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Determining the Likelihood of Locals' Dependence on Forest Resources Influenced by Personal and Household Characteristics

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Abstract

Forest resources are critical for the livelihood and survival of tribal and other disadvantaged communities that live in and around protected areas. Dependence on forest resources is a function of cultural, social, and economic inequalities, which might influence household forest resource preferences. We investigate whether personal and household characteristics influence the likelihood of managing locals' dependency on forest resources. The research is conducted in 28 villages of the Chandrapur district of Maharashtra, India. A total of 1498 respondents are chosen using a systematic random sampling method and data is collected using a semi-structured interview schedule. SPSS V21 is used to clean and analyze the data. As forest resource dependence is discrete data, an ordinal logit model was applied. Hence, we determine the magnitude of the variation in the dependent variable. Although sex, poverty status, social category and fuel source for cooking appear to explain no significant change in dependence on forest resources such as Fuelwood, Timber, Tendu, and Mahua; respondents' age, education, type of household, primary occupation, source of lightning, income from agriculture and forest products determine statistically significant variations on forest dependence. We conclude that household dependence on forest resources is context-specific and depends on a variety of factors such as cultural alignment, complementarity of activities, habitat dependency and economic strata, economic value of resource and gender roles, and institutional arrangement between the locals and formal actors.

Key words: Dependence on forest resources, livelihood, timber and non-timber forest resources, logit model

Introduction

In developing countries, households in and around protected areas are dependent on various timber and non-timber forest resources[1] (Rahman et al., 2021; Mushi et al., 2020; Salafsky, 2000) to earn a part of their livelihood (Kumar & Saikia, 2020; Ntuli & Muchapondwa, 2015; Mulenga, 2014). Nearly 300 million people directly dependent on domesticated species for their nutritional needs, some 200 million depend on wild species for at least part of their food (IPBES, 2019; IUCN, 2007; Wiersum & Shackleton 2003; Byron & Arnold, 1999). Agriculture and allied activities are the main source of livelihood of local people (Kumar & Saikia 2020; Coe, 2013; Belcher et al., 2005; Kabra 2003). The dependence of rural households on forest resources and their linkages has become an important topical issue in developing economies (Hussain et al., 2019; Mcelwee, 2008; Pattanayak, 2003; Salafsky & Wollenberg, 2000). These resources are characterized by multiple use values such as consumptive, recreational, environmental and spiritual with different interests of different rural households (Sapkota & Oden, 2008; Baland & Platteau, 1999). A study reported that the number of wild species used by households ranged from 2 to 21, with an average of 7 species (Cocks & Wiersum, 2000). However, in the studied region, on average, the rural household benefits from 11 wild species (field data). Wild species are not only used for self-consumption, but also for cultural purposes, such as ceremonies and the construction of cultural artifacts (Zamora-Maldonado & Avila-Foucat, 2020).

Poverty, remoteness, lack of livelihood opportunities, and easy access are one of the key drivers of high forest resource dependence and degradation (Adams, 2020; Mukete, 2018), but their degree depends on institutional mechanisms that promote or inhibit the collection and degradation of resource. Several scholars point out that poorer households (such as 'Below Poverty Line' and 'Antodaya' category) benefit more from forest resources than wealthier households (such as 'Above Poverty Line' category) (Shackleton et al., 2007; Mahapatra & Tewari, 2005; Hedge & Enters, 2004) because they have less man-made assets (Shackleton & Shackleton, 2006) and are involved more in consuming and selling NTPFs (Mc Gregor, 1995; Arnold et al., 2006) thus generating cash income from NTFPs through diverse livelihood strategies (Vaughan, 2013; McElwee, 2008; Mulenga, 2014). However, few scholars suggest that poor people are getting involved in conservation practices for subsistence incentives (Karki, 2013; Heady, 2000) while wealthier landlords are more dependent on forest resources. We therefore argue that the dependency of households on forest resources is unique to the context and depends on the various factor that need to be investigated.

Several scholars have clarified that higher dependence on forest resources contributes to higher household income (Soltani et al., 2014) while others have established complex relationships (Narain et al., 2008). The overall household income in this paper is comprised of income from agricultural activities and income from forest resources. Many scholars have noted that the dependence on resources and income produced by large cultivators is high compared to small cultivators or landless households (Singh et al., 1996). Traditionally, most of the forest resources have been used for subsistence (Rahman et.al., 2021). However, growing non-subsistence livelihood strategies and urban networks have resulted in the commercial selling of forest products (Hussain et al., 2019; Arnold et al., 2006; Shackleton & Shackleton, 2004).

Variations in livelihood strategies are dependent on various factors culture, caste, gender (Mushi et al., 2020), languages, ethnicity, political ideology, preferences, appropriation skills and settlements. Variation in preference for resources and the degree of involvement of social groups in access to resource may be a function of cultural, social and economic inequalities (Shen et al., 2022; Sapkota & Oden 2008). Social categories or religions play an important role in drawing benefits from the forest resources. Several scholars have pointed out that disadvantaged and oppressed groups (such as Scheduled Caste; Scheduled Tribe and lower layers of Other Backward Classes) are victims of unequitable distribution of wealth due to network barriers compared to prosperous households or forward social categories (Coe, 2013; Mansuri & Rao, 2004; Barbier, 1997; Williams, 1996).

Household dependency on fuelwood is characterised by family size (Hussain, 2019), landholdings (Edmunds, 2002); livestock (Fikir et al., 2016; Sills et al., 2003); regular income from forest resources (Rahman, 2021); total household income (Shen, 2022; Rahman, 2021); livelihood opportunities other

1 Non-timber forest products (NTFPs), also known as Minor Forest Produce, special, non-wood, minor, alternative and secondary forest products, are useful substances, materials and/or commodities obtained from forests which do not require harvesting (logging) trees.

than agriculture; bonding with community members; and conflict with formal institutions (field data). The gathering of non-timber forest products (NTFP) is undertaken for subsistence purposes as well as to generate cash income but appears a risky endeavor. At times, such attempts entail threats, such as arrests by forest authorities, wild animal attacks, instances of insinuation, community conflicts and disagreements. Livelihoods in the studied region continues to be largely dependent on forest resources that tend to be at the core of cash economy. Though, from an ecological point of view, an intensive harvesting of leaves, bark and fruit may be detrimental to the sustainability of the ecosystem, it does not appear that forests do not suffer long-term harm from subsistence usage, given that the population density is low (Cocks & Wiersum, 2012). However, in the studied region, the population density is much higher, making it difficult for households to increase standards of material life by making use of available resources. This study therefore seeks to understand the likelihood of managing forest resource dependence shaped by personal and household characteristics.

Methods

Study Site

The study was undertaken in villages in the vicinity of the Tadoba-Andhari Tiger Reserve (TATR). TATR is one of the largest Tiger Reserve National Parks situated in the Chandrapur district of Maharashtra State, India. The area lies between 20º 04' to 28º 25' N and 79º 13' to 79º 33' E (Champion & Seth, 2005), consisting of Tadoba National Park (116.55 sq.km.), Andhari Wildlife Sanctuary (505.85 sq.km.) and is surrounded by a buffer region of 1,153.94 sq.km. The International Union for Conservation of Nature Red List reports that TATR is home to rare and endangered fauna (Bhargav et al., 2011). Most of the TATR is classified as reserved forest, while some area comes under protected forest, and a very small area as unclassified, other government land and private land. TATR itself has been designated as an important bird area with a total of 280 species and five globally threatened species. Chandrapur is one of the few districts in India that meets the National Forest Policy target of 33 per cent forest cover (ibid). The vegetation of the Tadoba forest is the southern tropical dry deciduous teak forests, with a mixture of other timber species (Ain[2], Bija[3], Shisham[4]). Bamboo[5], *Tendu*[6], *Mahua*[7], charoli[8], Amla[9] and other fruiting species are also common in the studied region.

Household Survey

The primary objective is to determine whether the likelihood of managing locals' dependence on forest resources is shaped by their personal and household characteristics or not. A household survey was conducted using a two-stage sampling method, first involving the selection of villages based on characteristics such as distance between the village and the Tadoba-Andhari Tiger Reserve boundary, intensity of human-wildlife conflict, ownership of domesticated animals, and other demographics. In this first screening phase, 30 villages were selected out of a total of 59 villages in close proximity to TATR. However, due to impermeable behaviour of gram panchayat[10] members, two villages declined to participate in the study. This resulted in the participation of a total of 28 villages in the study. In the second step of household selection, first stratification was done based on the list of households made available by the gram panchayat offices and then, a systematic random sampling method was used. A

2 Terminalia elliptica willd is the botanical name of 'Ain'.

3 *Pterocarpus marsupium* is the botanical name of '*Bija'.*

4 *Dalbergia Sisso* is the botanical name of '*Shisham'.*

5 *Bambusoidea* is the botanical name of '*Bamboo'.*

6 *Diospyros melanoxylon* is the botanical name of '*Tendu'.*

7 *Madhuca Longifolia* is the botanical name of '*Mahua'.*

8 *Buchanania lanzan* is the botanical name of '*Charoli'.*

9 *Phyllanthus emblica* is the botanical name of '*Amla'.*

10 Gram Panchayat is the primary unit of the three-tier structure of local self-governance in the rural India (MGNREGA Sameeksha 2012).

total of 1498 households were included in this study on the basis of this two-stage sampling.

With a detailed household list obtained from the respective gram panchayat offices, the research team found it important to locate households according to their community affiliations. The aptness of this method lies in the belief that households from all communities would have an equal chance of representing in the research. A semi-structured interview schedule was used to collect data on household characteristics, forest resources dependence and the conflict of villagers with wildlife and officials. Catering to the comfort level of the respondents, the research tool for data collection has been developed in both Hindi and English language. This seems to have elicited a good response to our data collection, with a total of 1498 observations. Data is cleaned and analyzed using SPSS V15. A descriptive and predictive analysis is performed on the collected data. The ordinal logit model[11] is used to estimate whether the dependence on forest resources is influenced by the household and personal characteristics.

Results

In Table 1, we present the coefficients, the respective standard errors, and the associated p-values (chances of type 1 error). We posit that dependence on forest resources appears to be determined by the following variables: Age of the Respondent (Reference Category: Below 25 years); Sex (Reference Category: Male); Education (Reference Category: Illiterate); Poverty Status (Reference Category: Below Poverty Line); House Type (Reference Category: Thatched[12]); Social Category (Reference Category: Scheduled Caste [13]); Primary Occupation (Reference Category: Farming); Source for Lightning (Reference Category: Electricity); Fuel source for Cooking (Reference Category: Wood); and Income from Agricultural Activities (Reference Category: Upto $35). As mentioned above, dependence on four major resources - Fuelwood[14], Timber[15], *Tendu*[16], and *Mahua*[17] is calculated. With respect to each resource, we calculate the dependent variable by using a five-point scale. While 1 is the least dependency, 5 is extremely dependent.

As the dependent variable is discrete in nature, an ordinal logit model was applied to estimate whether dependency on forest resources is influenced by household and personal characteristics. We classify categories into two: one reference category and the other. This means that when analyzing the results, we calculate the magnitude of the variation in dependent variable due to the transition from reference category to other categories. Furthermore, although the reference category is used for comparison, there are no coefficients estimated with respect to reference categories. In Table 1 (appendix), we present the odds ratios obtained from the coefficients. The odds ratio above one means the odds are in favour of more dependence, while the odds ratio below one suggests the opposite.

Since dependence on forest resources is both cultural and poverty-related, it helps them meet their subsistence needs, but regular dependence on various forms of forest dependence could push them into continued poverty (Talpa et al., 2022; Arnold, 2001). As shown in Table 1, with respect to fuelwood dependence, select categories in five variables - lighting source, age, caste, education, and income from agricultural activities – report statistically significant odds ratios that are greater than one, while select categories in four variables – poverty status, house type, source of cooking fuel, and income from forest products – show statistically significant odds ratio below one.

11 Ordinal logit model is used to predict an ordinal dependent variable given one or more independent variables (McCullagh 1980).

12 Thatched is a type of house; its roof is made up of material such as straw, rushes, leaves etc.

13 The Scheduled Castes (SCs) are various officially designated groups of historically disadvantaged people in India. *See lawmin.nic.in, accessed on 8th August 2017*

14 Fuelwood or woodfuel is a fuel, such as firewood, charcoal, chips, sheets, pellets, and sawdust (TERI 1999).

15 Timber tree is any tree that is valued as a source of lumber (Sarin and Baginski 2010:9).

16 The botanical name of '*Tendu'* Tree is Diospyros Melanoxylon.

17 The botanical name of '*Mahua'* is Madhuca Longifolia.

Table 1. *Personal and Household Characteristics Shaping Dependence on Forest Resources*

Independent Variables	Odds Ratio	Std. Error	P>|z|	Odds Ratio	Std. Error	P>|z|	Odds Ratio	Std. Error	P>|z|	Odds Ratio	Std. Error	P>|z|
	Fuelwood Dependence			**Timber Dependence**			***Tendu* Dependence**			***Mahua* Dependence**		
Poverty Status (Reference Category: Below Poverty Line)												
Above Poverty Line	0.773	0.106	0.06	1.081	0.222	0.70	0.696	0.096	0.00	0.809	0.161	0.29
Antyodaya	0.740	0.109	0.04	1.437	0.289	0.07	0.769	0.116	0.08	1.091	0.218	0.66
House Type (Reference Category: Thatch)												
Semi-Concrete	0.718	0.098	0.01	1.167	0.227	0.42	0.765	0.107	0.05	1.116	0.212	0.56
Concrete	0.929	0.216	0.75	1.208	0.398	0.56	0.499	0.132	0.00	0.763	0.299	0.49
Lighting Source (Reference Category: Electricity)												
Kerosene	2.301	0.312	0.00	1.131	0.209	0.50	0.964	0.131	0.79	0.965	0.178	0.84
Fuelwood	3.635	1.076	0.00	1.031	0.365	0.93	2.202	0.506	0.00	2.501	0.701	0.00
Others	6.289	2.394	0.00	0.392	0.236	0.12	0.594	0.173	0.07	0.176	0.139	0.02
Cooking Fuel Source (Reference Category: Wood)												
Kerosene	1.878	0.783	0.13	0.664	0.329	0.41	0.871	0.32	0.70	0.437	0.249	0.14
Crop Residue	1.021	0.517	0.96	2.024	1.155	0.21	0.313	0.159	0.02	1.128	0.667	0.83
LPG	0.670	0.107	0.01	1.74	0.372	0.01	0.645	0.116	0.01	0.965	0.219	0.87
Others	1.066	0.353	0.84	0.847	0.472	0.76	1.144	0.328	0.63	0.381	0.252	0.14
Sex (Reference Category: Male)	0.779	0.194	0.31	0.400	3459	0.07	0.5	5006	0.02	0.8	1647	0.58
Age (Reference Category: Below 25 years)												
Between 26 - 45 years	3.610	1.802	0.01	2.474	2.714	0.40	1.46	0.959	0.56	0.787	0.557	0.73
More than 45 years	4.160	2.1	0.00	2.522	2.774	0.40	1.13	0.745	0.85	0.408	0.293	0.21
Caste (Reference Category: Scheduled Caste)												
Scheduled Tribe	1.162	0.187	0.34	1.614	0.368	0.03	1.243	0.212	0.20	1.85	0.436	0.00
Other Backward Caste	1.342	0.234	0.09	0.619	0.175	0.09	0.91	0.17	0.61	1.28	0.345	0.35
Others	1.272	0.296	0.30	1.339	0.442	0.37	1.066	0.259	0.79	1.1	0.394	0.79
Education (Reference Category: Illiterate)												
Literate but not matriculated	1.545	0.203	0.00	1.069	0.203	0.72	0.693	0.09	0.00	0.75	0.138	0.11
Matriculation and above	1.179	0.226	0.39	1.343	0.377	0.29	0.553	0.109	0.00	0.839	0.224	0.51
Primary Occupation (Reference Category: Agriculture)												
Wage Labourers	0.352	0.341	0.28	7.786	7.129	0.02	0.918	0.529	0.88	0.574	0.413	0.44
Others	0.396	0.423	0.38	0.000	0.000	0.98	0.475	0.429	0.41	1.796	1.643	0.52
Income from agricultural activities (Reference Category: Up to Rs. 2500)												
Between $35 - $70	2.584	2.512	0.32	0.198	0.185	0.08	0.703	0.412	0.54	1.81	1.326	0.41
Between $70 – $140	1.824	2.041	0.59	6.650	9.691	0.19	1.24	1.196	0.82	0.36	0.393	0.35
Between $140 – $280	6978	4900	0.98	0.271	0.266	0.18	0.947	0.406	0.90	1.801	0.944	0.26
More than $280	4.828	4.409	0.08	0.857	0.774	0.86	0.942	0.517	0.91	1.025	0.71	0.97
Income from forest products (Reference Category: Up to Rs. 2500)												
Between $35 - $70	0.380	0.072	0.00	0.497	0.109	0.00	0.174	0.025	0.00	0.553	0.122	0.00
Between $70 – $140	0.520	0.138	0.01	3.384	0.898	0.00	1.648	0.371	0.02	6.301	1.659	0.00
More than $140	0.471	0.181	0.05	9.658	3.545	0.00	0.864	0.306	0.68	3.519	1.362	0.00
N		1498			1498			1498			1498	
Psuedo R^2		0.0785			0.1568			0.1246			0.1416	

Source: Field Data

Among the positive odds ratios, the 'others' category, included in the 'lighting source', has the highest value (6.3; $p < 0.01$), while the 'fuelwood' and 'kerosene[18]' categories have odds ratios 3.6 and 2.3, respectively. The result indicates that changing from the reference category 'electricity' to other categories appears to increase fuelwood dependency. Put differently, more electrification as a source of lighting for households means less dependence on fuelwood for lighting. Presumably, sources other than electricity for lighting tend to be complementary to dependence on fuelwood. Drawing the cues from the multivariate data analysis and field anecdotes, it appears that linkages between fuelwood and communities are not simply a scenario of substitutability between alternative fuel scenarios, but are also embedded in a fascinating sense of complementarity, too. For instance, while fuelwood is used as a fuel for cooking and boiling water, it is a common practice in the region to use the fire made out of fuelwood as a deterrent against human-wildlife conflict, particularly in the night.

Among several socio-economic characteristics, income from primary activities plays a crucial role in dependency over forest resources. The second highest positive odds ratio is seen in the category '< $266', found in the independent variable 'income from agricultural activities' (odds ratio = 4.8; $p < 0.1$) with respect to the reference category income of $35. This result means that there is a highest level of income from agricultural activities, there are higher odds to depend on fuelwood. Intuitively, extensive engagement in agriculture needs more use of fuelwood as inputs. This contradicts the existing literature, which assumes that the level of fuelwood dependency of the poor is very high in comparison to the rich since the integral part of their subsistence is frequently based on the fuelwood selling (field data).

In the present study, the minimum, maximum and mean age of respondents is 20 years, 90 years and 48.4 years, respectively. Interestingly, as age increases, odds in favour of fuel dependence to grow. Highest interval of age – 'more than 45 years' – reports an odds ratio of 4.2; $p < 0.01$ moving from the reference category 'below 25 years' age. However, the magnitude of odds ratio declines to 3.6 with respect to the category 26 – 45 years (statistically significant at 1%). This trend is likely to point to a direct link between cumulative tacit knowledge in the use of forest resources and age; older people appear to acquire tricks in making use of forests through systems of tacit knowledge such as internalizing norms, oral knowledge, and shared experiences (Hussain, 2019; Jain & Sajjad, 2016). Perhaps this means that accumulation of in-depth tacit experiential knowledge, while being used for the use of forest resources, can be the potential base for promoting efforts to conserve forest resources (Gadgil, 2005; Lacuna-Richman, 2002).

Data on educational attainment indicate that one-third (539) of respondents are illiterate, 48 per cent (729) are literate but not attained matriculation, and only 10 per cent attained matriculation. Moving the reference category from 'Illiterate' to 'Literate but not attained matriculation' results in an odds ratio of 1.5; $p < 0.01$. However, moving to the category 'matriculation and above' produces a statistically not significant odds ratio. This implies that, compared to the illiterate, people who have attained some level of schooling up to matriculation tend to be more fuelwood dependent, apparently because of the higher proclivity of this category to engage in livelihood streams that are not necessarily wage labour (Hussain, 2019). Interestingly, field insights tell us that compared to people who have never been educated, at least some schooling has appeared to be less exposed to informal linkages between forest resources and the market.

Quite importantly, fuelwood dependency appears to be sensitive to the social structure (Hussain, 2019). Studies conducted in a similar domain by several scholar's report that caste is positively associated with dependency on forest resources; households belonging to the lower caste and even in the category of poor income are more dependent on forest resources compared to higher caste groups or higher income groups (Sapkota & Oden, 2008; Khanal, 2001; Springate-Baginski et al., 1999). In this study, people belonging to Scheduled Caste (SC) and Scheduled Tribe (ST)[19] groups make up around 60 per cent of the total population, while a little less than one-third of households belong to 'other backward classes' which are considered to be more prosperous than SCs and STs in this region, in terms of land ownership, multiple engagements in economic activities, easy access to information and resources, and higher political participation. Interestingly, moving from the reference category

18 Kerosene is also known as paraffin, lamp oil, and coal oil.

19 The Scheduled Tribes (STs) are various officially designated groups of historically disadvantaged people in India. *See lawmin.nic.in, accessed on 8th August 2017*

'scheduled caste' the category 'other backward classes[20] (OBC)' reports an odds ratio of 1.3; $p < 0.1$, whereas odds ratios for other categories are not statistically significant. Drawing cues from the field, this pattern appears to have emanated from OBC's relatively higher engagement with livelihood options like self-employment than other categories are engaged. Our results show that it does not seem fair to say that households belonging to lower caste or class or poor income groups are more dependent on forest resources for their survival than household's belonging to higher caste or class or higher income groups. Moreover, data suggest that households with more than 1.61 hectares of agricultural land tend to be more dependent on several forest resources, especially fuelwood and timber, than households with a holding capacity of up to 0.4 hectares.

Now, we are turning to less than one odds ratios for fuelwood dependency. Changing from the reference category 'below poverty line' to 'above poverty line' results in favourable odds of least fuelwood dependency (odds ratio = .77; $p < 0.1$), whereas the odd ratio for 'antyodaya[21]' category is .74; $p < 0.05$, indicating odds in favour of least dependence. As described earlier, household's belonging to the lower economic group seems to be less dependent on forest resources than the wealthy. However, scholars claim that there is a direct correlation between poverty and dependence on forest resources (Sapkota & Oden, 2008; Pattanayak, 2003). Similarly, other scholars found that poor people generated more than 22 per cent of their gross income from forests (Reddy & Chakravarty, 1999) but elite households have captured more valuable resources (Wickramasinghe et al., 1996). Therefore, poverty is often viewed as primary reason for resource depletion due to high social discount rates and shorter time horizons for the disadvantaged. Due to shorter time horizons, poor people tend to adopt strategies which yield more immediate results rather than long-term resource use considerations (Sapkota & Oden, 2008). However, as can be seen from the results, even households belonging to lower economic groups are least dependent on forest resource. To a greater extent, this trend appears to have emerged from the field because poorer households tend to depend on a frictional and segmented labour market that generates discrete and seasonal employment, such as casual wage work.

As far as the house type is concerned, moving from the reference category 'thatched' to the 'semi-concrete' type of house moves the odds for the least dependence on fuelwood. NSSO[22] data on key indicators of drinking water, sanitation, hygiene and housing conditions in India using the 69th round of surveys shows that 65.8 per cent of rural households live in a concrete house and 24.6 per cent lives in semi-concrete houses. In comparison to macro data, field data reveals that just 6.8 per cent (107) are concrete households; nearly one-third (492) are *kutcha*[23]; little more than one-third (527) are tiled-one and about one quarter (377) are semi-concrete households. Among the categories of cooking fuel source, only the category 'LPG' (Liquified Petroleum Gas) has a statistically significant odds ratio of less than one (odds ratio = .68; $p < 0.01$) with respect to the reference category 'fuelwood'. This means that having an LPG connection at home tends to have a negative effect on fuelwood dependency. Data show that nearly three-fourth (1107) of the respondents use fuelwood as a cooking fuel source, 14.8 per cent (221) use LPG, and few use other sources such as kerosene, crop residue[24], gober-gas[25], etc.

Scholars like (Shackleton et al., 2001) reported that the livelihoods of many rural households include not only agricultural activities, but also the use of natural resources. Quite important, in comparison with the reference category 'income from forest products' (Up to $35), all other categories report statistically significant odds ratio that are less than one, clearly implying that having more income

20 Other Backward Class (OBC) is a collective term used by the Government of India to classify castes which are socially and educationally disadvantaged. The OBCs were found to comprise 52% of the country's population by the Mandal Commission report of 1980. *See lawmin.nic.in, accessed on 8th August 2017*

21 Antyodaya Anna Yojana (AAY) is an Indian Government sponsored scheme for ten million of the poorest families.

22 http://articles.economictimes.indiatimes.com/2013-12-25/news/45540803_1_households-urban-india-nsso. Accessed on 19th October 2015

23 'Kutcha' house is defined as a 'hut' having less than 350 sq. ft. area with roof made up of bamboo and leaves.

24 Crop residue is the biomass leftover from the harvesting or processing of planted crops from existing agricultural land (Lawes and Gilbert 1889).

25 Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen (Moulik 1985).

from forest products contributes to less dependence on fuelwood. This also means that households that are less dependent on fuelwood appear to be more dependent on resources with higher economic values or gains.

As far as timber dependency is concerned, interestingly, as moving from the reference category of 'income from forest products' (Up to $35) to higher brackets of income, odds ratio tends to show a non-linear pattern. Although for category $35 – $70, the odds ratio is .5; $p < 0.01$, as we move higher odds ratio turns positive and discernibly higher magnitudes (the category $70 – $140 reports an odds ratio of 3.4 and the uppermost interval reports an odds ratio of 9.7). This pattern seems to indicate that more income from forest products implies more timber dependence, and vice-a-versa. An interesting fact about timber dependence reveals that there is a direct relation between timber dependence and dowry[26]. Field data suggests that in absence of cash for dowry, furniture carved out of high value timber compensate demands related to dowry.

Another interesting pattern is that the odds in favour of timber dependency appears to have been significantly affected by changing the reference category 'agriculture' as primary occupation to 'wage labour', reporting an odds ratio of 7.8; $p < 0.05$. Agriculture and allied activities constitute the main income and livelihood activity of local people (Hussain, 2019; Adam & Tayeb, 2014, Belcher et al., 2005; Mbile et al., 2005). Field data demonstrates that about 47 per cent (708) of the respondents are engaged in farming, while 49 per cent (736) are engaged as farm labourers. Compared to livelihoods such as farming, the wage labour in rural areas is mostly transient and seasonal in nature. In the absence of sustainable agricultural growth and rural development programmes, the State has not been very successful in meeting the 'basic needs' of the poor, which seem to have resulted to higher dependence on local resources. While existing Indian literature reports that forest dwellers mitigate the risk of impoverishment by collecting high economic value forest resources, the State's restrictions on over access to resources seem to have reduced the chances of communities pursuing sustainable livelihoods. In such scenarios, a few dwellers that are not in sync with agents and actors of formal institutions are forced to take maximal risk to gain more and more in just one or few collection instances. However, (Arnold, 2001) comments that access to timber resources may help rural households to diversify their livelihood and reduce their exposure to risk. This may work in some part of the world but not necessarily in the global south, particularly in India.

For the variable 'caste', when we change from the reference category 'scheduled caste' to the category 'scheduled tribe', the odds appear to be in favour of having more timber dependence (odds ratio = 1.6; $p < 0.05$). However, with respect to the category 'other backward class', the odds ratio is .62; $p < 0.1$, inclined to odds against timber dependence. However, interestingly, the engagement of respondents belonging to 'other backward class' in other livelihood opportunities is quite higher than that of SC and ST respondents. Dependence on Timber generates huge revenue for forest dwellers who have access to forest resources. It also reflects on Monthly Household Expenditure. The National Sample Survey Organization's Household Consumer Expenditure across socio-economic groups, 2011-2012 reports that people in the General Category[27] have the highest Monthly Household Expenditure followed by members of the Other Backward Category. In Urban India, people belonging to the category-Scheduled Caste have the lowest Monthly Household Expenditure whereas in rural India; those in the Scheduled Tribe have the lowest.

In comparison to male (reference category), female appears to be inclined towards odds in favour of less timber dependence (odds ratio = .4; $p < 0.1$). This pattern raises concerns about the nature of gender role in the use of natural resources, in particular timber dependency. Drawing cues from the field experiences, it appears that local communities found timber dependence and associated livelihoods to be more masculine. Women play an important role in particularly in bridging seasonal gaps, meeting particular needs, helping households to tide themselves through longer periods of scarcity, and maintaining agricultural productivity (Arnold, 2001). Women tend to associate themselves more with the collection of non-timber forest products having low economic value. Another interesting fact is that

26 Dowry is defined as transfer of money, goods and services from brides and their families to grooms and their families (Dalmia and Lawrence, 2005)

27 In an Indian context, General Category refers to the communities which is socially well developed and financially has good position in economic ladder. *See lawmin.nic.in, accessed on 8th August 2017*

the confiscation of forest products from women is quite a common phenomenon while imposing penalty or judicial custody on them for collection of forest resources is rare.

Having an LPG connection as a 'cooking fuel source' appears to be in favour of preferring more timber dependence (odds ratio = 1.74; $p < 0.01$), while the same variable reports odds ratio less than one with respect to the fuelwood dependence. This means that once the household uses LPG for cooking food, there tends to be more time with the household to explore activities such as collection of timber products that offer more economic value. It is important to note that just 15 per cent households in the study use LPG for cooking purposes.

Assessing the impact of poverty status on timber dependence in the 'antodaya' category, the odds ratio is 1.44; $p < 0.01$. This implies that timber wood appears to be the principal source of cash for the poorest to cope with the vulnerabilities to which they are exposed. Except for the category 'between \$70 – \$140', included in the variable 'income from forest products' (odds ratio = 1.65; $p < 0.05$) and 'fuelwood' included in the variable 'lighting source' (odds ratio = 2.2; $p < 0.01$), all other statistically significant odds ratios are less than one. Statistically significant odds ratios that are less than one was estimated with respect to the categories that are included in different variables: 'above poverty line', 'antodaya', 'semi-concrete', 'concrete', 'others', 'crop residue', 'male', 'literate but not matriculated', 'matriculation and above', and 'between \$35 – \$70'.

Although *Tendu* dependence is a visible pursuit of livelihood, it is seasonal in nature. Intuitively, this seems to explain why most statistically significant odds ratios are less than one, suggesting sightly discernibly lower levels of dependency. It is worth mentioning, however, two exceptions to this pattern. First, with respect to lighting source, the 'fuelwood' category reports an odds ratio of 2.202; $p < 0.01$, indicating that a possible link between the collection of firewood and the knowledge about the availability of *tendu*, culminating in a scenario of complementarity between firewood and *tendu* collection. Second, 'income \$70 - \$140' category in the variable 'income from forest products' reports an odds ratio of 1.648; $p < 0.01$. Presumably, this implies that in the mid income range, there appears to be higher proclivity towards earning income from seasonal opportunities. In short, as far as the scenario of *tendu* dependence is concerned, this opportunity seems to be complementary to the principal activities such as farming, fuelwood collection and timber related pursuits. Interestingly, field anecdotes suggest that while collecting *tendu*, it is not rare to align with the collection of fuelwood, resulting in multipurpose visits to the forest. *Tendu,* as a raw material, feeds into the value chain of 'Beedi'[28] production, creating economic benefits for the actors engaged in this activity.

It is important to note that, despite being seasonal in nature, *Mahua* tends to be of higher economic significance as a natural resource. Interestingly, for the variable 'income from forest products', while categories representing higher strata of income from forest products report visibly higher odds ratios that are more than one, the lower strata report lower odds ratio. While doing field work, we observe that the direct linkage between income and dependence on *mahua* seems to have emanated from the initial processing of the product which involves the drying of *mahua* tends to be done on the rooftop of the private habitat, because the public display of *mahua* attracts surveillance by the formal institutions. More succinctly, having a more spacious habitat appears to be a strategy to minimize transaction costs resulting from surveillance by formal institutions. Unequivocally, there appears to be a direct functional relation between spacious habitat and economic strata.

In the case of 'lighting source' keeping 'electricity' as a reference category, the 'fuelwood' category has an odds ratio of 2.5 ($p < 0.01$), which is inclined towards more *Mahua* dependence, while the category 'others' has an odds ratio of .18; $p < 0.05$. This pattern is quite akin to the case of *tendu* dependence, because fuelwood collection appears to have acclimatized members of local communities, allowing them to recognize the source of *mahua* in the forest. Clearly, this is a scenario of complementarity of activities that tend to evolve in a milieu of interdependent forest resource dependencies.

As far as the variable 'caste' is concerned, the category 'scheduled tribe' in comparison with the reference category, appears to be inclined to *Mahua* dependence (odds ratio = 1.85; $p < 0.01$. Based on our field findings, tribes as an ethnic group are more culturally aligned with '*Mahua*' than others.

28 A 'Beedi' also spelled 'bidi' or 'biri' is a thin cigarette filled with tobacco flake and commonly wrapped in a Diospyros melonoxylon or Piliostigma racemosum leaf tied with a string or adhesive at one end (Rajasekhar and Sreedhar, 2002).

Discussion

We discovered favourable and adverse odds in dependencies on firewood, timber, tendu, and mahua resulting from variations in the socio-demographic characteristics of households in this field-based study that traces the linkage between forest resource dependency scenarios and socio-demographic characteristics of the communities living on the outskirts of Tadoba-Andhari Tiger Reserve. Quite evidently, timber dependency appears to be of a different kind among dependency scenarios. We posit that this pattern seems to have emerged because timber extraction as an activity is largely orchestrated by State-based formal institutions, generating a frictional labour market in the region; this implies that casual labour tends to associate with timber extraction. On the contrary, other dependency scenarios of appear to have been enmeshed with informal social structures or networks that are endemic to the region and to community life. This means that when it comes to firewood, *tendu* and *mahua*, the tacit knowledge of community and networks may work in tandem in the process of resource gathering. Moreover, these dependencies not necessarily render scenarios like frictional labour market that pays wages to casual workers; rather, streams other than timber seem to have formed more stable sources of livelihood.

Although a clear inverse relationship between resource dependency and conservation can be drawn, setting these two presumably counter-acting themes as a complex inter-dependent process may be positioned as a prospective theme. As inferential patterns arise, there are possible synergies that these communities use when obtaining resources from the forest. As anecdotes from the field suggest community's collective experience in gathering resources have been revolving around shared knowledge, wisdom and practices. While in the field, we came across narratives and images that showcase plural context of self-ordered community initiatives that harness energies to collect natural resources without compromising the ethos of sustainability. Interestingly, although self-ordered communities organised in small groups resort to firewood collection almost on a daily basis except in some extreme weather conditions, community tends to form larger groups to collect seasonal resources having more economic value such as *tendu* and *mahua*. Drawing cues from our observation and learning from lived experiences of people, firewood is primarily the need of household, although at times firewood collection may serve community needs as well, while *tendu* and *mahua* collection caters to value chain that is moderated by middlemen who connects the resource and commodity market.

Conclusion

We argue that controlled collection of forest resources aids local communities in self-organizing toward conservation systems because forest resource dependence livelihood strategies are frequently adopted by the poorer economic strata of society, as well as culturally dependent tribal and other disadvantage groups. Because market-linked and self-consumptive forest resources demonstrate habitat and spatial dependency, the relationship between higher and lower local reliance on forest resources is directly proportionate and cannot be observed independently. Similarly, the institutional arrangement between locals and officials influences the locals' dependence on a wide range of forest resources. This arrangement, which may determine the continuum of dependence on forest resources, is highly dependent on the locals' caste, class, and gender and should not be disregarded. Finally, despite the fact that the rural poor are offered subsidised LPG gas and cylinder connections, locals' dependence on fuelwood as a source of cooking fuel appears to be inevitable. The state should design strategies to reduce the cost differential between fuelwood collection and LPG connection in order to reduce the burden on forest regions caused by over-collection.

Research Implications

The study will aid the state to design social welfare programs and conservations strategies considering the needs of locals, form and extent of poverty, remoteness and access to forestry and non-forestry resources, low or no livelihood opportunities, land and asset ownership status, and the dynamics between the formal and informal players and their institutions. This study undoubtedly opens the door

for further research regarding groups (lower social strata) bear the costs and groups (higher social strata) enjoy the benefits of institutional arrangements with the key players of formal institutions. Further, data on forest resources dependence can be collected on dimensions such as species dependence, habitat dependence, temporal dependence, spatial dependence, and conservation dependence, as a continuous data. A time-series analysis can be performed on such data to cluster similar and dissimilar villages based on the dependency ratio and institutional arrangement analysis.

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