mustard	Agrosilviculture
		Eucalyptus – Potato	Silvihorticulture
		Guava – Eucalyptus	Silvihorticulture
		Teak – Bajra/Chari – Paddy	Agrisilvipastoral
6.	Cholapur	Eucalyptus–Wheat/ Mustard	Agrosilviculture
		Teak–Potato/ Cabbage/Chilli	Silvihorticulture
		Mango – Berseem/Chari	Silvipastoral
		Eucalyptus – Mango/*Neem*	Silvihorticulture
7.	Chiraigaon	Teak – Marigold/Bela/Rose	Silvihorticulture
		Eucalyptus–Cabbage/ Cauliflower	Silvihorticulture
		Teak – Berseem/Chari	Silvipastoral
		Mango – Wheat/ Mustard	Agrohorticulture
8.	Kashi Vidyapith	Teak – Wheat/ Mustard	Agrosilviculture
		Mango – Brinjal/ Cabbage/ Potato	Silvihorticulture
		Teak – Mango/ Guava	Silvihorticulture

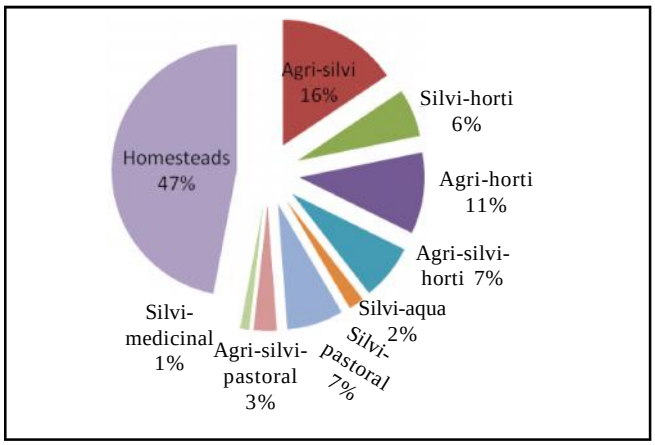

Fig. 1: Status of agroforestry systems in Varanasi district (%)

and other plant species were recorded. The different agroforestry combinations were recorded namely: mango-marigold, eucalyptus-wheat, eucalyptus-mustard, teak-vegetables, eucalyptus-pigeonpea, teak- marigold, eucalyptus -marigold in Pindra block, mango- wheat / mustard, teak- vegetables, Eucalyptus- vegetables, *Neem*-vegetables, eucalyptus-mango in Harahua block, teak-mustard, mango-wheat, eucalyptus-vegetable, eucalyptus-pigeonpea, teak-maize-vegetables in Sevapuri block, mango-mustard, eucalyptus-pea, teak-aquaculture and eucalyptus-wheat/mustard in Arajiline block, teak-wheat/ mustard, eucalyptus-vegetables, eucalyptus-guava, eucalyptus-pigeonpea, teak- millet/paddy/fodder crops in Badagaon block of the district Varanasi. It was recorded

Table 4 : Existing agroforestry systems in developmental blocks of Varanasi district

Sr. No.	Classes of agroforestry systems	Agroforestry systems in developmental blocks (%)								Status in Varanasi district (%)
		Pindra	Harhua	Sevapuri	Arajiline	Badagaon	Cholapur	Chiraigaon	Kashi Vidyapith	
1.	Agri-silvi	18	20	20	18	12	13	11	13.5	15.6
2.	Silvi-horti	7	8	6.5	5	6	5.5	5	7	6.2
3.	Agri-horti	9	11	11.5	2	10	11	9.5	10	10.5
4.	Agri-silvi-horti	7	8	7.5	6.5	8.5	7.5	5.5	7.5	7.2
5.	Silvi-Aqua	0.75	2	1.5	3.5	2.5	2.9	1.75	1.5	2.0
6.	Silvi-pastoral	6.8	6.5	5.5	7.2	8.5	7.5	7.9	8.6	7.3
7.	Agri-silvi-pastoral	2.6	2.25	2.5	4	3.5	3.6	3.25	2.5	3.0
8.	Silvi-medicinal	1	1.5	1.75	0.5	2	1	0.5	1.5	1.2
9.	Homesteads	48	41	43.3	44	47.5	48.2	56	48	47.0

Table 5 : Status of tree plantation in Varanasi district

Sr. No.	Tree species	Status in developmental blocks (%)								Status (%)	Preference score
		Pindra	Harhua	Sevapuri	Arajiline	Badagaon	Cholapur	Chiraigaon	Kashi Vidyapith		
1.	Teak	2	6.5	18.5	20	10	10	25	20	14.0	1
2.	Shisham	2	6	15	6	2	15	15	15	9.5	9
3.	Mango	35	37.5	27.5	35	40	30	25	35	33.1	2
4.	Neem	43.5	37.7	22.5	20	30	25	10	15	25.5	4
5.	Babool	1	1.2	3	1.5	2	2	5	1	2	8
6.	Bamboo	6	4	3.5	3	4	3	5	5	4.1	6
7.	Mahua	1	2	2	4	1	4	5	3	2.8	7
8.	Eucalyptus	1.5	1.5	1.5	1.5	2	1	2	2	1.6	5
9.	Aonla	0.5	0.5	1	1.5	0.25	1	0.5	0.5	0.7	3
10.	Others	7	3.5	5.5	9	8.75	9	7.5	3.5	6.7	10

that out of existing agroforestry practices, scattered near farms and around homestead was found most common (about 47.0 %). The existing agroforestry systems were also quantified in different developmental blocks (Table 4 and Fig.1) followed by agri-silviculture (15.6 %) and agri-horticulture (10.5 %). The status of tree plantation (Table 5) in different area was also studied and found trees of Mango were most abundant (33.1%), it was noticed that old Mango trees were of deshi variety but new trees were mostly of kalmi variety for fruits. The *Neem* trees were recorded (25.5 %) followed by shisham (9.5 %) and teak (14.0 %). The old plantations of *Neem* and shisham trees were recorded while teak trees were mostly young. The teak, mango and aonla were most preferred species in plantations. The pattern of plantation in agroforestry was also studied and found that systematic tree planting on bunds and blocks was very less with 22.0 and 13.0 per cent, respectively (Table 6). The benefits ranking from trees depicted that shade was ranked most preferred followed by daily need (fruits and vegetables) as second and timber was ranked as third benefit. The other benefits were nutrients, protection, soil erosion control and N-fixation (Table 7).

Farmers have common practice to integrate crops, trees and livestock to solve the problem of acute shortage of fuel, fodder and other goods (Bhatt, 2002). The farmers have little opportunities to select the tree species and therefore, they accept whatever is available on their land (Bhatt *et al*., 2010). In the Himalayan region, a number of indigenous agroforestry systems have been known from Himachal Pradesh and Uttarakhand (Atul and Khosla, 1990) out of which agri-horti-silviculture, agri-silviculture and agri-horticulture were very frequent. Dadhwal *et al*. (1989) and Toky *et al*.(1989) have recognized three agroforestry systems with their multifarious benefits. The various problems and constraints of agroforestry can be overcome through policy and institutional reforms (Smith *et al.*, 1998). Moreover, there is deficiency in the understanding of biophysical concerns correlated with productivity, water-resource sharing, soil productivity and plant interactions in agroforestry systems, since most of the research is site-specific, observational in nature and not process-oriented (Puri and Nair, 2004). In almost all tropical and subtropical eco zones, agroforestry is represented by the homestead farming, essentially the mixed cropping of annual and perennial crops around the farmer's dwelling houses. Home gardens are recognized worldwide as an epitome of a sustainable agroforestry systems (Torquebiau, 1992 and Kumar and Nair, 2004).

Thus, agroforestry practices can be an important

Table 6: Pattern of agroforestry plantation in the district

Sr. No.	Pattern of agroforestry plantation	Pattern in developmental blocks (%)								Pattern in Varanasi district (%)
		Pindra	Harhua	Sevapuri	Arajiline	Badagaon	Cholapur	Chiraigaon	Kashi Vidyapith	
1.	Scattered on farms	15	19	21	22	15	19	17	16	18
2.	Bunds	22	24	23	25	18	23	21	20	22
3.	Block	20	18	9	11	8	12	11	15	13
4.	Others	43	39	47	42	59	46	51	49	47

Table 7: Benefits from agroforestry

Sr. No.	Benefits	Pindra	Harhua	Sevapuri	Arajiline	Badagaon	Cholapur	Chiraigaon	Kashi Vidyapith	Preference score
1.	Shade	1	1	1	2	2	1	2	1	1
2.	Fruit/ Veg.	2	2	2	1	1	2	1	2	2
3.	Timber	3	3	3	3	3	3	3	3	3
4.	Fire wood	4	5	8	6	7	7	7	6	5
5.	Medicinal	7	6	5	8	5	8	4	5	7
6.	Soil erosion	4	5	8	6	7	7	7	6	6
7.	Protection	5	4	4	5	6	4	8	7	4
8.	Fodder	6	8	7	7	8	6	5	8	8

tool to achieve the 4 per cent sustainable growth in agriculture (National Agroforestry Policy, 2014). The promotion of sustainable agroforestry practices on a large scale in future is only possible through amalgamation of proactive farmer policies of government, involvement of the industries, support services from NGOs and willingness of farmers (Verma *et al.*, 2017). Extension services are important for smooth dissemination of research results on the different aspect of agroforestry but research results on agroforestry, available in the public and private domain do not regularly reach the farmers due to lack of a proper or dedicated extension system. Also, Farmers with major land holdings will get more benefit by the agroforestry related schemes than the small and marginal farmers. So there is need to introduce special programmes on agroforestry models for marginal and small farmers (Verma *et al.*, 2017) because 2/3rd farmers of Indian farmers are small and marginal farmers (Kumar *et al.*, 2017 and Singh and Pandey, 2011) .

Conclusion:

The different combinations of agroforestry systems were recorded in the studied area which were of various benefits for rural livelihood. The systematic pattern in tree planting needs to be improved for the region. The extension and training programmes regarding selection of species, tree planting pattern, nursery raising, quality planting material, maintenance and management of plantations and most importantly, the marketing of trees as end produce. In marketing or sale of trees, transit and felling permit to be issued by forest department is very important. The unawareness of rules and fear of administration discourages farmers for adopting agroforestry widely at large level in this region. It is well known that western part of UP is more flourished than Eastern part for adoption of agroforestrty. It is now urgent need of time to adopt tree plantations in massive way in districts of Eastern Plain zone to achieve our national target of forest policy. Agroforestry is the only way for progress for farmers and rural people, leading to sustainable development, food and nutritional security. Agroforestry adoption with suitable species of economic value will improve country's forest and tree cover to the 33 per cent. The foresters, researches, NGOs and tree growers and traders are needed to be co-ordinated on a common platform for successful implementation of agroforestry programme on massive level. Further, to enhance the efforts of farmers, sale of end products should be strengthened with the involvement of project planners and wood based industries.

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