Chapter 16
Managing the Forest Fringes of India: A National Perspective for Meeting Sustainable Development Goals

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Abstract Forest fringes are the outer reach of the forests which witness majority of the extraction pressure from the community living near to it. For a country like India, where most of the lands are rainfed and lack sufficient irrigation facilities for the agricultural activities, the dependence of the communities is significantly high on the forests for meeting their subsistence needs. When compared to the overall area of the forests, the fringe areas are more vulnerable to extraction pressure. Fringe forests safeguard the interior core forests as long as the anthropogenic pressure does not exceed their resilience. However, the phenomenal increase in human and cattle populations over time and lack of effective management interventions is acting as a barrier in meeting the goals of sustainable development. Over-exploitation of the forest resources had led to the diminishing supply of goods and services. A quantitative assessment of the dependence of the fringe communities on forests is essential for formulating the sustainable actions. We present here a national perspective of the current status of fringes in meeting the goals of sustainable development. We emphasise that forest fringes demand an urgent site-specific prioritised intervention to improve livelihood as well as the ecological health for addressing the goals of sustainable development.

Keywords Fringe forest · Fodder · Fuelwood · Agroforestry · Forest degradation · Socio-economic

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P. A. Khaiter, M. G. Erechtchoukova (eds.), *Sustainability Perspectives: Science, Policy and Practice*, Strategies for Sustainability,
https://doi.org/10.1007/978-3-030-19550-2_16

16.1 Introduction

India is one of the most diverse nations in the world, be its societal and cultural setup or the natural ecosystems. The ever increasing population of the country and the dependence of the rural forest fringe communities upon forest resources pose an alarming situation. Country's population was 1.21 billion as per Census of India (2011) with a population density of 382 per km^2. The projected growth of population indicates that India will be the first most populous country in the world and China will be second by 2050 (PRB 2001). Having 18% of the world's population on 2.4% of its land area exerts tremendous pressure on its natural resources. Forest cover of the country as per FSI (2017) is 7,08,273 km^2 which is 21.54% of the geographical area of the country. There has been a stable to slightly increasing trend of forest cover as per the biennial assessments by Forest Survey of India (FSI), Dehradun, India. FSI is an organisation in India under the Ministry of Environment, Forest & Climate Change, Government of India whose mandate is to conduct survey and assessment of forest resources in the country. FSI (2017) assessment report highlighted an increase of 6778 km^2 in the forest cover at the country level compared to the preceding assessment of 2015. Report further states that hilly districts of the country have 40.22% forest cover of their total geographical area that makes them short by nearly 26% for achieving two-third area under forests. The tribal districts have 37.43% area under forests, which acts as one of the major sources for the local tribal population. Hilly areas of the country had a net increase of 754 km^2 in the forest cover while the same was 86.89 km^2 in tribal areas. Areas within 1000 m elevation had net increase in forest cover while those above this elevation witnessed a net decrease.

Ashraf et al. (2017) showed divergent trends from decline to an expansion of country forest areas and *vice-versa* depending on the local socio-environmental conditions. Forest expansion was found to be correlated with the level and the long-term sustainability of the socio-economic development (Moretti et al. 2014; Redo et al. 2012; Rodríguez and Pérez 2013). Looking at the close linkages between the forest and the society, it is imperative to understand the relationship and the extent of resource extraction for prioritising goals of the sustainable development. Sustainable development has been variously conceived in terms of vision expression (Lee 1993), value change (Clark 1989), moral development (Rolston 1994), social reorganization or transformational process (Viederman 1994) toward a desired future or better world (Gladwin et al. 1995). The core idea was defined most influentially by The World Commission on Environment and Development (i.e., The Brundtland Commission) as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland 1987), which is more widely and universally accepted definition (Gladwin et al. 1995).

Definition of sustainable development encompasses sustainable use of natural resources including forests. Forests and the communities have a close linkages and there always exists a risk of imbalance between them. To improve the forest

quality together with the livelihood support in the country in an effective way, there is a need to identify the present status of the forests not only in the form of its canopy density, type of forests but also in the form of information about the extent of dependence of the fringe communities for their livelihood and other essential commodities. Information on identification and mapping of the fringe forest, extent and distribution of forestlands in rainfed areas, identification of forest fringe villages, areas supporting open and/or dense forests, forest vegetation community structure, species diversity, regeneration status, dominant species, socio-economic parameters of human population like land holding, cropping pattern, occupational status, income and household size, livestock population, distance between fringe villages and the nearest town, irrigation facilities, energy consumption/energy use pattern, extent of dependence on forests for fuelwood and fodder, forest products extraction, etc. has recently been studied by Forest Research Institute (FRI), Dehradun (FRI 2017). The information generated by FRI is relevant for the policy makers and would serve as a vital input in planning especially the site-specific planning to address the goals of sustainability.

We present in brief the results of above mentioned study conducted by FRI compiled at the state level (an administrative unit next below the country) that could be helpful in prioritising actions of sustainable development for a country like India. The chapter makes special effort to understand the wider perspective of fringes with reference to sustainability and planning. The overall objective of this chapter is to illustrate how one can compile extensive information at a larger national scale and work out the dimensions or components that could be helpful for the managers to plan sustainable development and management strategies for the forest fringes. The broader theme relates to the communities' dependence at household level for their subsistence needs and their influence on the ecological state of the fringes. The study also provides an understanding on the relationship of the forest fringe villages with the fringe forests summarised at the State level to rank them as low, medium and high categories of dependence. Each State has also been ranked on the basis of use of non-wood forest products (NWFPs) for self-consumption/sale and Shannon's index of diversity representing ecological status. We illustrate various levels of household dependence of respective States which can contribute in prioritising State-specific actions to achieve the overall goals of sustainable development. This task could be achieved by visualising the priority States, which need urgent interventions for the forest conservation, livelihood improvement of forest dependent communities, reducing dependence of the communities upon forest resources and the major forest resources which supports the livelihood. Once these interlinked components are identified and measured, this will certainly help manage our forest fringes in a better way for improving the health of the forests as well as the economic status of the fringe communities.

16.2 Case Study: Forest Resource Dependence of Fringe Communities in Selected Rainfed Districts of India

16.2.1 Background

Rainfed areas are those areas which have scanty rainfall and very often socio-ecological systems of these areas suffer due to lack of sufficient irrigation facilities (Savita et al. 2018). Social as well as ecological systems of these regions depend heavily on rains. Agriculture-dependent communities of rainfed areas are especially at greater risks due to the lack of sufficient irrigation facilities. This forces the communities to look for alternate sources of livelihood for meeting their subsistence needs and this trend is increasing significantly. However, rainfed agriculture plays an important role in India's economy. The crop-wise analysis shows that major coarse cereals are grown in rainfed areas. The crop productivity in rainfed areas is low and people are dependent on alternative sources including common property resources such as forests for their livelihood. There is, therefore, a need to look into feasible solutions for improving the productivity of rainfed areas along with the other means of livelihood. The serious question being faced by the policymakers is "how to improve the productivity of land while maintaining the ecological equilibrium". Looking at the implications of the situation and for addressing the emerging issues, National Rainfed Area Authority (NRAA) was constituted as an attached office of the Department of Agriculture, Cooperation, and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India with an objective to prepare perspective plan and guidelines for effective management with special focus on rainfed areas. Soon after its establishment, NRAA has been successfully developing and implementing various management plans for tackling the emerging issues of the rainfed areas in consultation with various agencies including premier research institutes. One of the mandates of the authority is to serve as a knowledge platform and connect research, academic, and other institutions for the effective planning and implementation of the identified activities through various implementing agencies. NRAA also focuses on the issues of livelihood opportunities for the landless and marginal farmers who constitute a large proportion of the rainfed area population.

While there have been various attempts to define and demark the rainfed areas in the country, there is still a general lack of understanding and consensus for a commonly acceptable definition. According to NRAA, rainfed areas are those where irrigation is $\leq$ 30% of the net sown area (NRAA 2012). Regions with an extent of irrigation exceeding 30% are often defined as "irrigated areas". According to official statistics, about 86 million ha of the total cultivated area of 143 million ha is rainfed (NRAA 2011, 2012). Rainfed areas are characterized by low agricultural productivity in terms of crop yields as compared to irrigated areas (NRAA 2011, 2012; Kumar et al. 2017). The extent of the rainfed area varies from year to year depending upon the rainfall and water availability in the reservoirs. Most of the rainfed districts of the country suffer from lack of sufficient irrigation facilities making agriculture a cumbersome activity. Consequently, people explore other

means of livelihood and forests serve as one of the option to be explored. The prevailing situation exerts pressure on the forests by fringe communities, specifically in the rainfed areas. Thus, there is a need to be more pragmatic while addressing the issues of the rainfed areas for achieving the goals of sustainable development. Identification of the issues and its prioritisation for the effective solution seems to be the top agenda for all of the rainfed districts falling in all agro-climatic zones. Majority of these areas are located in arid and semi-arid regions of the country with a relatively larger population of low-income people.

Foremost identified key issues of the rainfed areas include the degradation of the land mainly because of the unplanned activities, over-exploitation of the natural resources, and an ever-increasing pressure of human and livestock populations on the resources. As a result, even marginal lands are being cultivated by the communities with little support to the livelihood. This has resulted in the degradation of forests because of livestock grazing, fodder extraction and heavy dependence of the local people for fuelwood, timber and non-wood forest resources. The communities of the region have various levels of annual income, agriculture land holding, education and engagement in terms of government and private jobs, thereby making various levels of hierarchical dependence defined by these respective attributes. Landholding and income from agriculture lands are also inadequate and at various levels. This frames various socio-economic hierarchy in these regions, which actually form one of the criteria for ranking of the districts. In rainfed areas, most of the farmers are small land holders. Phenomenal increase of human and cattle populations and lack of effective management interventions in the fringe areas is affecting not only the fringe but also the core forests (FRI 2017). Overexploitation of the forest resources has resulted in vast trails of degraded forests in turn leading to diminishing supply of goods and services from the forests. Hence, there is an urgent need to develop a system in which food, fodder, and fibre can be grown in an integrated manner on the same unit of land. One such system is agroforestry which is a climate-smart solution with many significant co-benefits. In other words, agroforestry can serve as a useful practice in rainfed areas to increase the productivity from land and also to mitigate the climate change impacts. Authorities may also act proactively to implement management interventions that would help in improving the regeneration, thereby improving the health of the forests and the flow of ecosystem services.

This case study focused on the socio-economic assessment with reference to forest resource dependence and ecological status of the fringe forest lands in the rainfed areas. The study will help in prioritising the states for addressing the issues of sustainability and evolving an effective plan at country level to manage forest fringes in a better way. In-depth understanding of the fringe forest areas and the communities depending on these forests will help decision-makers to undertake the meaningful interventions to achieve the goals of sustainability in a more pragmatic manner.

16.3 Materials and Methods

16.3.1 Study Area

The study was conducted in 275 districts of India identified for this study (Fig. 16.1).

Villages located within 1 km distance along the outer periphery of the forest boundary identified for the survey were considered as "forest fringe villages" and has been referred as "forest fringe", where the forest boundaries were derived from the FSI (2011) and represents the forest cover densities mapped using remote sensing signatures of the forests. Whereas, forest areas within reach of 1 km distance inside the forest from outer periphery (i.e. boundary) of the forest were defined as

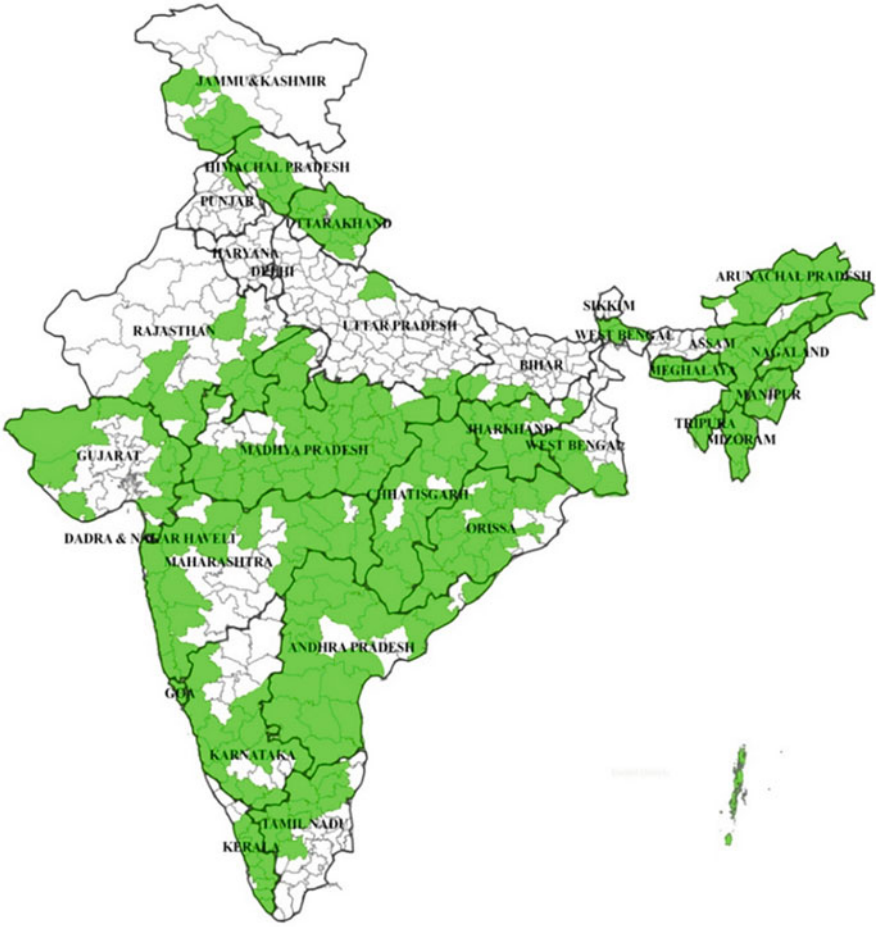

Fig. 16.1 Distribution of rainfed study districts in India (in green colour)

'fringe forests'. For the representation of both outer as well as the inner buffer area of 1 km as a combined representation, word "fringes" has been used throughout the chapter.

16.3.2 Sample Size Selection

Sample size selection for the complete enumeration was tested by conducting initial pilot survey. The number of samples (sample size) appropriate for selecting the number of villages in a district was derived using formula suggested by Cochran (1977) as indicated below.

$$n = \left(\frac{CV(Y) * t}{\varepsilon}\right)^2, \tag{16.1}$$

where n = number of sample plots, CV = coefficient of variation, Y = character under study (magnitude of extraction of forest resource or the degradation/deforestation of forest), t = confidence interval, ε = margin of error. A precision level of $\pm 5\%$ at 95% probability level was achieved.

16.3.3 Socio-Economic and Phytosociological Survey

Socio-economic conditions of the forest fringe communities were assessed by collecting information at the village as well as household level through a standard questionnaire developed specially for this study. Field survey-based information was collected for the sociological and ecological study across more than 100,000 fringe villages spread across 275 districts. Both qualitative, as well as quantitative information were compiled from survey data. For collecting information on the ecological status of the fringe forests, nested quadrat method was followed. The layout of the sample plots for the phytosociological study was adopted from the Forest Survey of India forest inventory manual (FSI 2002) (Fig. 16.2).

Stratified Random Sampling was used for collecting information of socio-economic parameters where first stage sampling units were the villages and the second stage sampling units were households. The first sampling units, i.e. villages within each district were stratified based on the population of the villages available in the population census data of 2011 (Census of India 2011). All the villages in the said districts were arranged in the descending order of population. If 'n' villages were to be selected, then the list of villages was grouped into n/5 groups and 5 villages were randomly selected from each group using a random number table. In the selected villages, the households were categorized into three groups based on their economic status, i.e., affluent, less affluent, and others. Twelve households in a village were selected randomly for the survey to collect desired information

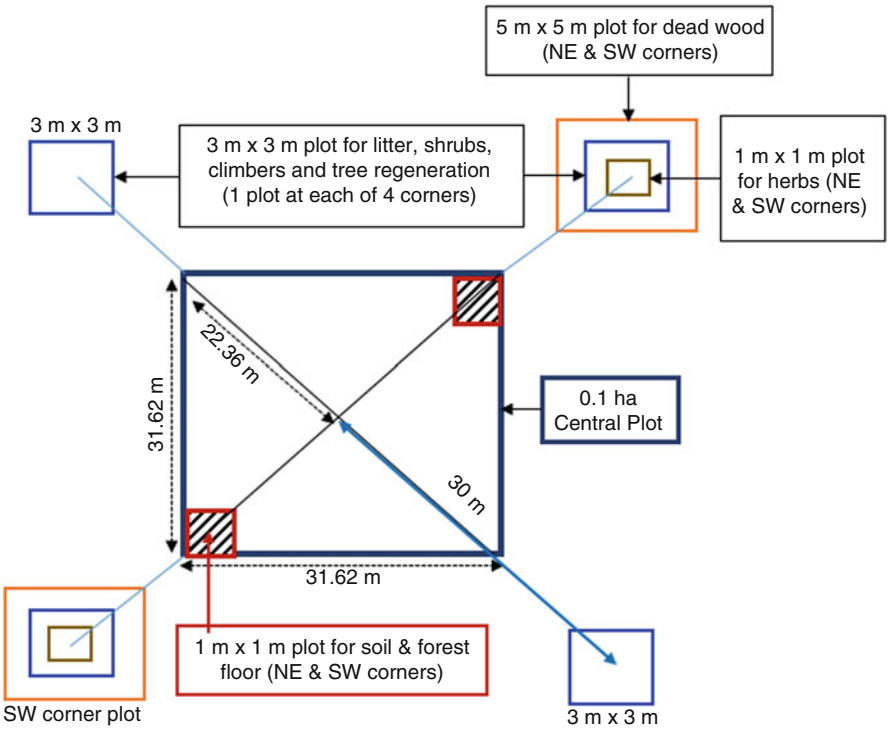

Fig. 16.2 The layout of the sample plots for the phytosociological study (NE: North-East, SW: South-West)

Table 16.1 Selection of household class for the survey

S. No.	Condition	Selection of household classes		
		Affluent	Less affluent	Other
1.	If all 3 household classes are available	Two families from this category	Five families from this category	Five families from this category
2.	If affluent class is not available	Nil	Six families from this category	Six families from this category
3.	If less affluent class is not available	Six families from this category	Nil	Six families from this category
4.	If other class is not available	Four families from this category	Eight families from this category	Nil

in a way so that two, five, and five households are selected from affluent, less-affluent and other class, respectively. The shortfall, if any, in any of the category, was compensated from other classes (Table 16.1).

The ecological study focused for the observation on the importance value index (IVI) (Curtis 1959) and index of diversity (Shannon's Index) (Shannon 1948). Regeneration status of important species was also enumerated while the focus

primarily remained to assess regeneration of dominant species only. Shannon's index of diversity has only been discussed in this case study for the sake of simplicity.

Species diversity is an expression of community structure and is unique to the community. The number of species in a community is referred to as species richness when the topography of compartment is homogeneous. The relative abundance of all species is called evenness. Species diversity includes both species richness and evenness. A community demonstrates a high species diversity if many equally or nearly equally abundant species are present. Plant communities with a large number of species that are evenly distributed are the most diverse and communities with fewer species that are dominated by one species are the least diverse. Species diversity was calculated using Shannon's Index of diversity (Shannon 1948).

$$Shannon's\ Index\ of\ diversity\ (H) = -\sum_{i=1}^{s} (P_i * \ln P_i)\,, \tag{16.2}$$

where, P_i = fraction of the entire population made up of species, *i;* s = numbers of species encountered; ln = natural logarithm and $\sum$ = sum from species 1 to species s.

The diversity of the study area was grouped into low, moderate, high and very high based on the calculated Shannon's value using criteria; low (up to 1.50), medium (1.60–2.50), high (2.60–3.50), and very high (>3.50).

16.4 Results and Discussion

The total number of villages in the studied districts is 310,434, of which 147,127 were identified as forest fringe villages. State-wise distribution of total geographical area, total area under forest, total number of villages and the number of villages identified as fringe villages is presented in Fig. 16.3.

The total geographical area includes 3,233,442 km^2 which is having a total forest cover of 702,819 km^2 comprising 21.73% area under forests. Whereas, the total area demarcated as fringe forests is 386,079 km^2 which is nearly 55% of the total forest area. This indicates that more than half of the forest area is vulnerable to the pressure of extraction by the fringe people. This is primarily witnessed in the form of fuelwood extraction, non-wood forest product (NWFP) collection and fodder usage. Annual fodder consumption from the fringe forest is 45,074,032 Mt., of which 41,577,706 Mt. is grazed and 3,496,326 Mt. is stall-fed.

There is variation in the state-wise pattern of dependence for each of the resources among households. The pattern of dependency for the resource extraction or utilization from the fringe forest areas is not similar among all of the states. This signifies that selection and utilization of the resources are governed by other attributes of the communities which could be their economic status, literacy and the

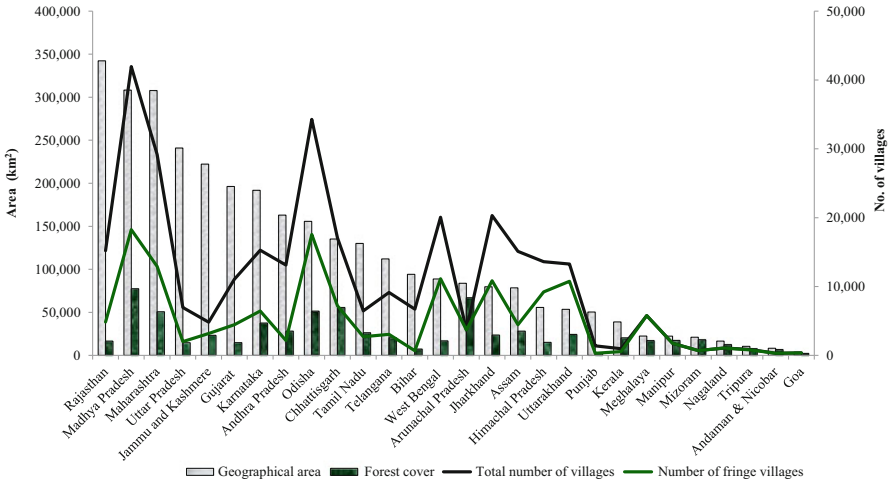

Fig. 16.3 Profile of the States including names, geographical area, forest area, number of villages and the number of villages identified as fringe villages

way of living. While analyzing the percentage of households in respective states for extracting resources from the fringe forests, it was observed that states could be categorized into high, medium and low level of dependency. The categorization of different states for their dependency of fodder in the form of grazing, fodder in the form of stall-fed and the extraction of fuelwood is shown in Figs. 16.4, 16.5 and 16.6, respectively.

Extraction and utilization of NWFP is one of the most hunted activity by the forest fringe communities in many of the fringe areas. The communities make use of NWFP for self-consumption as well as trading them in the market. Self-consumption of NWFPs is more prevalent than using it in trades for cash income (Fig. 16.7). Trade routes for most of the NWFPs are not well understood and therefore the collection of information on the quantity being extracted is a little bit difficult. In many of the cases, communities do not want to reveal the information in anticipation and apprehension of facing legal issues; whereas sometimes people don't have any idea about the exact quantum of stuff they extract. However, an attempt was made to distinguish between the consumption and sale out pattern prevalent among the states (Fig. 16.7).

Cattle provide one of the major support to the livelihood of the fringe communities. Most favoured livestock in the fringe villages is cow throughout India, while chickens and pigs are preferred in the north-eastern States and goats in the states of Rajasthan, Madhya Pradesh (MP), Jharkhand, and Andaman & Nicobar (A & N). A large number of cattle are owned by the majority of the households, thus making nearby forests as one of the priority choices for the grazing or stall-feeding. Due to lack of availability of alternate sources of fodder in the form of fodder grown on the

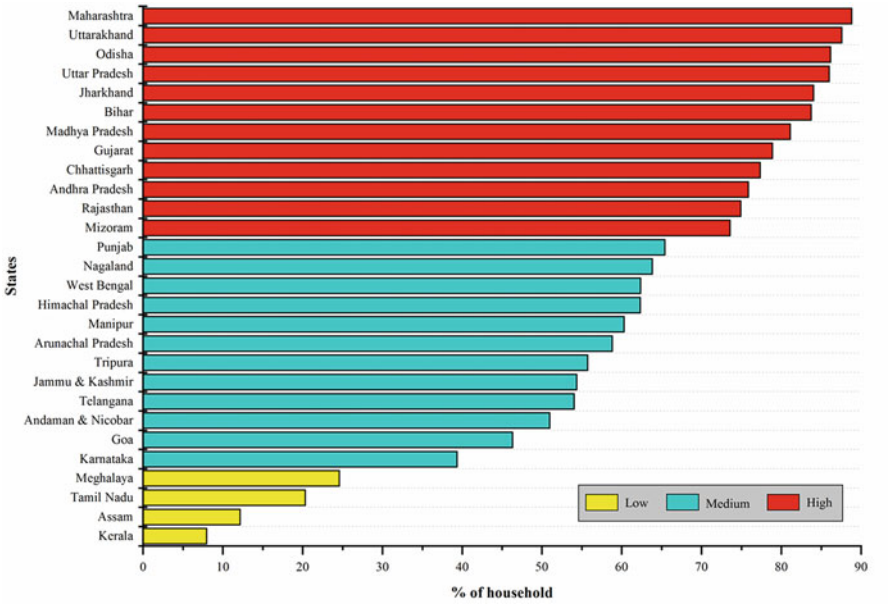

Fig. 16.4 Households (%) in different States where dependence for fodder is in the form of grazing

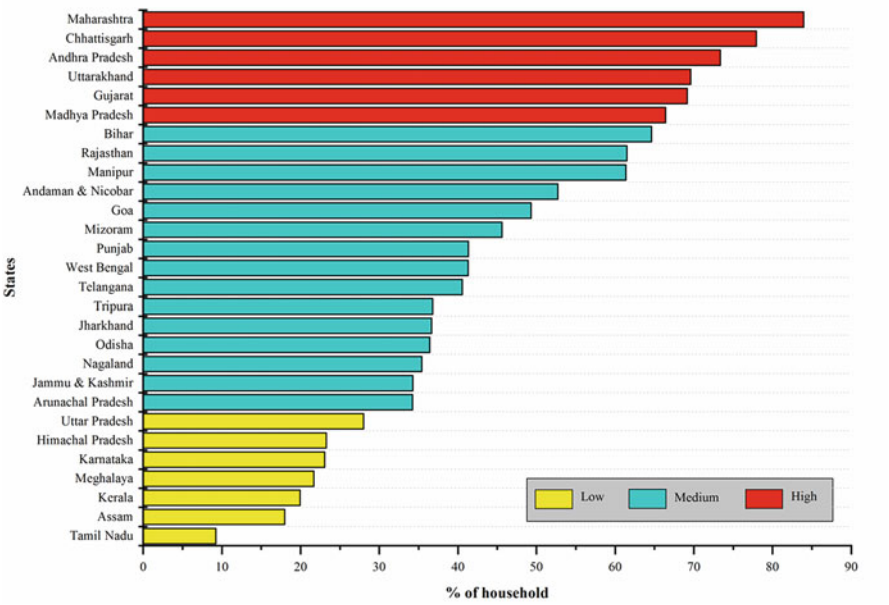

Fig. 16.5 Households (%) in different States where dependence for fodder is in the form of stall-feeding

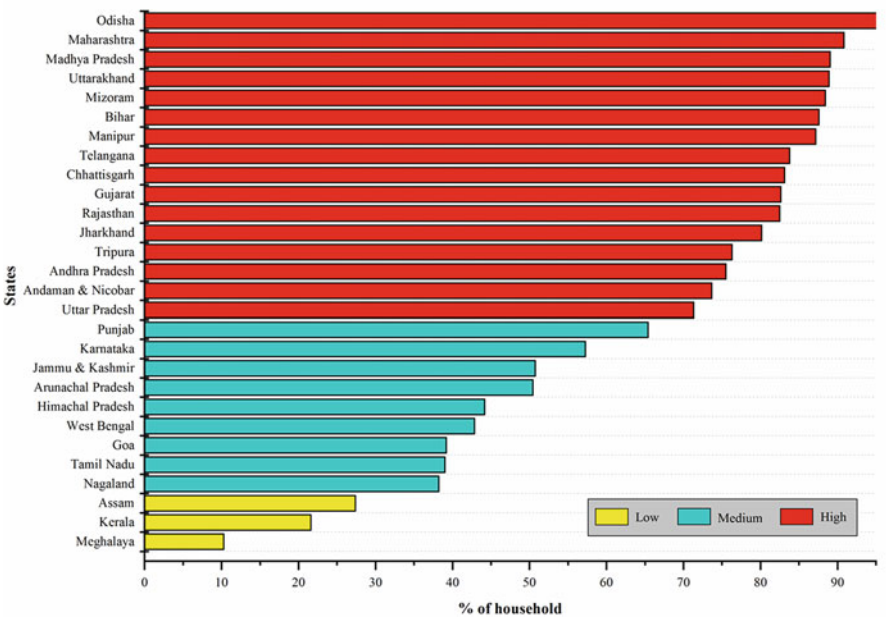

Fig. 16.6 Households (%) in different States that extracts fuel wood from the forests

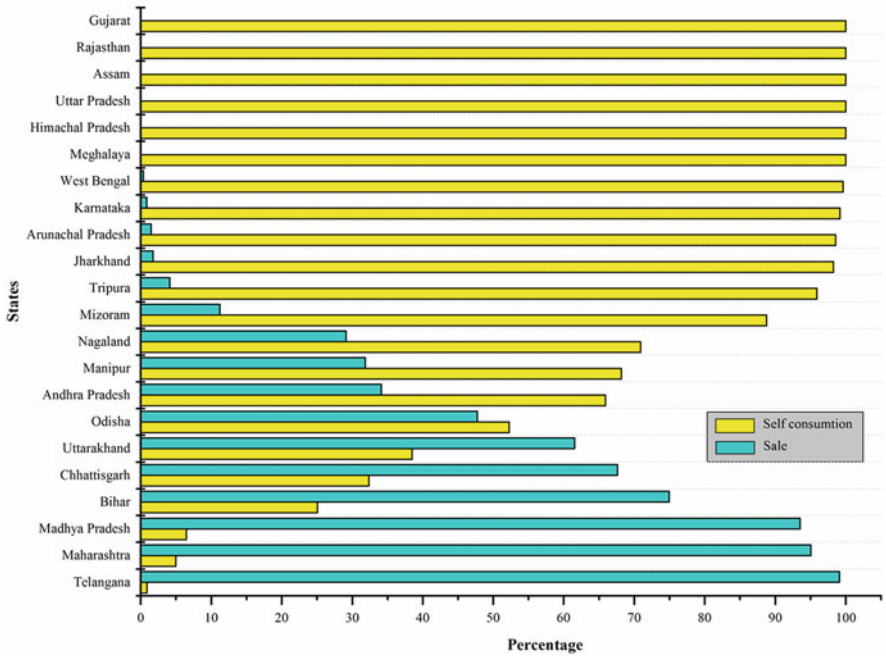

Fig. 16.7 Households (%) in different States making use of NWFP for self-consumption and sale

individual fields or community-owned lands, this has further increased dependency of communities for fodder upon fringe forests. The tree species found in the forests, which are not at all meant for the fodder resources also bear the brunt of fodder extraction and their leaves and branches are chopped for the stall-feeding. Species like *Aegle marmelos* and *Mangifera indica* also become choice of fodder for stall-feeding. This calls for immediate intervention to provide the alternate source(s) of fodder to support cattle population that will help to protect natural forests of the fringes.

The most used species for fodder in the country are *Acacia catechu, Acacia senegal, Apluda mutica, A. varia, Bambusa vulgaris, Brachiaria mutica, Caulanthus pilosus, Chionachne koenigii, Chrysopogon montanus, Cymbopogon martini, C. ambiguous, Cynodon dactylon, Cyperus rotundus, Dactyloctenium aegyptium, Dendrocalamus calostachyus, D. strictus, Desmostachya bipinnata, Diospyros melanoxylon, Echinochloa colona, Eleusine coracana (residue), Eragrostis tenella, Eulaliopsis binate, Exbucklandia populnea, Ficus religiosa, Grewia optiva, Hardwickia binata, Heteropogon contortus, Imperata cylindrica, Mangifera indica, Mussaenda frondosa, Oryza sativa (residue), Panicum notatum, Podocarpus neriifolius, Quercus leucotrichophora, Saccharum officinarum (residue), S. spontaneum, Schima wallichii, Schleichera oleosa, Shorea robusta, Sorghum bicolor, Trifolium alexandrinum, Triticum aestivum (residue) and Zea mays.*

Due to lack of alternate sources of fuel for cooking, a majority of the fringe communities ultimately have to rely upon the forests. Although fuelwood is mainly used for the purpose of cooking while in most of the cold regions of the country, it is also used for heating to combat the cold. Dependence of the communities upon forests for the fuelwood has emerged as one of the top cause of forest degradation in the country. Additionally, such dependency also has engaged the community into the drudgery of collecting firewood where women have the major stake. At the same time, smoke generated from such fuels causes serious health implications to the women and children in the form of respiratory disorders, poor health and a decrease in average life expectancy. Communities engaged in fuelwood collection from fringe forests are more at the risk of death because they are highly vulnerable to the attacks of wild animals and snake bites. Looking at intricacies of the situation, Government of India has recently launched Pradhan Mantri Ujjwala Yojana (PMUY) (www.pmujjwalayojana.com) initiated through the Ministry of Petroleum and Natural Gas for the distribution of relatively clean fuel in the form of Liquid Petroleum Gas (LPG) cylinders. The PMUY aims for distribution of clean cooking fuel to protect health of the communities who are otherwise exposed to smoky kitchens and have to engage themselves in the drudgery of fuelwood collection.

The preferred species for fuelwood in the fringes are *Ailanthus malabarica, Albizia lebbeck, Alnus nepalensis, Azadirachta indica, Bambusa vulgaris, Bauhinia variegata, Cedrus deodara, Dalbergia latifolia, Dendrocalamus hamiltonii, Grewia optiva, Mangifera indica, Schima wallichii, Shorea robusta, Terminalia myriocarpa, Acacia arabica, A. catechu, A. nilotica, A. planifrons, Albizia lebbeck,*

Anogeissus latifolia, Artocarpus chaplasha, Artocarpus heterophyllus, Azadirachta indica, Bambusa vulgaris, Bassia latifolia, Boswellia serrata, Buchanania lanzan, Butea monosperma, Cajanus cajan, Casuarina equisetifolia, Chloroxylon swietenia, Cocos nucifera, Dalbergia sissoo, Dendrocalamus strictus, Diospyros melanoxylon, Gmelina arborea, Hevea brasiliensis, Lagerstroemia parviflora, Lantana camara, Madhuca indica, Mangifera indica, Pinus kesiya, P. roxburghii, Populus tremula, Prosopis juliflora, Shorea robusta, Syzygium cumini. Tamarindus indica, Tectona grandis, Terminalia arjuna, T. tomentosa and *Toona ciliata*.

The choice of species for the fuelwood is governed by the non-availability of alternate options. Cow dung (including that of buffaloes) is extensively used by the communities as cooking fuel. However, in absence of sufficient quantity of fuel from alternate sources communities extract fuelwood from the fringe forests. Similar to the choice of species for fodder, selection of species for fuelwood is also guided by non-availability of appropriate species and sometimes villagers also extract these by chopping useful species.

The highest number of forest fringe households practice agriculture while the number of skilled and non-skilled labourers are also very high. Paddy, wheat, and tapioca among major food and rubber among the plantation crops are the dominant crop cultivated across the study area. Average monthly income of the households in a state is as low as $\$ \leq 422$,[1] while few also have the income above $ 2535. Generally, the average household size in fringe villages is larger than the State average. Average monthly household income at state level ranges between $ 46 to 297.

The species regeneration is adequate in A & N, Meghalaya, and Karnataka fringe forests while it is inadequate in Arunachal, Assam, Kerala, Mizoram, Punjab, Rajasthan, Tripura, Uttar Pradesh (UP), and West Bengal (WB). Generally, arid to semi-arid states have inadequate regeneration. Only Arunachal and Assam are an exception. This is also true for Shannon's Index of plant diversity. Highest index value was noticed in A&N (4.5) while Maharashtra had the lowest value of 0.79 (Fig. 16.8).

It was observed that in the majority of the state forests serve as the major source of livelihood to the fringe communities in the form of fuelwood, fodder and NWFP. Fringe forests also act as a guard to the inner core of the forests and the majority of the activities of the fringe communities is restricted to these fringe areas for their daily basic requirement. Hence, the significance of the fringe forests has emerged as the top priority for managing forests to meet the goals of sustainable development. This demands an early intervention to manage the fringes (both fringe forests as well as forest fringe communities) through the application of site-specific way-out that fulfils the goals of sustainability.

[1]Conversion done from INR (₹) to US $ considering 1 US $ = 71 INR

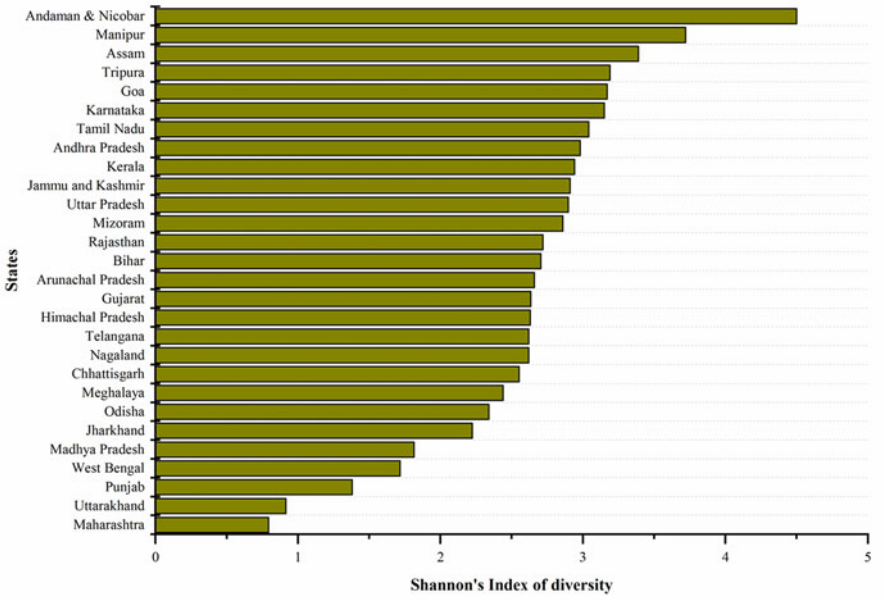

Fig. 16.8 Shannon's index of diversity in the fringe forests of different States

16.5 Conclusions and the Way Forward

Looking at the present need to develop appropriate management strategies for reducing extraction pressure posed on the forests by fringe communities, the present study provides ample scope to formulate viable options to safeguard and improve the fringes. The study is expected to help in developing strategies to check the unsustainable resource extraction from the fringe forests. The findings suggest that there is an urgent need to manage the fringes to fulfil the goals of sustainability. The areas where the sign of degradation is quite evident require immediate attention. The areas where gaps in tree density are visible and the vegetation has deteriorated, planting activity with an active involvement of local people could be taken up to fulfil the gaps. The planting should invariably use local plant species. The present case study provides a baseline in the country to prioritise site-specific interventions, although there can be multiple strategies for improving the ecological status of forest fringes. However, considering the pressure emerging mainly as fuelwood and fodder extraction, agroforestry can play a significant role. This will not only reduce the pressure on forests but also augment the livelihood of the fringe communities by providing the additional source of income.

Agroforestry is a land use practice which involves the combination of trees with agricultural production systems with social, economic and environmental benefits. Agroforestry term can be used for any part of the land, whereas, "Rainfed Agroforestry" may be referred exclusively for those specific agroforestry models

which can successfully be implemented in rainfed areas and are effective in the management of rainfed areas. Rainfed agroforestry can act as a decisive tool for compatible livestock management, integrated land development, improving the livelihood of communities by increasing income, improving biomass productions, improving regeneration and fetching multiple benefits from the available marginal lands. The development of non-forest areas for their sustainable use would call for regenerating or recreating an integrated and interdependent land management system. Rainfed agroforestry may help in enhancing sustainable livelihood security through the simultaneous production of food, fodder and firewood. Management of trees in synchrony with crops in rainfed areas would decrease the risks associated with stress period through the efficient use of the limited natural resources. Rainfed agroforestry will also help in conserving soil, water, and in providing security against a fast changing climate.

In order to implement agroforestry at country level successfully, dissemination of knowledge and capacity building of people at the various hierarchical levels of implementation involving both the planner as well as executors is imperative. Categorically, the knowledge dissemination and orientation of action can be in the form of:

(a). information related to the identification of suitable sites and models of agroforestry,
(b). testing the applicability of selected models for its implementation on specific sites, and
(c). skill up-gradation of stakeholders through training programmes for the transfer of technologies to implement agroforestry models.

In view of the above facts, there is a considerable scope for managing the forest fringes in the country for meeting the sustainable development goals. There is an urgent need for advocating land use diversification and crop intensification in identified selected areas having various levels of natural resources and livelihood support. Fringes may require a combination of natural resource protection and livelihood support systems that are not heavily dependent on water. Authorities may plan to provide support services in the form of improved technology, innovations, infrastructure support, capacity building, credit, institutional linkages, knowledge dissemination, forward and backward linkages with concerned agencies, etc. The packaging of technologies is the need of the hour while the pragmatic approach for wider acceptability needs to be explored for successful implementation of proposed activities in the prioritized fringe areas. As solutions to rural fringe community problems become increasingly sophisticated with every passing day; the institutional and management models including the external support agencies have to evolve and adapt site-specific interventions and policies to abstain from any significant loss to communities as well as forests.

Acknowledgements The authors sincerely acknowledge the financial support provided by National Rainfed Area Authority (NRAA), Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi for the study. Sincere thanks are also due to Directors and

Nodal Officers of the participating ICFRE institutes for their support in field data collection. Support of all individuals and agencies like Forest Survey of India and Survey of India is also gratefully acknowledged.

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