Contribution of Agroforestry Tree Species in Vindhyan Region of Uttar Pradesh, India

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Abstract— *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. The trees play an important role in fulfilling daily needs of people. The Eastern part of Uttar Pradesh in India is in great deficit of tree plantations on agriculture lands. Agroforestry is only way for growing trees on available lands in block/boundary plantations, thus, reducing pressure on forests for tree based needs in day-to-day life. As per latest report of FSI, 2021, only 9.23 % (6.18 % forest and 3.05 % Tree cover outside forests) area is covered with trees in the state of Uttar Pradesh. In Vindhyan region, total 15489782 trees were enumerated, where highest (2509795) number of trees were found in 121-150 cm girth class, followed by 2283850 trees in 151-180 cm girth class and 1996340 trees in 91-120 cm girth class Similarly, Eucalyptus tree possessed highest contribution (18.29%), followed by Mango(15.1%), Teak (14.34%) and Neem (13.83 %) .The smallest (629466) no. of trees were found in 271-300 cm followed by 756034 in 0-30 cm class. It clearly indicates that overall there is urgent need of time to plant these species in different agroforestry models to overcome wide demand supply gap of traditional tree species like, desi Mango, Neem, Teak, Eucalyptus, Mahua and Shisham. Similarly, new species, like Mahogany, Melia, Gamhar and Chironji may be planted in various agroforestry combinations in view of their great economic value. In recent past, Mahogany gave a good response in the region and 44358 no. of trees were found in 0-30 cm girth class in respective districts. Like Gamhar was also seen in some villages with 7747 no. of trees in 0-30 cm girth class in studied districts. The condition of Mahua planting is alarming as being a slow growing species, only 6798 no. of trees were found in 0-30 cm girth class. In new species, Melia dubia istaking good place, as 28646 trees were found in 0-30 cm class in villages. Chironji trees were rare in Mirzapur and Sonbhadra district and completely absent in Prayagraj district. In a total, only 4480 Chironji trees were recorded in the Vindhyan region. The girth class wise trees in Vindhyan region depicted that in 271-300 girth class, minimum number of trees were existing followed by 0-30 cm girth class and 31-60 cm class. This is clear that old trees were harvested at very fast rate for most of the species and less young plantations showed that these established and new tree species should be planted at fast rate in agroforestry so as to maintain their sustainable availability.*

Keywords— Agroforestry, ToFs, contribution, Vindhyan region, Eastern UP, sustainable availability.

I. INTRODUCTION

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). 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). Growing trees outside forests (ToF) presents a significant environmental and economic opportunity in India. Nearly 80 million hectares (Mha) of these trees could sequester 3.4 gigatons of carbon dioxide-equivalent (Gt CO2e) by 2040 to help India achieve its international climate commitments. It can also support food and livelihood security for rural India, especially for its poor and vulnerable groups (Duraisami *et al.* 2022). The alternatives

of energy have been generated but still the wood energy is a prime energy source in domestic sector. The contribution of biomass is 14% of the world energy and 38% in developing countries (Dagar *et al.,* 2014). These changes in ecology and economics through on- farm trees are well documented and traditionally been followed. The wood demand has increased by over 60% and the output from forests has reduced to half in the same period. It is because of the dramatic rise of outputs from plantation and farm forestry, if has been reduced by over 50%. In the private sector, more than 50% of industrial timber is being contributed by agroforestry. The community lands share major part of the annual 250 million tons of fuel consumption (FSI, 2021). The trees play an important role in fulfilling daily needs of people. The Eastern part of Uttar Pradesh in India is in great deficit of tree plantations on agriculture lands. Agroforestry is only way for growing trees on available lands in block/boundary plantations, thus, reducing pressure on forests for tree based needs in day-to-day life. As per latest report of FSI, 2021, only 9.23 % (6.18 % forest and 3.05 % Tree cover outside forests) area is covered with trees in the state of Uttar Pradesh.

The Trees outside forests (TOFs) occur in natural and in cultivated landscapes and serve in a number of ecological and economic functions (Kleinn and Morales, 2005). Trees and other woody plants in the landscape serve also important ecological functions, particularly for the conservation of biodiversity, offering shelter and food, and nesting sites (Waltert *et al.,* 2005); other ecological functions are erosion control, water protection and carbon sequestration (Khadanga and Jaykumar, 2018; Bhardwaj and Panwar, 2003). It is now being increasingly argued that the role of TOF in providing food, wood and fuel to rural masses, carbon sequestration, prevention of soil erosion, biodiversity conservation, checking desertification, establishment of wildlife corridors and microclimatic stabilization, is quite substantial (Bhattarai, 2000) . The share of wood energy from non-forest land used for cooking in rural India is 59% while that of biomass energy is 90% (Saxena, 1997) . After the creation of Uttaranchal State, the forest cover including tree cover in Uttar Pradesh is only 9.20 % (FSI, 2021) of the total geographical area. This forest cover in the state is mainly confined to the Tarai and Vindhyan regions. In Eastern Uttar Pradesh, the forest cover is negligible and mostly in the form of small wood lots and plantations. In this region, due to population explosion, illiteracy, poverty and urbanization, the scope of increase in forest area is very limited. However, the vegetation cover may be increased by adopting social forestry, particularly the agro forestry.

This study shall be helpful in collecting the information regarding needs and suggestions about forestry in eastern U.P. To identify deficit Agroforestry species *viz. Melia dubia* (Barma drek), *Gmelina arborea* (Gamhar), *Neolamarckia cadamba* (Kadamb), *Swietenia macrophylla* (Mahogany), *Dalbergia sissoo* (Shisham), *Acacia nilotica* (Babool*), Mangifera indica* (Mango), *Azadirachta indica* (Neem), *Madhuca indica* (Mahua), *Eucalyptus sp.* (Safeda), *Poplar deltoids* (Poplar), *Buchanania lanzan* (Chironji) and *Artocarpus heterophyllus* (Kathal) in Vindhyan region of Uttar Pradesh for incorporating them in Agroforestry/ afforestation programmes, this study has been conducted. As forest cover in the districts of Vindhyan region, Prayagraj, Mirzapur and Sonbhadra is 2.36, 18.25 and 36.79 % respectively. In these districts, tree cover area is very negligible and green cover of the region can be increased well by increasing Agroforestry in the rural region. Thus, for making suitable choice of species on the basis of assessment of trees outside forests in the rural area may also give a clear picture of girth class-wise number of existing trees.

II. STUDY AREA

2.1 Vindhyan region:

The Vindhya region of Uttar Pradesh lies between 22° 45′ to 24° 34′ North latitude and 82° E to 83° 23′ East longitude. The forest of Vindhya region is tropical dry deciduous type. The rainfall varies from 1200-3720 mm in July-August. The Vindhyan region consists of the Vindhyan plateau and hills in the state. The topography consists mainly of plateau lands but has lot of local variations too.The soil of this region has red lateritic soils with often-pronounced nodules locally called “Murram”. Three districts - Prayagraj, Mirzapur and Sonbhadra existing in Vindhyan region were selected for study. Vindhyan region was with dense forests, but now depletion of this resources is increasing very fast due to developmental activities, agricultural land expansion and, of course, spurt in forest offences, like-illicit felling, encroachment, poaching etc. Factors, like- abiotic and edaphic, have also played a key role in determining and also restraining the growth of plant species in this area.

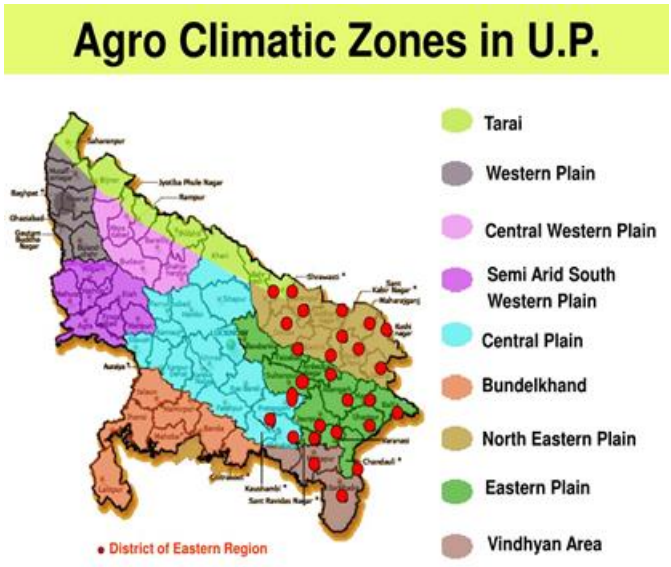

FIGURE 1: Vindhyan region in agro-climatic zones of U.P.

2.2 Prayagraj:

It is located in the southern part of the state, at between 24° 47′ to 25° 47′ North latitudes and 81° to 82° 21′ East longitudes, and stands at the confluence of the Ganga (Ganges), and Yamuna Rivers. Prayagraj division consists of Prayagraj, Kaushambi and Fatehpur districts. Prayagraj District consists of 8 Tehsils and 20 development blocks. It has an area of 5482.10 sq. km and borders the state of Madhya Pradesh. The district falls under the central Ganga alluvial plain. It has 23 developmental blocks.

2.3 Mirzapur:

Mirzapur is located at 23.52° & 25.32° North latitude and 82.7° and 83.33° East longitude. It is a part of Varanasi Division. This District is surrounded by the Varanasi, Sonbhadra, Prayagraj districts. Mirzapur is enriched with natural beauty and is located at a distance of about 60 km both from Varanasi and Prayagraj. It has an average elevation of 265 feet or 80 meters from sea level. South of Mirzapur is Sonbhadra district, on its north-west is Prayagraj district. Sandstone, red sand and ordinary sand are found aplenty in Mirzapur. Trees like mahua, neem, saal, teak, mango and guava are commonly found throughout the district.

2.4 Sonbhadra:

Sonbhadra lies between 23° 52′ to 25° 32′ North latitudes and 82° 72′ to 83° 33′ East logitudes. It is surrounded by Mirzapur, Chandauli, Kaimur and Rohtas District districts.The district headquarters is Robertsganj. Sonbhadra's major part of land is classified as forest land. But, very less no. of trees exist in the forest and in 40 percent of the land, urbanization led for crop cultivation.

III. METHODOLOGY

The districts Mirzapur, Sonbhadra and Prayagraj, located in Vindhyachal Region (Zone-9) were in study area. List of districts villages were compiled from population census records of U.P. One percent villages selected in each district- Prayagraj, Mirzapur and Sonbhadra, through purposive random sampling representing each block (with high population and tree growers). A total of 10 households of each selected village following stratified random sampling (Progressive - 04, Medium -03 and Lower -03) were taken. The demand and supply of selected species and socio-economic studies conducted for villages of selected districts in their respective tehsils through developed questionnaire. The data were collected through structured questionnaire for tree species existing in villages especially on farm bunds/block plantations, village road side, pond side and other locations.With the help of villagers locations were verified for tree orchards, agroforestry plantations The observations were grouped on the basis of the development blocks of the districts covering 1% of the total villages. In all three districts, species wise number of trees were tabulated in respective girth classes *viz.* 0-30, 31-60, 61-90, 91-120, 121-150, 151-180, 181-210, 211-240, 241-270 and 271-300 cm. After combining data in blocks of respective districts, the number of TOFs in rural area of district was assessed. The species wise percent contribution of trees for respective districts in Vindhyan region was

calculated (Manhas *et al.,* 2006; Explorable.com, 2009; Kothri, 2012; Cochrein, 1977; National Statistical Office (NSO); Anand *et al.,* 2016).

IV. RESULTS AND DISCUSSION

The tree species selected for the study were very common as Trees Outside Forests (TOFs) in rural area of the districts of Vindhyan region *viz.* Prayagraj, Mirzapur and Sonbhadra. The species as *Mangifera indica, Tectona grandis, Azadirachta indica* and *Dalbergia sissoo* were most demanded species of the region. The total enumerated tree species with respective girth classes in these districts of Vindhyan region had been depicted in results.

In Prayagraj, the results clearly depicted (Table 1, Fig. 2) complete picture of enumerated trees of selected fourteen species in the villages of the district. Out of total 7994888 number of trees, the highest no. of species was for Mango (17.42 %) followed by Neem (17.11 %), Eucalyptus (16.63%), Mahua (10.97%), Teak (10.35%), Babool (9.76 %), Shisham (9.62 %), Kathal (3.44%) and Kadamb (2.47%). The other new species as Melia, Mahogany, Gamhar and Poplar contributed 0.85%, 1.14%, 0.12% and 0.11% respectively. The Chironji trees were not found in the district. For Teak, young plantations in girth class of 0-30 cm were very less (21249 in the district). Similarly young plantations of Shisham was also negligible with 5540 number of trees. The young plantations of Neem and kalmi Mango was found in the district. In Mirzapur, the results clearly showed (Table 2, Fig.3) complete picture of enumerated trees of selected fourteen species in the villages of the district. Out of total 5739415 number of trees, the highest no. of species was for Eucalyptus (22.49 %) followed by Babool (16.93 %), Teak (16.07%), Mango (12.06%), Shisham (9.19 %), Neem (8.86) and Mahua (6.84%). The other new species as Melia, Mahogany, Gamhar, Chironji and Poplar contributed in very negligible number respectively. The young plantations of timber species were less, thus, needs to be planted in form of agroforestry/orchards /afforestation programmes of tree growers.In Sonbhadra, the results clearly depicted (Table3, Fig 4) complete picture of enumerated trees of selected fourteen species in the villages of the district. Out of total 1755479 number of trees, the highest no. of species was for Teak (26.85 %) followed by Neem (16.10 %), Mango (14.51 %), Eucalyptus (12.09%), Shisham (9.81 %) and Mahua (8.26 %). The other new species as Melia, Mahogany, Gamhar, Chironji and Poplar contributed in very negligible number.

In Vindhyan region, Table 4 and Fig. 5 indicated that out of total 15489782 trees enumerated in Vindhyan region, highest (2509795) number of trees were found in 121-150 cm girth class, followed by 2283850 trees in 151-180 cm girth class and 1996340 trees in 91-120 cm girth class. The smallest (629466) no. of trees were found in 271-300 cm followed by 756034 in 0-30 cm class. Similarly, Eucalyptus tree possessed highest contribution (18.29%), followed by Mango (15.1%), Teak (14.34%) and Neem (13.83 %) (Fig. 6, 7 & 8). It clearly indicates that overall there is urgent need of time to plant these species in different agroforestry models to overcome wide demand supply gap of traditional tree species like, desi Mango, Neem, Teak, Eucalyptus, Mahua and Shisham. Similarly, new species, like Mahogany, Melia, Gamhar and Chironji may be planted in various agroforestry combinations in view of their great economic value. In recent past, Mahogany gave a good response in the region and 44358 no. of trees were found in 0-30 cm girth class in respective districts. Like Gamhar was also seen in some villages with 7747 no. of trees in 0-30 cm girth class in studied districts. The condition of Mahua planting is alarming as being a slow growing species, only 6798 no. of trees were found in 0-30 cm girth class. In new species, Melia dubia istaking good place, as 28646 trees were found in 0-30 cm class in villages. Chironji trees were rare in Mirzapur and Sonbhadra district and completely absent in Prayagraj district. In a total, only 4480 Chironji trees were recorded in the Vindhyan region. The girth class wise trees in Vindhyan region depicted that in 271-300 girth class, minimum number of trees were existing followed by 0-30 cm girth class and 31-60 cm class. This is clear that old trees were harvested at very fast rate for most of the species and less young plantations showed that these established and new tree species should be planted at fast rate in agroforestry so as to maintain their sustainable availability (Table 5 and Fig 9).

The girth class distribution of Mahua is very much wide and young plantations are not taking up by the villagers. Mostly trees of Mahua were old aged and results indicated that an important species of timber was found occasional in villages. Majority of the farmers have adopted Teak on their farm bunds as agro forestry species. Most of the Teak trees are too young to be harvested. It is clear from tree enumeration studies that young plantations of desi Mango, Neem, Mahua and Shisham were less. Some other tree species as Jamun (*Syzygium cumini*), Arjun (*Terminalia arjuna*), Ashok (*Saraca asoka*), Sahjan, Aonla, Shahtoot, Siras, semal and Karanj (*Pongamia pinnata*) were seen occasionally in all three districts of the region.

TABLE 1
GIRTH CLASS WISE TOFS IN PRAYAGRAJ

PRAYAGRAJ																
S. No.	**Girth class (cm)**	**Teak**	**Shisham**	**Mahua**	**Eucalyptus**	**Melia**	**Mango**	**Neem**	**Gamhar**	**Mahogany**	**Chironji**	**Poplar**	**Kadamb**	**Kathal**	**Babool**	**Total**
1	0-30	21249	5540	4464	55356	15450	115647	61967	980	32682	0	2350	15620	8675	24234	364214
2	31-60	60761	11581	16680	91180	19170	74092	101181	1050	12924	0	3890	16980	26909	62222	498620
3	61-90	151041	57463	18737	205452	21340	98330	157420	5400	26722	0	1200	64097	43070	163831	1014103
4	91-120	158646	78533	29359	233898	12045	89338	194800	1290	18822	0	765	44119	78849	146761	1087225
5	121-150	153321	198358	143629	244927	0	212152	194454	1210	0	0	840	36212	66015	125135	1376253
6	151-180	104966	141411	159283	224205	0	192792	179906	0	0	0	0	9766	25451	67486	1105266
7	181-210	78425	117307	163751	136375	0	151044	171901	0	0	0	0	8056	13381	61945	902185
8	211-240	41631	83827	123895	79664	0	236820	175834	0	0	0	0	2370	5510	95092	844643
9	241-270	25819	54481	111204	34014	0	121499	101200	0	0	0	0	0	3014	25578	476809
10	271-300	31641	20717	106098	24669	0	100956	29437	0	0	0	0	0	3836	8216	325570
Total no. of trees		**827500**	**769218**	**877100**	**1329740**	**68005**	**1392670**	**1368100**	**9930**	**91150**	**0**	**9045**	**197220**	**274710**	**780500**	**7994888**
Mean		82750	76921.8	87710	132974	17001.25	139267	136810	1986	22787.5		1809	24652.5	27471	78050	799488.8
± SD		±	±	±	±	±	±	±	±	±	-	±	±	±	±	±
		55504.07	61457.16	63568.49	87205.47	4105.8	56362.22	59057.31	1912.47	8687.06		1325.05	21389.08	27006.02	53473.53	361524.69

TABLE 2
GIRTH CLASS WISE TOFS IN MIRZAPUR

MIRZAPUR																
S. No.	**Girth class (cm)**	**Teak**	**Shisham**	**Mahua**	**Eucalyptus**	**Melia**	**Mango**	**Neem**	**Gamhar**	**Mahogany**	**Chironji**	**Poplar**	**Kadamb**	**Kathal**	**Babool**	**Total**
1	0-30	58899	9508	2334	70949	12316	31133	38752	2800	3180	0	457	10127	8050	75680	324185
2	31-60	83765	47550	19001	107040	20899	36705	24472	3877	3710	0	1267	11774	9605	87678	457343
3	61-90	108080	44518	12261	132384	30569	51072	58934	4726	2650	0	590	17778	15902	151840	631304
4	91-120	127308	55646	27466	142333	29206	88357	63906	4748	1060	195	0	18846	11729	109563	680363
5	121-150	146897	71753	63403	204725	23636	100427	71875	7258	0	0	0	11073	25402	110073	836522
6	151-180	146225	101229	63866	149440	20215	138126	69786	2551	0	380	0	24865	18903	135596	871182
7	181-210	62082	80083	77954	162814	0	99121	80853	0	0	0	0	16673	28918	86613	695111
8	211-240	110070	85037	34926	181067	0	57631	39705	0	0	0	0	17715	13393	69760	609304
9	241-270	63705	18365	60870	66698	0	49635	25299	0	0	0	0	1909	5309	68229	360019
10	271-300	15369	13826	30319	73330	0	39713	17918	0	0	0	0	0	7139	76468	274082
Total no. of trees		**922400**	**527515**	**392400**	**1290780**	**136841**	**691920**	**491500**	**25960**	**10600**	**575**	**2314**	**130760**	**144350**	**971500**	**5739415**
Mean		92240	52751.5	39240	129078	22806.83	69192	49150	4326.67	2650	287.5	771.33	14528.89	14435	97150	573941.5
± SD		±	±	±	±	±	±	±	±	±	±	±	±	±	±	±
		42839.1	31922.37	25589.23	48337.28	6667.88	35289.18	22635.9	1709.71	1144.93	130.81	434.38	6604.44	7896.33	28802.52	210686.99

TABLE 3
GIRTH CLASS WISE TOFS IN SONBHADRA

SONBHADRA																
S. No.	**Girth class (cm)**	**Teak**	**Shisham**	**Mahua**	**Eucalyptus**	**Melia**	**Mango**	**Neem**	**Gamhar**	**Mahogany**	**Chironji**	**Poplar**	**Kadamb**	**Kathal**	**Babool**	**Total**
1	0-30	27720	2849	0	6250	880	7061	1716	3967	8496	1111	150	5398	220	1817	67635
2	31-60	39025	1376	0	2440	1720	1817	9864	4361	7516	1160	280	6029	80	5767	81435
3	61-90	76745	35931	1430	23775	2950	16471	39657	7756	1265	1114	190	6272	11628	25799	250983
4	91-120	72547	32515	640	25642	2928	16479	34880	1027	0	620	0	5178	16656	19646	228758
5	121-150	77768	21760	2548	58538	1342	61062	44539	5257	0	300	0	4578	11204	8124	297020
6	151-180	56023	34775	32527	54995	0	45672	65956	0	6139	0	0	3753	3296	4266	307402
7	181-210	63100	23747	34102	27038	0	48450	31779	0	1809	0	0	0	5846	0	235871
8	211-240	9150	12314	35004	13590	0	24184	34782	0	612	0	0	3197	510	0	133343
9	241-270	49300	4765	24163	0	0	24698	15215	0	5077	0	0	0	0	0	123218
10	271-300	0	2186	14556	0	0	8846	4226	0	0	0	0	0	0	0	29814
Total no. of trees		**471378**	**172218**	**144970**	**212268**	**9820**	**254740**	**282614**	**22368**	**30914**	**4305**	**620**	**34405**	**49440**	**65419**	**1755479**
Mean		52375.33	17221.8	18121.25	26533.5	1964	25474	28261.4	4473.6	4416.29	861	206.67	4915	6180	10903.17	175547.9
± SD		±	±	±	±	±	±	±	±	±	±	±	±	±	±	±
		23552.85	14213.47	15230.93	20710.44	938.48	19837.6	20290.75	2425.71	3184.8	383.64	66.58	1140.19	6301.67	9581.62	100311.79

TABLE 4
GIRTH CLASS WISE TOFS IN VINDHYAN REGION

GIRTH CLASS WISE TOTAL TREES IN VINDHYAN REGION																
S. No.	**Girth class (cm)**	**Teak**	**Shisham**	**Mahua**	**Eucalyptus**	**Melia**	**Mango**	**Neem**	**Gamhar**	**Mahogany**	**Chironji**	**Poplar**	**Kadamb**	**Kathal**	**Babool**	**Total**
1	0-30	107868	17897	6798	132555	28646	153841	102435	7747	44358	1111	2957	31145	16945	101731	756034
2	31-60	183551	60507	35681	200660	41789	112614	135517	9288	24150	1160	5437	34783	36594	155667	1037398
3	61-90	335866	137912	32428	361611	54859	165873	256011	17882	30637	1114	1980	88147	70600	341470	1896390
4	91-120	358501	166694	57465	401873	44179	194174	293586	7065	19882	815	765	68143	107234	275970	1996346
5	121-150	377986	291871	209580	508190	24978	373641	310868	13725	0	300	840	51863	102621	243332	2509795
6	151-180	307214	277415	255676	428640	20215	376590	315648	2551	6139	380	0	38384	47650	207348	2283850
7	181-210	203607	221137	275807	326227	0	298615	284533	0	1809	0	0	24729	48145	148558	1833167
8	211-240	160851	181178	193825	274321	0	318635	250321	0	612	0	0	23282	19413	164852	1587290
9	241-270	138824	77611	196237	100712	0	195832	141714	0	5077	0	0	1909	8323	93807	960046
10	271-300	47010	36729	150973	97999	0	149515	51581	0	0	0	0	0	10975	84684	629466
Total		**2221278**	**1468951**	**1414470**	**2832788**	**214666**	**2339330**	**2142214**	**58258**	**132664**	**4880**	**11979**	**362385**	**468500**	**1817419**	**15489782**
Mean		222127.8	146895.1	141447	283278.8	35777.67	233933	214221.4	9709.67	16583	813.33	2395.8	40265	46850	181741.9	1548978.2
± SD		±	±	±	±	±	±	±	±	±	±	±	±	±	±	±
		115138.84	97896.54	99907.76	145694.89	13270.31	98404.83	96792.87	5388.52	15820.05	387.42	1924.63	25792.73	36280.76	84631.15	662410.42

TABLE 5
SPECIES-WISE CONTRIBUTION OF TREES OUTSIDE FORESTS IN DISTRICTS OF VINDHYAN REGION

Species	Prayagraj (a)		Mirzapur (b)		Sonbhadra (c)		Vindhyan region (a+b+c)		Score in region
	Number	Contribution (%)	Number	Contribution (%)	Number	Contribution (%)	Number	Contribution (%)	
Teak	827500	10.35	922400	16.07	471378	26.85	2221278	14.34	3
Shisham	769218	9.62	527515	9.19	172218	9.81	1468951	9.48	6
Mahua	877100	10.97	392400	6.84	144970	8.26	1414470	9.13	7
Eucalyptus	1329740	16.63	1290780	22.49	212268	12.09	2832788	18.29	1
Melia	68005	0.85	136841	2.38	9820	0.56	214666	1.39	10
Mango	1392670	17.42	691920	12.06	254740	14.51	2339330	15.1	2
Neem	1368100	17.11	491500	8.56	282614	16.1	2142214	13.83	4
Gamhar	9930	0.12	25960	0.45	22368	1.27	58258	0.38	12
Mahogany	91150	1.14	10600	0.18	30914	1.76	132664	0.86	11
Chironji	0	0	575	0.01	4305	0.25	4880	0.03	14
Poplar	9045	0.11	2314	0.04	620	0.04	11979	0.08	13
Kadamb	197220	2.47	130760	2.28	34405	1.96	362385	2.34	9
Kathal	274710	3.44	144350	2.52	49440	2.82	468500	3.02	8
Babool	780500	9.76	971500	16.93	65419	3.73	1817419	11.73	5
Total	**7994888**	**100**	**5739415**	**100**	**1755479**	**100**	**15489782**	**100**	**-**

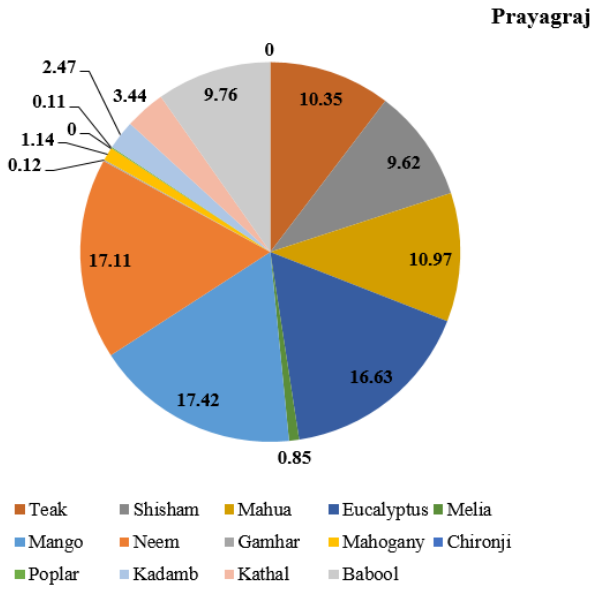

FIGURE 2: Contribution (%) of Tree species in Prayagraj

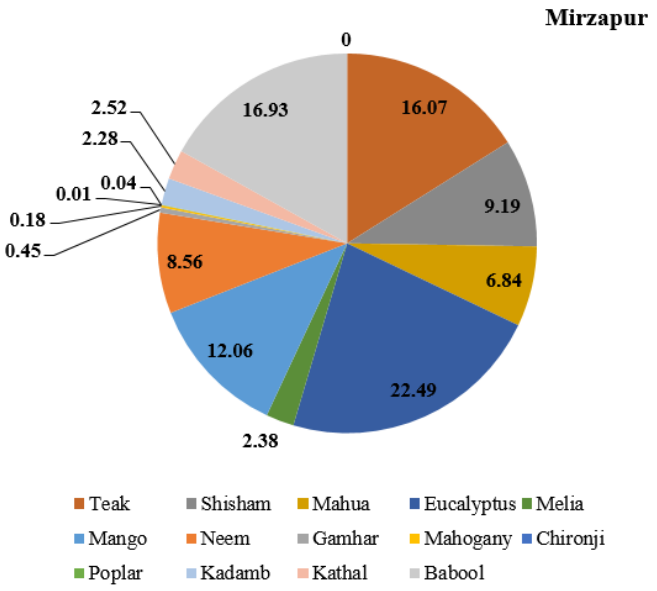

FIGURE 3: Contribution (%) of Tree species in Mirzapur

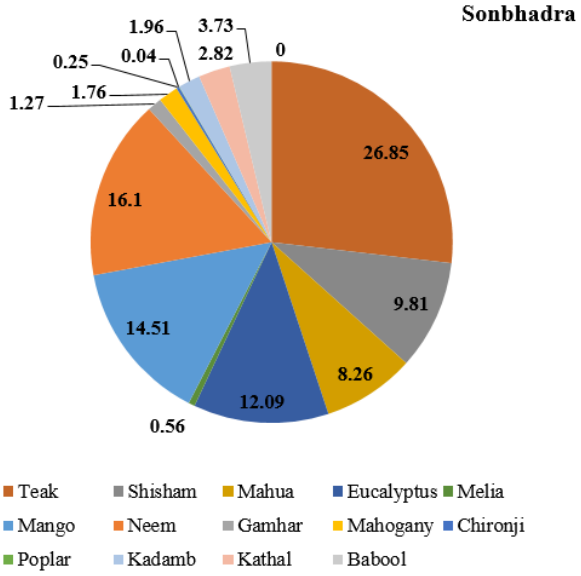

FIGURE 4: Contribution (%) of Tree species in Sonbhadra

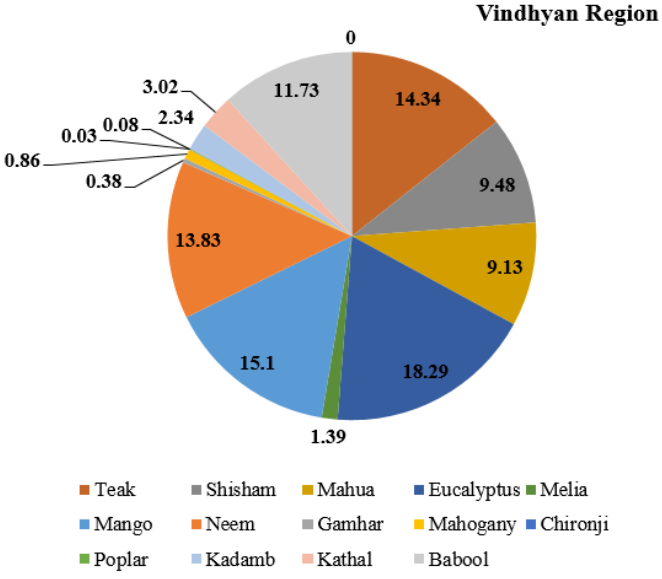

FIGURE 5: Contribution (%) of Tree species in districts and Vindhyan region

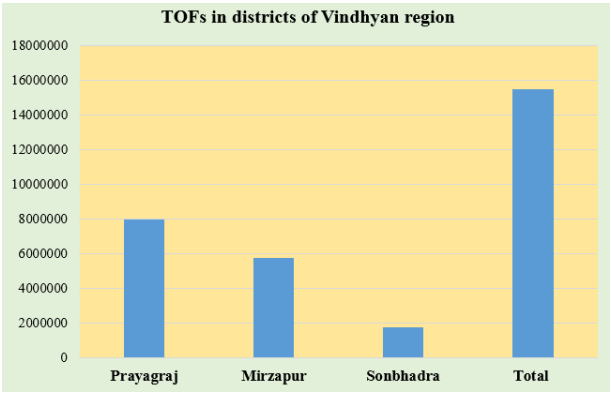

FIGURE 6: TOFs in districts of Vindhyan region

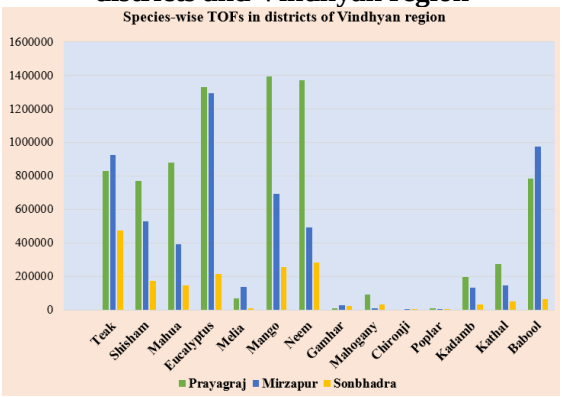

FIGURE 7: Species-wise TOFs in districts of Vindhyan region

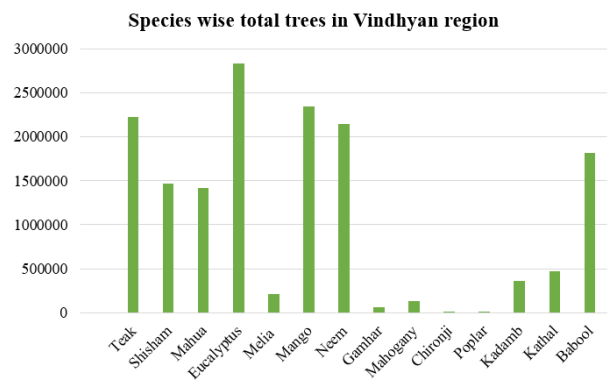

FIGURE 8: Species wise ToFs in Vindhyan region

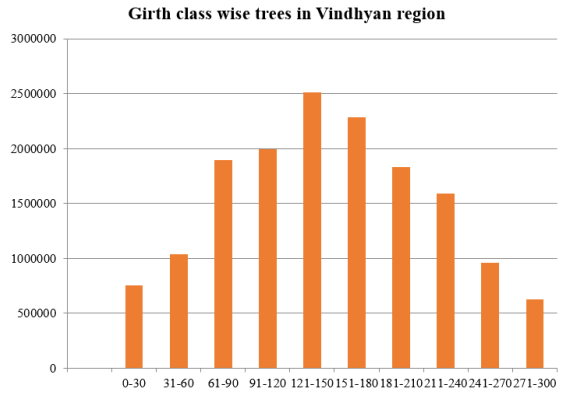

FIGURE 9: Girth class wise trees in Vindhyan region

The farmers have little opportunities to select the tree species and therefore, they accept whatever is available on their land. Bhatt *et al.,* (2010); 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 sustainable agroforestry systems (Torquebiau, 1992; Kumar & Nair, 2004). Thus, agroforestry practices can be an important tool to get four per cent sustainable growth in agriculture (National Agroforestry Policy, 2014). The upgradation of agroforestry is possible through agroforestry policy, industries, NGOs and participation of different stakeholders (Verma *et al.*, 2017). The Farmers with major land holdings will get more benefit by the agroforestry related schemes than other catefory of 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; Singh & Pandey, 2011). Jain & Singh (2000) stated that it is needed to strengthen the agroforestry practices by identifying successful models that can be adopted by the farmers on a wide scale. Advancement of contemporary agricultural technology would also be helpful in increasing the yield of sole crops as well as intercrops.

V. CONCLUSION

The systematic pattern in tree planting needs to be improved for the region. It is well known that western part of U.P. is more flourished than Eastern part for adoption of agroforestry. It is now urgent need of time to adopt tree plantations in massive way in districts of Vindhyan zone to increase green cover in the region and decrease pressure on forests. Agroforestry is the only way for progress of farmers and rural people, leading to sustainable development, food and nutritional security. Agroforestry adoption with suitable recommended species of economic value will improve state / country forest and tree cover to the 33 percent as desired in national forest policy. The foresters, researches, NGOs, tree growers and traders are needed to coordinate for successful implementation of tree plantation in agroforestry at large 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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