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Forest resources of Bihar: Bio-ecological and socio-economic perspectives

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Abstract

Due to its geographical origin, varied physiographic conditions, and favorable climate, Bihar is one of India's states with the most biodiversity. It is well-known because of its indigenous populations and abundant forest resources. Bihar is home to tropical moist deciduous and tropical dry deciduous forests consisting of main plant species like *Shorea robusta*, *Anogeisuss latifolia*, *Terminalia tomentosa*, *Diospyros melanoxylon*, *Pterocarpus marsupium*, *Butea monosperma*, *Madhuca longifolia*, etc. Timber, fuel wood, fodder, and a variety of Non-Timber Forest Products (NTFPs) such as fruits, nuts, edible fungus, vegetables, fish, animals, medicinal plants, resins, essences, and a variety of barks and fibres like bamboo, rattans, palms, and grasses are all commonly extracted forest products. Some of the serious threats endangering the current populations of significant plants include over-exploitation of useful plants, a lack of knowledge and awareness about the status of the plants' current populations. Researchers' collection of plant materials, particularly rare and endangered plant species, from natural settings for diverse experimental reasons also endangers the species' wild populations. To meet the increasing demand for these precious resources while also ensuring their long-term sustainability, efforts should be made to cultivate and multiply them on a vast scale. Research on the spatial distribution patterns, habitat utilization patterns, feeding ecology, and effects of herbivores on significant plant populations is urgently needed.

Keywords: Sustainability, resources, indigenous, NTFPs. endangered, utilization, ecology

Introduction

According to the FAO (2015) [26], forests cover one-third of the planet's geographical area and offer a variety of advantages to human communities. In addition to their crucial roles as habitat and environmental regulators, these advantages are frequently described as resources that people can access for fuel for heating, cooking, and industrial needs and protection of watersheds to enable hydroelectric generation, food security, and improved livelihoods, carbon sequestration, climate amelioration, soil and water conservation, recreation, etc. Additionally, forests are essential for keeping clean air and water, as well as helping to control climate, floods, pollination, and the biological control of diseases, among other regulatory functions (Bahuguna and Bisht, 2013) [10]. In India, the second-largest land use after agriculture is forestry (21.05% of the nation's total land area) (Anonymous, 2011) [4]. Important biological criteria affecting forest composition, structure, and diversity include current environmental conditions as well as anthropogenic factors (Gairola *et al.*, 2008 and Ahmad *et al.*, 2010) [29, 2]. Important ecological products and services are maintained by forests, and the species that make up the forests support human life (Daily, 1997) [19]. By regulating water flows and stabilizing soils and climate, they promote sustainable farming and human well-being. In India (FSI, 2021), over 853 million people (49% of the population) cook food with wood, while Bihar, Chhattisgarh, Tripura, Meghalaya, Assam, Nagaland, Odisha, and Manipur follow with 57.6 percent dependence on wood for cooking. Since the 1990s, excessive use of forest resources for building homes and fuel wood has resulted in more than 30 percent of the world's forests being lost. Forest destruction results in biodiversity loss, pressure on the delicate ecology, soil fertility loss, erosion, and excessive water runoff into the lowlands. An estimated 3.3 million acres of forests are lost globally each year, and agriculture is thought to be responsible for 80 percent of that loss (FAO, 2015) [26].

In India, almost 85 percent of the rural population uses wild plants and their varied parts for

food, income, social advancement, and the treatment of a variety of illnesses (Farnsworth, 1994 and Jain, 1992) [27, 40]. A significant portion of India's tribal population finds shelter in forests, which are essential to their economic and sociocultural existence. Tribal groups rely on forests for their way of life, to meet their basic requirements, to be traded for money when the market allows it, and to serve as the source of raw materials for a variety of processed commodities (Angelsen *et al.*, 2014) [3]. Tribal people are peaceful, nature-loving individuals who uphold a strong bond between man and the environment (Sajem and Gosai, 2006) [48]. There are around 30 different tribal groups in the state of Bihar. Santal, Oraon, Kharwar, Gond, Munda, Lohara, Kisan, and Kora are the primary groups with the largest populations (between 10,000 and one lakh) (Bhatt & Bhargava, 2006a) [13]. Only 0.9 percent of the state's overall population is tribal, according to statistics.

Forests of Bihar

Given that a sizable section of the population relies directly or indirectly on forest resources for their basic requirements, forests are vital to the development of Bihar. Bihar is fortunate to have a wide variety of forests comprising of Northern dry mixed deciduous forest (29.97%), Dry Siwalik Sal forest (5.20%), *Boswellia* forest (4.33%), Bhabar-dun Sal forest (3.68%), Dry deciduous scrub forest (3.26%) and West Gangetic moist mixed deciduous forest (2.33%) are the major forest types of the state (ISFR, 2021). The total carbon stock of the forests in the state including the TOF (Tree Outside Forests) patches which are more than 1ha in size is 56.88 million tonnes (208.56 million tonnes of CO₂ equivalent) which is 0.79 percent of total forest carbon of the country (ISFR, 2021). Major forest types of Bihar are mentioned in Table 1.

The total forest cover of India is 80.9 mha which is 24.62 percent of the geographical area of the country. The overall area covered by trees and forests in the country has increased by 2,261 sq. km since the assessment of 2019. According to the report by FSI, 2021, the recorded forest cover of Bihar is 7.84 percent of its geographical area (GA) i.e. (94,163 sq. km). The area covered by VDF (Very Dense Forests) is 0.35 percent of its GA, MDF (Moderately Dense Forests) is 3.49 percent, and OF (Open Forests) is 4 percent (FSI, 2021).

District-wise forest cover in Bihar is given in Table 2. Although, the state has lost some of its precious forest cover since its formation, from 2005 the forest cover has slightly increased from 5.92 percent in the year 2005 to 7.84 percent in the year 2021. This may be because a large portion of the local rural population's and industry demand for fuel wood and timber is satisfied by trees that are not part of forests. Table 3 clearly shows that though the forest cover in the state has increased with the passing years, the percentage of tree cover has fallen rapidly from 3.92 percent in the year 2001 to 02.49 percent in the year 2021.

Table 1: Forest types found in Bihar (Source: ISFR, 2021)

Sl. No.	Forest Type	Area	Percentage (%) of the total mapped area*
1	2/E1 Cane brakes	2.61	0.03
2	3B/C1b Moist teak forest	4.16	0.06
3	3C/C2b (l) Bhabar-dun sal	278.11	3.68
4	3C/C3a West Gangetic moist mixed deciduous forest	176.39	2.33
5	4D/SS2 <i>Barringtonia</i> swamp forest	1.63	0.02
6	4D/2S2 Eastern wet alluvial grassland	11.36	0.15
7	5B/C1a Dry Siwalik sal forest	392.89	5.20
8	5B/C2 Northern dry mixed deciduous forest	2266.39	29.97
9	5/DS1 Dry deciduous scrub	246.39	3.26
10	5/E2 <i>Boswellia</i> forest	327.59	4.33
11	5/E9 Dry bamboo brakes	69.34	0.92
12	5/1S2 Khair-sissu forest	2.61	0.03
Sub Total		5360.05	70.89
13	TOF/Plantation	2195.82	29.04
Total (Forest cover and scrub)		7555.87	
Grassland forest type (outside forest cover)			
14	4D/2S2 Eastern wet alluvial grassland	5.28	0.07
Grand Total		7561.5	100.00

* Forest types have been assigned to the natural forest formations under forest cover and scrub categories shown in forest cover mapping (ISFR, 2019). Grassland forest-type outside forest cover has also been mapped. The total mapped area, therefore, is the sum of forest cover, scrub, and grassland forest types (found in non-forest).

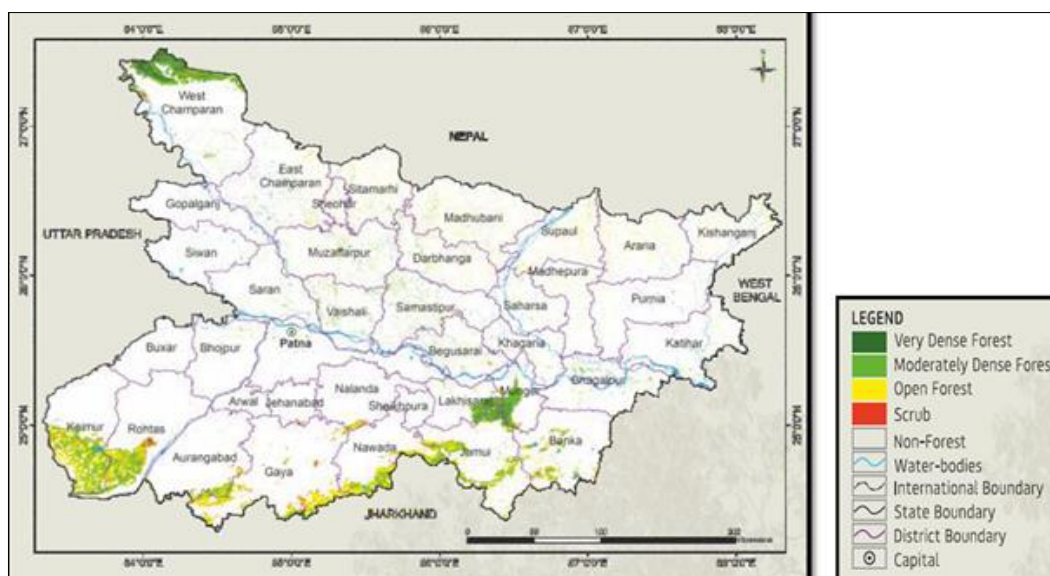


Fig 1: Forest cover map of Bihar (Source: ISFR, 2021)**Forest resources of Bihar**

Forests are crucial for maintaining human economic, cultural, and social well-being. A large portion of the Indian economy is contributed by the forest industry. 1.2 percent of India's total GDP is made up of industries related to the forest (Economic Survey, MoEF 2011) [22]. The physical, economic, and spiritual well-being of people depends heavily on forests (Byron and Arnold 1999) [15]. The primary means of subsistence for tribes in India is agriculture, which is crucial for the country's economy, rural development, employment, agro-industries, food and nutrition security, growth and survival, social, economic, and cultural circumstances, and poverty reduction (Surayya *et al.*, 2008) [51]. India's second-

largest land use after agriculture, accounting for 21.54 percent of the nation's total land area, is forestry (FSI, 2017) [28]. Rich Sal forests, various mixed forests, and sparsely populated grasslands make up the forest vegetation of Bihar. Sal dominates the floral composition, which includes a wide range of trees, shrubs, herbs, bamboo, grasses, lianas, climbers, creepers, runners, *etc.* Bihar is home to tropical moist deciduous and tropical dry deciduous forests, and the dominant trees are *S. robusta* Gaertner f., *Terminalia franchetii* var. *tomentosa* W. Nanakorn, *Madhuca longifolia* var. *latifolia* (Roxb.) A. Chev., *Pterocarpus marsupium* Roxb, *Adina cordifolia* (Roxb.)

Table 2: District-wise forest cover in Bihar (Source: ISFR, 2021)

District	Geographical Area	2021 Assessment				% of Geographical Area (GA)	Change w.r.t. 2019 assessment	Scrub
		Very Dense Forest (VDF)	Mod. Dense Forest (MDF)	Open Forest (OF)	Total			
Araria	2,830	0.00	8.10	142.78	150.88	5.33	-0.13	0.38
Arwal	638	0.00	1.63	2.51	4.14	0.65	0.14	0.39
Aurangabad	3,305	0.00	62.44	97.41	159.85	4.84	3.09	16.85
Banka	3,020	0.00	99.96	177.06	277.02	9.17	16.29	21.59
Begusarai	1,918	0.00	28.93	53.65	82.58	4.31	0.63	0.00
Bhagalpur	2,569	0.00	46.41	23.52	69.93	2.72	0.20	0.00
Bhojpur	2,395	0.00	19.44	12.55	31.99	1.34	-0.26	1.25
Buxar	1,703	0.00	2.94	2.95	5.89	0.35	0.00	0.00
Darbhangha	2,279	0.00	43.54	94.44	137.98	6.05	0.32	0.00
East Champaran	3,968	0.00	64.61	101.19	165.80	4.18	1.94	0.00
Gaya	4,976	0.00	132.03	470.52	602.55	12.11	12.24	66.50
Gopalganj	2,033	0.00	2.64	5.92	8.56	0.42	3.65	0.00
Jamui	3,098	28.97	352.76	279.44	661.17	21.34	13.22	3.21
Jehanabad	931	0.00	0.00	4.43	4.43	0.48	4.43	5.13
Kaimur	3,332	0.00	519.83	531.73	1,051.56	31.56	-4.83	25.65
Katihar	3,057	0.00	6.22	55.76	61.98	2.03	0.00	0.00
Khagaria	1,486	0.00	3.18	15.27	18.45	1.24	0.00	0.00
Kishanganj	1,884	0.00	16.32	87.23	103.55	5.50	-0.15	0.00
Lakhisarai	1,228	17.00	143.5	22.91	183.41	14.94	3.00	4.80
Madhepura	1,788	0.00	0.93	51.91	52.84	2.96	-0.04	0.40
Madhubani	3,501	0.00	40.39	164.98	205.37	5.87	1.30	0.00
Munger	1,419	37.97	223.61	24.43	286.01	20.16	2.41	9.43
Muzaffarpur	3,172	0.00	52.17	114.12	166.29	5.24	4.47	0.00
Nalanda	2,355	0.00	6.86	31.71	38.57	1.64	6.72	10.59
Nawada	2,494	0.00	214.68	302.20	516.88	20.72	3.38	18.13
Patna	3,202	0.00	19.55	8.48	28.03	0.88	4.49	0.54
Purnia	3,229	0.00	5.00	50.67	55.67	1.72	0.00	0.00
Rohtas	3,881	0.14	351.25	318.52	669.91	17.26	-2.32	40.92
Saharsa	1,687	0.00	4.17	30.22	34.39	2.04	-0.23	0.00
Samastipur	2,904	0.00	105.39	48.83	154.22	5.31	0.86	0.00
Saran	2,641	0.00	26.28	33.04	59.32	2.25	0.19	0.00
Sheikhpura	689	0.00	1.00	0.19	1.19	0.17	0.19	0.00
Sheohar	349	0.00	2.00	19.57	21.57	6.18	0.99	0.00
Sitamarhi	2,294	0.00	37.41	110.38	147.79	6.44	0.01	0.00
Siwan	2,219	0.00	2.11	5.55	7.66	0.35	0.50	0.00
Supaul	2,425	0.00	3.89	130.43	134.32	5.54	-4.46	0.00
Vaishali	2,036	0.00	86.19	29.51	115.70	5.68	3.88	0.00
West Champaran	5,228	249.34	548.47	105.53	903.34	17.28	-1.32	10.13
Grand Total	94,163	333.42	3,285.83	3,761.54	7,380.79	7.84	74.80	235.89

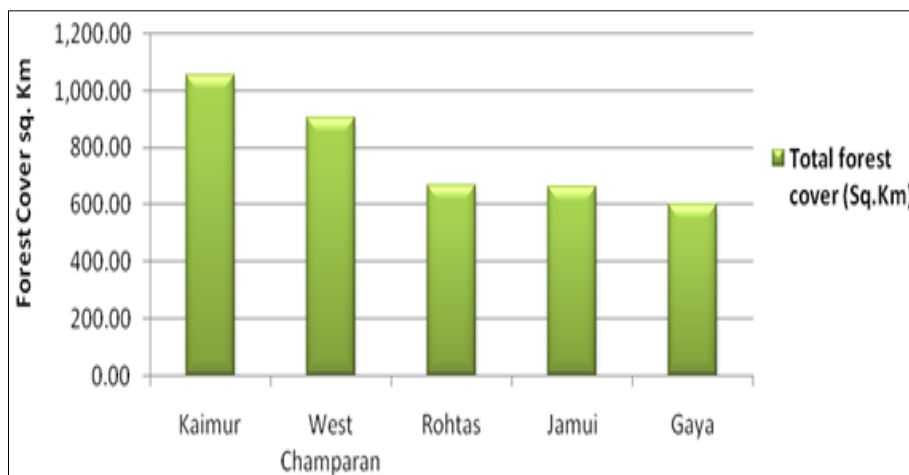


Fig 2: Top five districts of Bihar with maximum forest cover

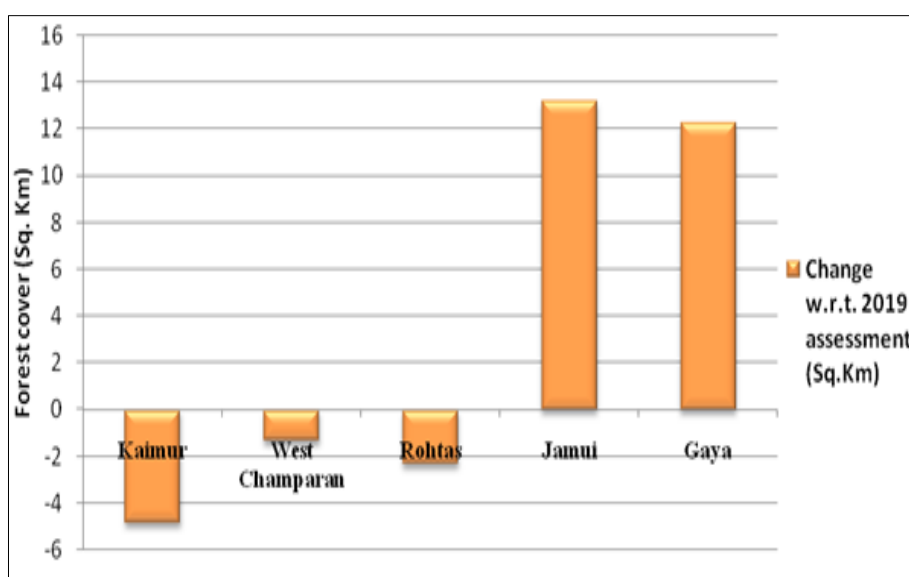


Fig 3: Forest cover change w.r.t. 2019 assessment of top five districts (max. forest cover) of Bihar

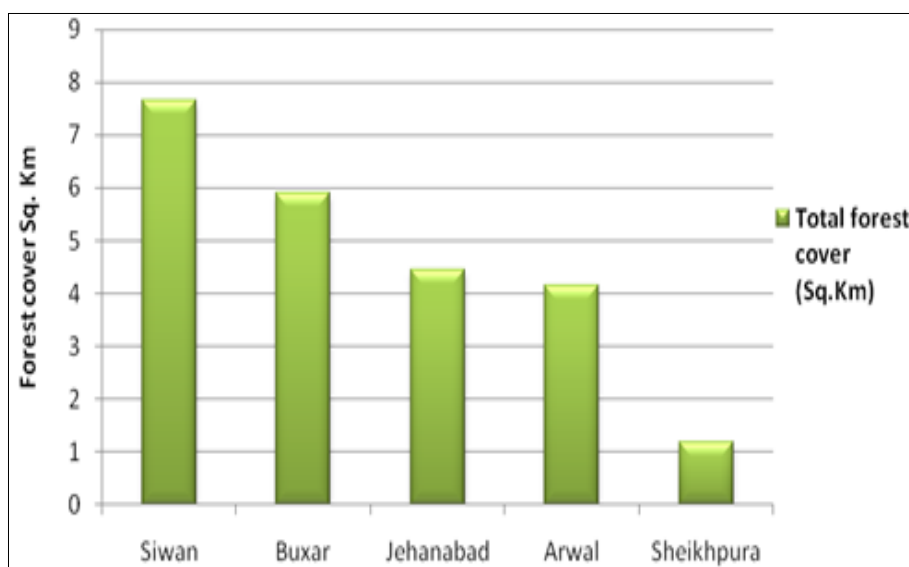


Fig 4: Top five districts of Bihar with minimum forest cover

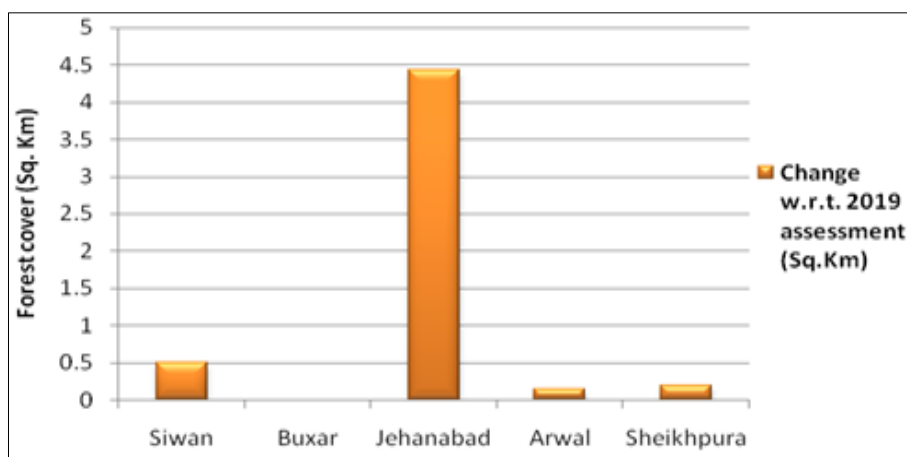


Fig 5: Forest cover change w.r.t. 2019 assessment of top five districts (min. forest cover) of Bihar

Table 3: Comparatively analysis of forest cover and tree cover of Bihar from 2001 to 2021

	Year	2001	2003	2005	2009	2011	2013	2015	2017	2019	2021
Forest cover	Very dense forest	11,787	9,396	2,595	2,590	2,590	2,551	2,601	332	333	333
	Moderate forest			9,892	9,873	9,917	9,586	9,692	3,260	3,280	3,286
	Open forest	10,850	8,518	10,235	10,205	10,470	10,450	11,231	3,707	3,693	3,762
	Scrub	976	749	676	662	683	670	685	228	250	236
	Non-Forest	56,101	55,123	56,316	56,096	56,054	55,444	55,507	86,636	86,607	86,497
	Total of state's geographic area (%)	94,163	94,163	94,163	94,163	94,163	94,163	94,163	94,163	94,163	94,163
		6.07%	5.90%	5.925	7.23%	7.27%	7.74%	7.74%	7.75%	7.76%	7.83%
Tree cover	Of State's geographic area (%)	3.92%	1.72%	2.68%	2.65%	2.52%	2.30%	2.32%	2.40%	2.13%	2.49%
Forest & Tree cover	Total forest and tree cover	9,413	7,178	8,101	9,299	9,214	9,455	9,470	9,562	9,309	9,722
	Of state's geographic area (%)	9.99%	7.62%	8.60%	9.88%	9.79%	10.04%	10.06%	10.15%	9.89%	10.32%

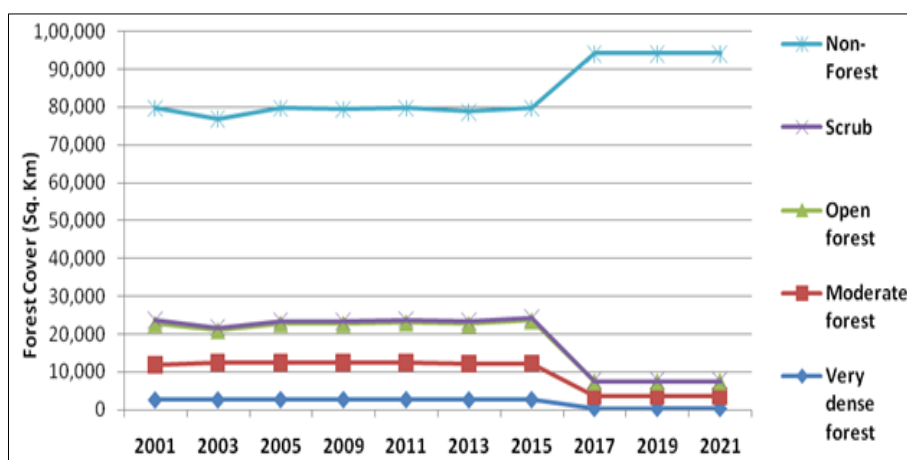


Fig 6: Trend in forest cover change of Bihar from 2001 to 2021

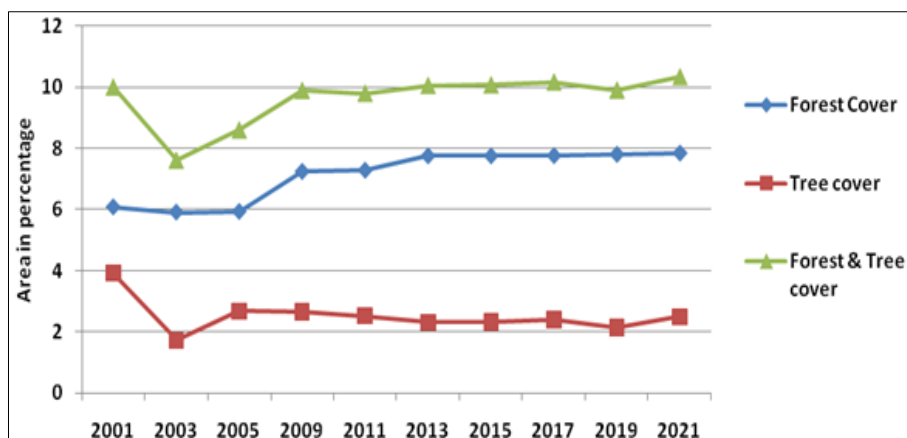


Fig 7: Percentage change in Forest & Tree cover from 2001 to 2021

Indigofera pulchella, *Carissa opaca*, *Wendlandia tinctoria*, *Woodfordia fruticosa*, *Croton oblongifolius*, *Zizyphus* sp. and *Phoenix* sp. Similarly, grasses consist of *Heteropogon contortus*, *Eulaliopsis binata*, and common climbers are *Bauhinia vahilli*, *Acacia pinata*, *Butea superba*, *Milletia auriculata*, *Smilax* spp. The wildlife in Bihar's forests is abundant and diverse, including animals, birds, reptiles, amphibians, and insects.

Rural families engage in a variety of activities to fulfill their fundamental requirements and raise their standard of living (Ellis, 1998) [24]. NTFPs are crucial to the livelihoods of several rural and urban populations worldwide (Areki and Cunningham, 2010 and Asfaw *et al.*, 2013) [6, 7]. Timber, fuelwood, fodder, and a variety of NTFPs such as fruits, nuts, edible fungi, vegetables, fish, animals, and medicinal plants, as well as resins, essences, and a variety of barks and fibres like bamboo, rattans, palms, and grasses, are the most often extracted forest products. For many of the world's economically underdeveloped people, NTFPs supply the products they need for food, shelter, medicines, fibres, energy, and cultural artifacts (Babulo *et al.*, 2009; Belcher *et al.*, 2005 and Chauhan *et al.*, 2008) [9, 12, 18]. The people who live in and near these forests rely on these products for their sustenance, which provides them with relief when they have no other options for a living or nourishment. The woodlands are used for economic operations, domestic subsistence, and the production of herbal remedies.

A resource's direct use value as goods for industry and consumption, its indirect use value as the protection or maintenance of economic activity, and its non-use value to people as the satisfaction of a resource's existence, even though they may never see it or consume any products derived from it are all examples of economic benefits (Pearce *et al.*, 1989) [45]. Timber and non-timber products are included in the direct use values of forestry resources, as well as non-commodity advantages like forest recreation. The importance of forests for indirect usage includes the preservation of watersheds and fisheries as well as the carbon sequestration in forest soil and vegetation. Non-use values in forestry include minor advantages like the survival of specific animal species that the public wants to preserve for future generations. The other direct employment includes labour force for rural masses produced by these departments under routine forestry activities for growth, development, and maintenance of the forests, research and training, surveying forest resources, protecting and conserving forest resources, conserving soil and water, harvesting, collecting, and processing NTFPs, preparing nurseries, fencing, soil working, transplanting, planting, tending operations, and watering. The sale of firewood and forage, grazing, lopping, and cutting of the grass, forest-based handicrafts and cottage industries, sericulture, lac husbandry, beekeeping, charcoal burning, plate making from leaves, liquor making, rope making and basketry, medicines, collection, processing, and marketing of NTFPs, etc. are all ways that forests provide self-employment services. Tribal people have secondary employment and livelihood opportunities due to the use of local knowledge and village-level technology in wood-based and small-scale forest-based enterprises. Notable examples include sawmilling, rayon, pulp and paper, plywood and panel products, wood seasoning and preservation, tanning, sports goods, match splints, veneers, wooden boxes, bamboo and cane products, agricultural implements, furniture, structural

wooden items, and a musical instrument (Pant, 1984 and Gera, 2002) [43, 31].

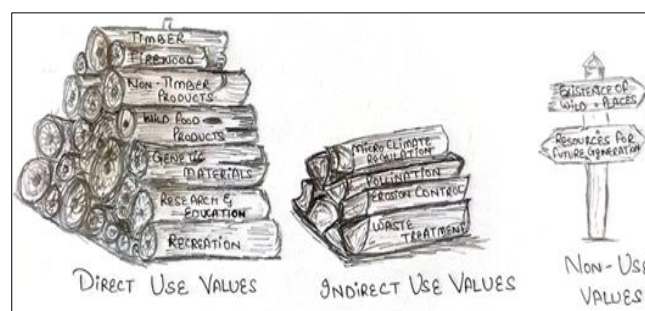


Fig 8: Different values given by forest ecosystem

Economic prospects of forest resources of Bihar

In unbroken Bihar, forests covered 29.48 lakh hectares or nearly 17 percent of the state's entire land area. Following its separation in 2000, just 6.87 percent of Bihar's total geographic area, or 6.16 lakh hectares, remained covered in forest. By way of this divide, Jharkhand received 79 percent of the total forest, while Bihar received only 21 percent. The only natural forest in North Bihar is in Western Champaran. South Bihar contains the majority of the world's remaining natural forests in places like Kaimur, Rohtas, Aurangabad, Gaya, Nawada, Jamui, Banka, Munger, and Bhagalpur. While some states like Maharashtra, Punjab, Haryana, and Gujarat are growing by 7-10 percent, others, particularly Bihar (Gupta, 2010) [34] have lagged (Dreze & Gazdar, 2006; Parker & Kozel, 2007 and Shand & Bhide, 2000) [21, 44, 49]. Although recently Bihar's economy has made a significant recovery, it has been classified as a low performer or BIMARU ('sick' in Hindi) state due to economies that are still primarily agrarian. (Ahluwalia, 2001) [1].

One facet of sustainable forest management is the contribution of the forestry industry to national economies, and data on this is required to track development in this area (FAO, 2011) [25]. The state's primary forest-based industries are those based on timber, lac, and medicinal plants. The state's primary timber species include *S. robusta*, *Gmelina arborea* Roxb. ex Sm., *M. longifolia*, *Dalbergia sissoo* Miq., *Schleichera oleosa*, etc. The abundance of forest resources in the state is more significant than the value of the plywood and paper sectors. Together, Bihar and Jharkhand used to play a significant role in the production of raw silk, contributing 50 percent of the country's total production. Tassar food plants cover a total of 2325 km² in the region, with *S. robusta* accounting for 90 percent of them and *Terminalia arjuna* (Roxb.) Wight & Arn, *T. alata* Heyne ex Roth, and *S. robusta* accounting for the remaining 10 percent. For their sustenance, the indigenous community mainly depends on NTFPs and other forest resources. More than 25 percent of the world's population relies on forests as a source of sustainable natural resources for their livelihood (Anonymous, 2001). Due to unchecked grazing, frequent fires, irresponsible usufruct harvesting, an expansion of agricultural fields, habitat damage, and fragmentation by mining, railways, human settlements, dams, and encroachment, among other factors, the state's forest biodiversity is seriously threatened. Major NTFPs and their product value of Bihar are shown in Figure 9 and 10.

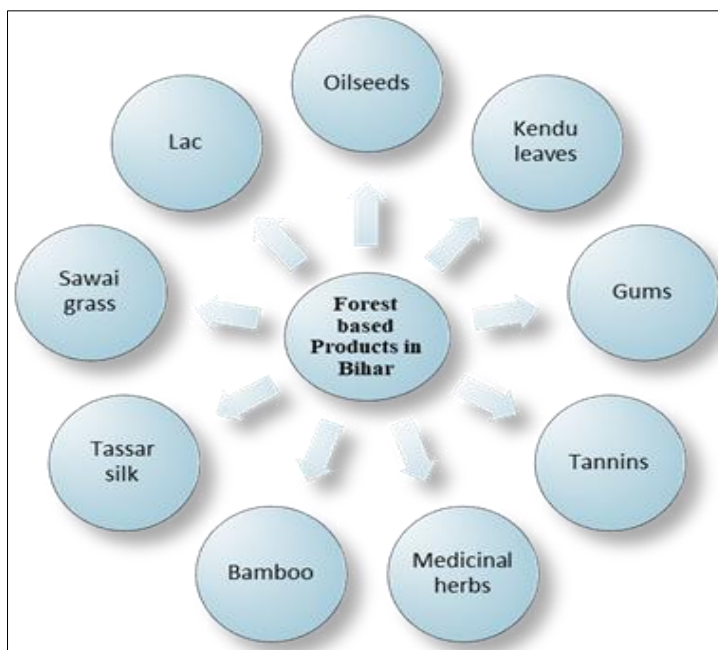
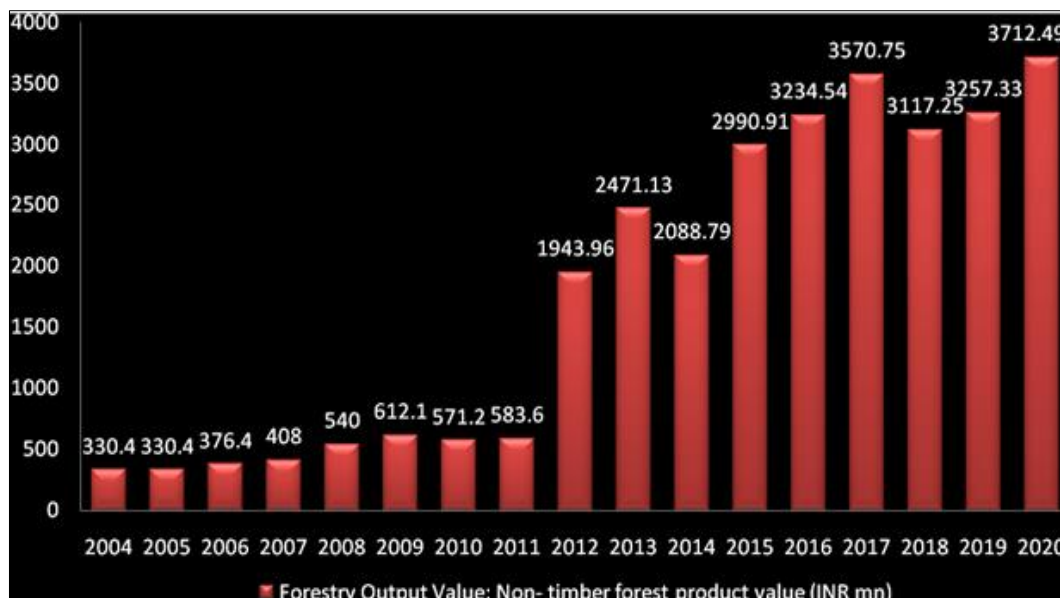


Fig 9: Forest-based products in Bihar



Source: www.ceicdata.com (Ministry of Statistics and programme Implementation)

Fig 10: Forestry Output value-Non Timber Forest Products (Bihar), India

Classification of forests in Bihar

- a) Tropical Moist Deciduous Forest (Himalayan Foothills and Terai Forest)
- b) Tropical Dry Deciduous Forest

Tropical Moist Deciduous Forest (Himalayan Foothills and Terai Forest)

This kind of forest is typically found near the Nepal-India border, particularly in the Himalayan Foothill region in the district's northwestern West Champaran, a 910 km belt, of which 846 km are protected, is significantly less wide.

Tropical Dry Deciduous Forest

The districts of Kaimur and Rohtas in Bihar's Vindhyan Extension contain sizable portions of this type of forest. More

than 140 cm of rain falls on average each year in this region. It results in a wet climate, which in turn encourages the growth of tropical moist trees that change colour in these woodlands. Trees like Sal (*Shorea robusta*), Sisam, Toon, Gambhar, Kadamb, Khair, Neem, and Semal may be found in this type of forest.

Along the border between West Bengal and Jharkhand, this type of forest is present. The average annual rainfall in these regions is less than 120 cm, which makes the climate dry and gives rise to tropical dry deciduous vegetation. This kind of forest is abundant with Amaltas, Sisam, Aawnoos, Mahua, Gambhar, Kadamb, Khair, Neem, Palas, Asan, Amla, Saal Bamboo, etc. In addition to this, Babool can also be found in drier areas. Mango, banana, and litchi plantations, which are well-known on the plains, help to keep the state green.

Table 4: Diameter class distribution of top five tree species inside recorded forest area (RFA) in Bihar (Source: ISFR, 2021)

Sl. No.	Species/ Common Name	Diameter class (cm)		
		10-30	30-60	>60
1	<i>Shorea robusta</i>	20,756	4,788	514
2	<i>Lannea coromandelica</i>	11,323	434	67
3	<i>Madhuca latifolia</i>	7,377	654	139
4	<i>Terminalia tomentosa</i>	7,058	708	137
5	<i>Anogeissus latifolia</i>	6,266	482	0

Table 5: Top five tree species in (TOF) Tree Outside Forests (Rural) in Bihar (Source: ISFR, 2021)

Sl. No.	Species/ Common Name	Relative Abundance (%)
1	<i>Mangifera indica</i> / Mango	34.16
2	<i>Dalbergia sissoo</i> / Shisham	11.52
3	<i>Borassus flabelliformis</i> / Tal palm, Ice apple	7.86
4	<i>Litchi chinensis</i> / Litchi	3.86
5	<i>Syzygium cumini</i> / Jamun	3.39

Table 6: Top five tree species in TOF (Urban) in Bihar (Source: ISFR, 2021)

Sl. No.	Species/ Common Name	Relative Abundance (%)
1	<i>Litchi chinensis</i> / Litchi	13.87
2	<i>Mangifera indica</i> / Mango	13.80
3	<i>Bombax ceiba</i> / Semul	8.82
4	<i>Dalbergia sissoo</i> / Shisham	5.73
5	<i>Psidium guajava</i> / Guava	4.53

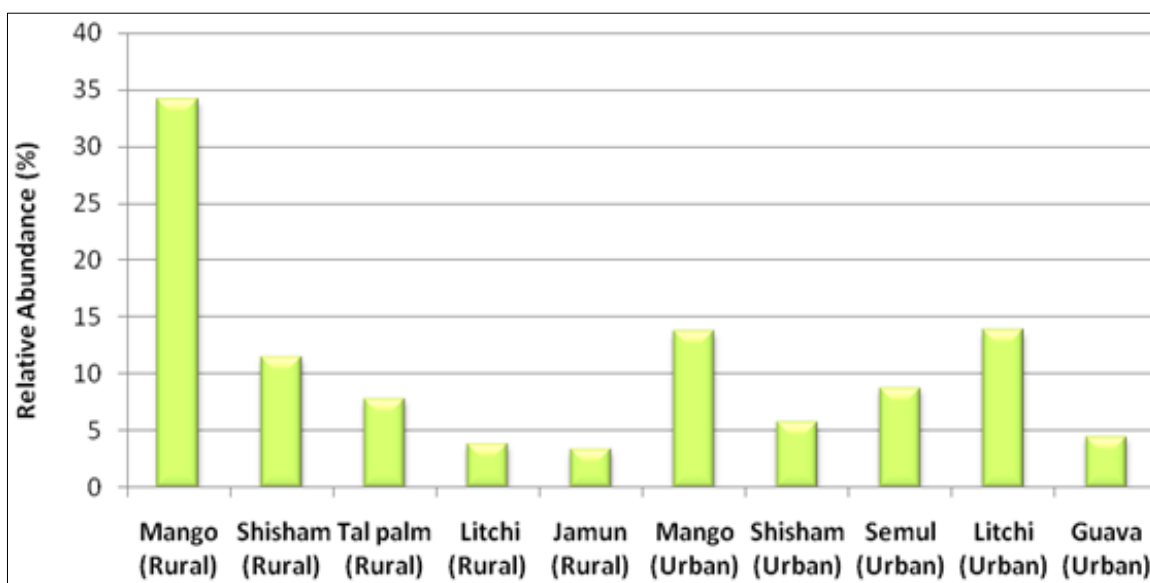


Fig 11: Dominant tree species in TOF (rural and urban areas) in Bihar

Government policies to boost forests in Bihar

Like National Forest Policy Bihar has its own **State Forest Policy**, which focuses on increasing its forest cover to 33 percent. The following are some of the laws and programs the state has in place to manage its forestry industry:

- **Tenancy Act:** (Bihar, Santhal Paragana, and Chotanagpur): These Acts have measures for the protection of trees as well as some provisions for regulating unauthorized tree removal and promoting TOF (trees outside forests).
- **Joint Forest Management (JFM):** policies are designed to elicit community involvement in forest conservation and ensure that people are involved in the preservation, development, and protection of forests. JFM, an adaptable social process, aims to produce enough future forest products to support lakhs of people.
- **Development and Value Addition of Lac and other Gums and Resin:** Improving rural income by facilitating extensive cultivation of lac and value addition through processing by villagers through SHGs in lac-growing areas of the state (to be marketed through state marketing federation) will be the focus of this scheme (IINRS, 2015).

The Policy brought two ways to increase the forest cover:- Forest Development

The Policy focuses on increasing the forest cover to 31030.11 sq. km from the current 7381 sq. km, which is almost 4.2 times present. To achieve this, the policy focuses on multiple approaches:

- Development of forest on unused lands.
- Development of forest on deserted and non-agricultural lands, which is about 1000 sq. km in the state.
- Development of forest on 11 percent of fallow land which is for fulfilling the 33 percent goal.
- Encouraging dense forestation on the premises of government and private institutions.
- Afforestation along roads, and public places.
- Encouraging social forestry on both private and public land will further help in achieving the 33 percent goal.

Rehabilitation and Conservation of Ruined Forests

Forest lands are decreasing because of agricultural land extension which is also affecting Bio-diversity negatively. The Forest Policy focuses on the following ways:-

A) Redevelopment of Ruined Forests

These forest lands where tree density has fallen to below 40 percent, are being redeveloped with the help of NGOs, international organizations, and with the people's support.

B) National Parks and Wildlife Sanctuaries

Rehabilitation of National Parks and Wildlife Sanctuaries is important. National Forest Policy 1972 gives more importance to these parks and sanctuaries. For the implementation of the State Forest Policy, the state government established Forest Department and for manufacturing forest products, the required wood and other forest produce are collected and traded by Bihar State Forest Development Corporation, This is a government company. To boost forest cover on private farmlands in Bihar, the Government of Bihar brought many schemes as follows:- Hariyali Mission was launched in 2012, it aims at increasing the forest cover to 17 percent by the end of 2022.

Mukhyamantri Niji Paudhshala Yojna was launched for Poplar and other trees. Under this scheme, GoB provides saplings of trees at a nominal cost to farmers to plant them on their farmlands.

Carbon stock in forest

The quantity of carbon that has been removed from the atmosphere and is now stored in the forest ecosystem, mostly in the form of live biomass and soil, but also to a lesser extent in the form of dead wood and litter, is known as the forest carbon stock. The state's overall carbon stock, which includes TOF patches larger than 1 ha, is 56.88 million tonnes (208.56 million tonnes of CO₂ equivalent), or 0.79 percent of the nation's total forest carbon. The following table shows Bihar's forest carbon by the pool:

Table 7: Forest carbon of Bihar in different pools (Source: ISFR, 2021)

Sl. No.	Carbon Pools	Forest Carbon (in '000 tonnes)	CO ₂ equivalent	Carbon credits price (EU)	Carbon credits price (INR) in Billion
1	AGB	14,743	54106810	4815506090	434.888355
2	BGB	5,249	19263830	1714480870	154.834767
3	Dead wood	231	847770	75451530	6.814028
4	Litter	785	2880950	256404550	23.155895
5	SOC	35,873	131653910	11717197990	1058.180150
	Total	56,881	208753270	18579041030	1677.873195

*Carbon credit price as on 03-05-2023 on <https://carboncredits.com/carbon-prices-today/>
One carbon credit= 89 EU in international market.

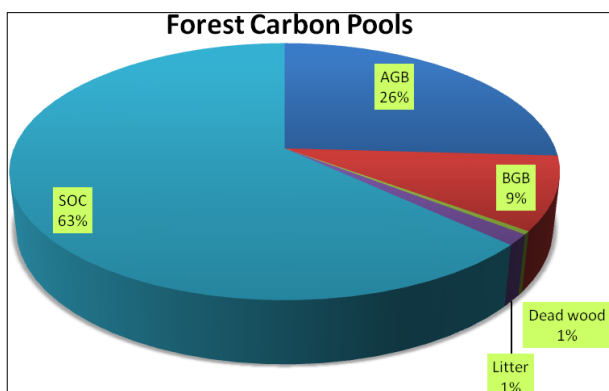


Fig 12: Different Forest carbon pools of Bihar

Growing stock of bamboo

The growing stock is estimated through forest inventory under which both qualitative and quantitative parameters are recorded to know overall health of growing forests. The following table lists the bamboo bearing area and growing stock inside the Registered Forest Area (RFA)/Green Wash, which includes culms of 1 year and older:

Table 8: Growing stock of Bamboo in Bihar (Source: ISFR, 2021)

Growing Stock (GS)		% of Country's GS of bamboo
Bamboo bearing area inside RFA/ Green-wash (in sq. km)	1,103	0.74
Total number of culms (in millions)	235	0.44
Total equivalent green weight (in '000 tonnes)	1,672	0.42

Major invasive species

Plants that do not occur naturally in a region but proliferate in the area they have been introduced into, and cause several negative impacts (such as affecting native biodiversity, causing economic losses and harming human health) in these new habitats, are called invasive plants. Major invasive species as assessed from forest inventory data are presented in the following table:

Table 9: Major invasive species in the state inside the RFA/ Green Wash in Bihar (Source: ISFR, 2021)

Sl. No.	Species/ Common Name	Estimated Extent (in km ²)
1	<i>Lantana camara</i> / Yellow sage, Wild sage	261
2	<i>Chromolaena odorata</i> /Devil weed, Siam weed	47
3	<i>Argemone Mexicana</i> / Mexican prickly poppy	17
4	<i>Cassia tora</i> / Tiger's claw, Indian coral tree	15
5	<i>Senna occidentalis</i> / Ant bush, Stinking weed	14

Timber industry

Timber is a naturally occurring, renewable building material that combines beauty, high performance, and environmental benefits. It is also appealing, strong, durable, and reasonably priced (Binkley and Earhart 2005 and Pirard *et al.*, 2016) ^[14, 46]. Numerous structural applications, including beams, walls, flooring, cladding, containers, packing cases, formwork, large timber panels, agricultural implements, fencing, hutments, housing, furniture, scaffolding, mine props, *etc.*, are made possible by its flexibility and adaptability (Chandramolly, 2015 and Gangoo *et al.*, 2015) ^[17, 30]. Timber materials have a distinctive aesthetic appeal, offer acoustic, thermal, and strength characteristics, store carbon dioxide, and require less energy to manufacture than other materials (Shukla, 2003) ^[50]. Government-run forests and non-forest sources, like farms and household gardens, provide the necessary resources to meet the demand for timber (Chandra *et al.*, 2008; Islam, 2008) ^[16, 38]. The paradox is that while the demand for wood is roughly 70 percent for fuelwood and 30 percent for timber, forests generate 70 percent of timber and 30 percent for fuelwood (Rai and Chakrabarti, 2001) ^[47].

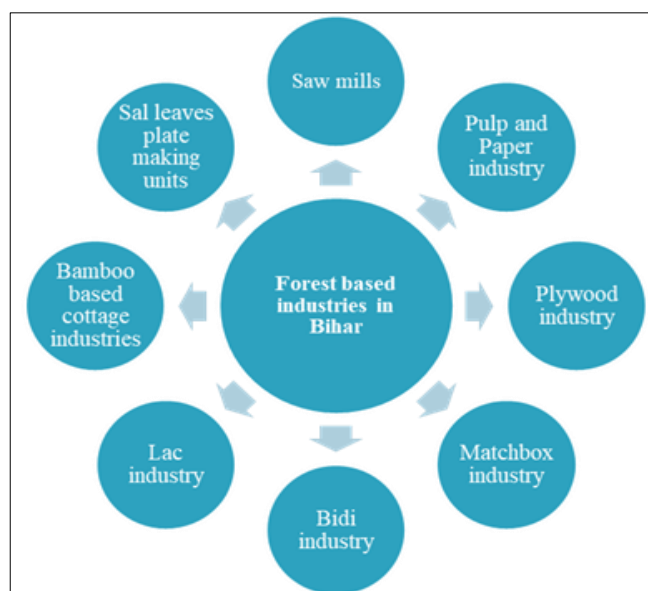


Fig 13: Forest-based industries in Bihar

Most people in both the rural and urban sectors rely heavily on forests to supply all of their timber needs. People who live in forest fringes depend on forests for the timber needed to build houses, fences, agricultural tools, and other structures, numbering between 275 million (World Bank 2006) ^[52] and 350–400 million (MoEF, 2009) ^[42]. A region's social, cultural, religious, ethical, traditional, spiritual, farming, and geo-environmental characteristics are significantly influenced by the extraction and consumption of timber in rural areas (Dangwal, 2005) ^[20]. Growing timber commerce has aided economic development and reduced poverty in several emerging nations (Anonymous 2016). There is compelling evidence that lumber, including in India, significantly contributes to the livelihoods of the world's rural poor. The primary means of income for the population living in forests is the collection and sale of timber (Yadav and Basera, 2013; Belcher *et al.*, 2015; Langat *et al.*, 2016 and Htun *et al.*, 2017) ^[53, 11, 41, 35]. These individuals frequently turn to the illegitimate overexploitation of forest resources due to widespread poverty and a lack of viable employment options. Due to the enormous tribal population and widespread pattern of dependence, overexploitation, and unsustainable harvesting have led to serious forest degradation, a loss of biodiversity, and a decrease in biomass output (Baba *et al.*, 2016) ^[8]. The finest environmentally beneficial method for producing timber and bamboo, in addition to protecting forests and diversifying livelihoods, is wasteland reclamation through the establishment of plantations of the trees such as *G. arborea* and *Tectona grandis* and the bamboo *Dendrocalamus strictus*. Due to a greater emphasis on forest protection, the amount of timber produced by the forest has decreased. The wood-based industries must increase supply to satisfy their rising demand by importing wood, promoting plantings of high-yielding genetically enhanced tree species outside of forests on farmer's property, and growing their captive plantations. Even though lumber remains the most lucrative commodity of the forests, since the 1988 National Forest Policy, the emphasis on production has changed from timber to non-timber forest products. The amount of timber needed for manufacturing furniture, farm equipment, handicrafts, pulp, paper, and other products is not accurately estimated.

While it is possible to calculate the needs of the industry from the existing capacity, it is more difficult to do so about other significant users of timber. To correct the market pricing and make it feasible to grow trees on farmlands, the country's import-export policy (EXIM) needs to be reviewed. This is because the large-scale import of timber influences the local pricing pattern of timber (GoI, 2006) ^[32]. In its report on agriculture and allied sector data, the Ministry of Statistics, GoI also refers to the deficit in the collection of forestry statistics (GoI, 2013) ^[33]. Population growth, rising demand for wood goods as a result of the domestic economy's recovery and the quickening growth of middle- and upper-class populations, and increased demand for wood all contributed to the sustained rise in demand for wood (International Tropical Timber Organization 2003) ^[39]. Typically, the Forest Department's auctions show an annual rise in the minimum price (India stat, 2015). More space is needed to engage in direct wood selling to improve community livelihoods through timber market systems. A significant barrier to the private commercial cultivation of trees is the time-consuming permitting process for removing privately cultivated high-value trees like teak. To make it more beneficial, alternative policy interventions through streamlining transit laws for forest products are also suggested. Growing stock in the denuded forest can be grown by establishing plantations of woody species like *D. sissoo*, *G. arborea*, *T. grandis*, *S. robusta*, etc. to fulfill the future need for timber for homes, businesses, and other profitable sectors. In addition, increased efforts should be undertaken to establish fruit trees and other types of energy wood.

Conclusion

Due to the drastic reduction in available land per person, an increase in the population of people and livestock results in an increase in demand for forest products and forest land. Through the effective use of resources, indigenous knowledge, and skills, the socio-economic conditions of indigenous communities in Bihar can be improved. It is important to encourage employment in NTFP-based value-added industries and their organized marketing system since NTFPs are crucial to the rural economy. To propose a technique of conservation and the preservation of not just the medicinal plant but also the forest and its products as a whole, further wide and thorough research is required. Researchers' collection of plant material, particularly from rare and endangered plant species found in their natural environments, for a variety of experimental objectives also endangers the species' wild population.

Future perspectives

For the conservation and sustainable utilization of natural resources, its scientific management and progressive development of people is the demand of the hour but it cannot be achieved without the active participation of government, non-governmental organizations, people and the traditional dwellers residing inside the forest. Together hand in hand approach can be used for the upgrading of the life standard of the people i.e. Government can bring new policies, schemes, programs to help people and forest extension activities as maximum of the land area under non forest which can be a great boost for conservation and the livelihood generation for village communities. Government universities can impart the education and extension activities towards the Forestry sector

to produce more Forestry professional and highly intellect young minds in this field to achieve the new research and entrepreneurship opportunity. NGO's can actively participate in the forest extension programs with the Forest department, youth awareness programs at school, college and university level to make them aware about the importance of forest and involve young minds in conservation. Local people are also very much important for forest conservation and utilization, the relationship they have with forest in terms of ethics, religion, customs, culture and aesthetic point of view, it creates an immense relationship with forests which opens a door for agroforestry, social forestry, extension forestry, farm forestry, energy plantation, paper and pulp wood tree plantation, multipurpose tree plantations. Social forestry is for the people, by the people to fulfill the needs and extend the forests cover of the state for the prosperous future and marvelous journey of forestry in Bihar.

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