doi:10.20896/yea0yh60

RESEARCH OPEN ACCESS

Harmonising Conservation and Livelihood: Sustainable Practices for Non-Timber Forest Produce in the Vidarbha Tiger Landscape, India

Manisha Ashraf,[†*] Sukanya Sharma,[¥] and Anil Kumar Nair[ì]

Abstract

In the fringe villages of a Protected Area for wildlife, the livelihood pattern is sometimes an issue of contestation. There is apprehension that Protected Area laws undermined people's livelihood and traditional access to forests. For a win-win situation to be achieved, wherein both the forest and local people attain ecological and social security, the study has discussed sustainable extraction and value-added practices for commonly collected Non-Timber Forest Produce, such as *Madhuca longifolia*, *Syzygium cumini*, and *Aegle marmelos*. Based on interviews and observation methods in three forest ranges of the Nawegaon Nagzira Tiger Reserve, a part of the Vidarbha Tiger landscape in Maharashtra, India, the skills and livelihood assets owned by the local community were assessed. The study suggests more frequent capacity-building training and encourages the plantation of commercially valuable natural resources in village common areas and residential backyards. There is enormous scope to guide the community towards an organised marketing system, indigenous technologies, institutional support in training and skill development, and appropriate extension and communication networks, as well as exploring natural resources-based livelihoods without venturing too far into the forest.

Keywords: Protected Areas; Non-Timber Forest Produce; Livelihood; Self-Help Group; Tiger; Community; Nawegaon Nagzira Tiger Reserve; Vidarbha Tiger Landscape; Sustainable Practices; India

[†] Centre for Indian Knowledge Systems, Indian Institute of Technology, Guwahati, Assam 781039, India
[*]Corresponding Author Email: a.manisha@iitg.ac.in
[¥] Department of Humanities and Social Sciences, Indian Institute of Technology Guwahati, Assam 781039, India
[ì] Wildlife Trust of India, Noida, Uttar Pradesh 201301, India

Introduction

The benefits and costs experienced by fringe communities due to the influence of Protected Areas shape their perception of forest conservation. Local people often have limited access to livelihood assets due to wildlife protection laws and regulations, as well as the lack of proper pricing mechanisms and marketing channels for natural resources. These have been an issue for communities residing near Protected Areas like Jaldapara National Park, West Bengal (Lepcha et al., 2019) and Tadoba-Andhari Tiger Reserve in Chandrapur District of Maharashtra where unsustainable method of Tendu (*Diospyros melanoxylon*) collection and lack of alternative livelihood options is not only degrading the forest ecosystem but also increasing the threats of attack by Tigers (Choudhari, 2025). Over 1.6 billion people worldwide, particularly in tropical nations, depend on forests to varying degrees for their livelihoods, and some 0.35 billion people who live on the fringes or inside dense forests rely only on natural resources for their primary source of income and food (Kumar & Choudhury, 2016; Saha, 2021). Non-Timber Forest Products (hereafter NTFP) are biologically derived products other than timber collected from natural, artificially altered or managed forestry areas. It is a form of provisioning service within the ecosystem, which includes vegetables, fruits, nuts, resins, gums, medicinal plants, grasses, seeds, leaves, essences, bamboo, rattans, fibres, flosses, mushrooms, honey, and lac, among others (Pandey et al., 2016). Mostly collected, processed, and traded by women, NTFPs also cater to various needs, such as those for fibre, fodder, medicine, religious, ornamental, and aesthetic purposes (Thapa & Singh, 2021; Vidhyarthi & Gupta, 2002). The gathering and sale of NTFPs are customary and cultural practices across multiple regions. Especially for those residing in relatively isolated locations, such as the hill district of Gumla in Jharkhand, India, where people have historically relied on nearby forest resources due to their greater accessibility and affordability. In most cases, people are unaware of the high market value of natural products. Verma et al. (2019) found that among the NTFPs collected in Jharkhand, the percentage household income contribution was highest from mahua (*Madhuca longifolia)*, that is, 36%, followed by kendu leaves (*Diospyros melanoxylon*) (12%), amla (*Emblica officinalis*) (12%), rugra (a mushroom in the family Geastraceae) (3%), and satwaar zaar (*Asparagus racemosus*) (1%), respectively. Drawing on research into the extraction of NTFPs and their impact on the rural economy in Gondia district, Maharashtra, India, it has been found that NTFPs are the most significant alternative source of income after agriculture (Maske et al., 2011; Nair et al., 2021). Rural off-farm activities, including NTFPs, are usually small-scale, demand minimal initial investment, and can be done from home. Due to this, NTFP-based income has the potential to play a significant role in enhancing the economies of developing countries. Moreover, they represent a viable strategy for mitigating the impacts of climate change-induced shocks (Haggblade, 2007; Leary & Kulkarni, 2007; Yaro, 2013). Based on a study conducted in rural Africa, Barrett et al. (2001) opine that the diversification of income-generating opportunities may occur either as an intentional household plan or as an involuntary response to the predicament; it can serve as a pressure relief valve for the impoverished in rural places as well as a means of accumulation for the wealthy in those areas. Gubbi & MacMillan (2008) in the Periyar Tiger Reserve of southern India revealed that 82% of collectors did not wish to continue harvesting NTFPs if alternative livelihoods from farming could be provided, and none of them desired their offspring to pursue careers as NTFP collectors. It is estimated that 275 million rural people in India depend on NTFPs as a part of their subsistence and cash livelihoods (Pandey et al., 2016). However, the majority of the time, human activity on NTFPs for livelihood gains has come at a certain environmental toll; for example, Kaul et al. (2004) provide a hint of the proximity between NTFP collection and poaching. More applied research is needed to clarify the

biological extraction thresholds, sustainable extraction practices, optimal harvesting time for different species and cultivation and marketing of NTFPs. This is especially important in reference to the ecological and economic sustainability of the 19 NTFP species (*Enicosanthus accuminata, Ochlandra stridula, Garcinia quaesita, Doona venulosa, Hopea discolor, Hopea jucunda, Shorea congestiflora , Cinnamomum multiflora, Cinnamomum verum , Coscinium feneatratum, Calamus digitatus, Pandanus ceylanicus, Calamus pseudotenuis , Calamus radiatus, Calamus thwaitesii, Caryota urens* and *Calamus ovoides*) extractions in Sri Lankan southwestern lowland tropical rain forests (Ekanayake et al., 2005). Melese (2016) rightly mentions that in the discourse of sustainable development, the relevance of social justice, poverty alleviation and environmental sustainability is called into question. Therefore, a holistic approach that fits in sustainable collection, skill development, and improved market linkages is essential to balance forest conservation with poverty alleviation and enhance rural resilience, especially in regions that are dependent on forests. As a result, to improve livelihood efforts for any of these communities, interventions must start with sustainable collection practices and be followed by a detailed comprehension of the varieties, quantities, availability, processing, repository and marketing links of the NTFPs (Kumar & Choudhury, 2016). Strategies for sustainable livelihoods are typically adaptive reactions to shifts in six important interrelated components: the biophysical factors including resource depletion, environmental changes and constraints; the political/legal factors include the effects of recent legislations and the advancement of governmental ideals; the economic factors include apparent requirements and opportunities; the social factors include interactions or well-being; the cultural factors include modification to traditional rituals and convictions; and the psychological factors include stress and future outlook (Walker et al., 2001).

Most of the studies discussed above focus on the distribution, collection, sale, and value addition of NTFPs in the Central and Eastern regions of India. Nawegaon Nagzira Tiger Reserve (hereafter NNTR) in Maharashtra, India, is surrounded by villages with visible anthropogenic dependency. For inclusive forest management vis-à-vis community development, the current study first highlights the need and techniques for sustainable collection of some commonly collected NTFPs. Secondly, the scope of value addition and requirements for strengthening the human capital and financial resource base. The study unfolds how Wildlife Trust of India's (hereafter WTI) intervention from 2017 to 2020 under the IUCN's (International Union for Conservation of Nature) project titled, 'Integrated Tiger Habitat Conservation Programme' have helped the local communities to decide on improving NTFP collection techniques and do value addition on specific resources for supplementing their livelihood. WTI is a conservation organisation formed in 1998 in India, dedicated to conserving wildlife and its habitat in partnership with communities and governments.

The paper opens with an Introduction that positions the study in the conservation–livelihood debate, emphasising the importance of NTFPs for rural households around Protected Areas. The conceptual framework draws on the Sustainable Livelihood Approach, a widely used framework for understanding how livelihood assets interact with institutions and vulnerabilities to shape livelihood outcomes. A group of trained respondents, selected through purposive sampling, was studied to examine the collection, processing, and marketing of NTFPs. The results and discussion section discusses the concerns over access restrictions imposed by Protected Area regulations. Findings highlight the potential of training for sustainable collection (e.g., mahua harvesting), value addition (such as juices, powders, and condiments), and basic infrastructure to reduce unsustainable practices. The Conclusion argues that NTFP-based enterprises can balance conservation and livelihoods if aided by training, cooperatives, and reliable market linkages.

Conceptual Framework

To stabilise long-term cooperation in conservation with the local community, the study has adhered to the Sustainable Livelihood Approach (hereafter SLA) (DFID, 1999). With this method, we can examine closely how individuals associate with institutions and resources to create a way of life, particularly considering the patterns of change. It uses the concept of five capital assets that is, natural (natural resource stocks, example, land, water, wild flora and fauna, biological diversity, and environmental resources), human (example, skills, knowledge, capacity for work and good health), social (example, networks, membership in groups, social relations, and access to wider institutions in society as safety net mechanisms to meet deficits in consumption needs), physical (basic infrastructure, example, transport, shelter, energy, communications, and water systems) and financial (effective resources and stores, example, savings, credit, remittances, pensions, etc.), that may result in an output flow and then potentially be depleted or it may accumulate as an excess to be used as capital for more productive endeavours in the future (Carney, 1998 as cited in Elasha et al.,2005). SLA highlights the consideration of the 'vulnerability context' that can jeopardise the livelihood outcome influenced by different factors, such as access to assets, trends (that is, economic trends) and shocks (illness, disease, floods and drought), stress (seasonal shortage, rising population or declining resource) as well as social factors such as policies, institutions and process (Frankenberger et al., 2000; Habib et al., 2021).

Methods

Study Area

With about 331 tigers living there, the eastern Vidarbha region serves as a link between Central and Southern India. These tigers are found in eight wildlife divisions or Protected Area, but they are dispersed throughout a sea of environments that humans dominate (Habib et al., 2021). Vidarbha Tiger landscape, which consists of Nagzira and New Nagzira Wildlife Sanctuary, Nawegaon National Park, Nawegaon Wildlife Sanctuary, Koka Wildlife Sanctuary, Umred-Pauni-Karhandla Wildlife Sanctuary, Mansingh-Deo Wildlife Sanctuary, Pench Tiger Reserve and Tadoba Tiger Reserve in Maharashtra, shares important links with both sink and source populations outside the state of Maharashtra, with Chhattisgarh, Madhya Pradesh, as well as southwards with the state of Andhra Pradesh and Telangana (Jhala et al., 2011; Qureshi et al., 2014). NNTR consists of five Protected Areas: Nagzira Wildlife Sanctuary, New Nagzira Wildlife Sanctuary, Nawegaon National Park, Nawegaon Wildlife Sanctuary and Koka Wildlife Sanctuary (Nair et al., 2021; NNTR Official, 2023).The buffer zone of NNTR encompasses 186 villages across Gondia and Bhandara districts in eastern Vidarbha of Maharashtra. The buffer zone was notified on 7th September 2016 with an area of 1241.27 sq. km, which includes 648.68 sq. km of forest and 592.59 sq. km as revenue (non-forest) area (Pinjarkar, 2019). The purpose of the notification is to ensure that the critical tiger habitat or core has sufficient area for the dispersal of tigers and other species, as well as supporting co-existence between wildlife and humans (Singh, 2016).

NNTR is formed with contiguous forest cover in between, which facilitates physical connectivity identified as the NNTR corridor. Today, the challenge is to bring the peripheral areas under the buffer zone by addressing the people-oriented agenda, like mitigation of human-wildlife conflicts, eco-development and livelihood options by fine-tuning the ongoing forestry practices (National Tiger Conservation Authority, 2014). Two major roads, National Highway 6 and State Highway 26, dissect the NNTR corridor.

Data Collection and Analysis

Since the data collection process was largely dependent on community insights, we applied Participatory Rural Appraisal (PRA) techniques such as semi-structured interviews, walks with key informants (hereafter KI), direct observation and seasonal diagrams (Jakson & Ingles, 1988). We evaluated the general socio-economic context of the respondents by asking about their age, gender, level of education and source of

income. The formulation of questions was informed by insights gained through participant observation and key informant interviews with community resource persons. The survey instrument evaluated the following aspects (Table 1).

The responses from semi-structured interviews were interpreted using simple descriptive statistics in MS Excel 2016. The use of PRA tools provided insights into local knowledge, practices, and lived experiences related to forest-based livelihoods. These qualitative methods are complemented by quantitative analysis through the Livelihood Vulnerability Index (hereafter LVI), which allows for a structured assessment of risks and resilience associated with NTFP collection. By integrating both qualitative and quantitative data sources, as illustrated in Figure 1, methodological triangulation enhances the validity and reliability of the findings, reduces bias, and facilitates an understanding of how local communities interact with forest ecosystems across spatial and temporal scales (Creswell, 2003).

Table 1: Aspects Evaluated During Semi-Structured Interviews

NTFP dependency	Aspects evaluated	Questions
Usage of NTFPs before the sustainable harvesting and value addition training	**Rate, quantity and process of marketing the NTFP**	• **Which part of the plant is extracted?** • **What tools and techniques are involved in extraction?** • **What is the rate per kilogram?** • **What are the challenges faced during the NTFP extraction?**
Engagement in farm and off-activity	**Sowing, growing and harvesting period for the selected cash crop and the engagement period in wage labour activity**	• **Which cash crop is cultivated in your area?** • **What are the months of sowing, the typical growth period, and the time of harvest?** • **Mention during which months are you engaged in wage labour activity like major NTFP collection, cotton and soyabean harvesting, construction labour, MGNREGA, etc.**
Access to livelihood capitals	**Based on five capitals under SLA, access and possession of livelihood skills and capitals: Human, Social, Physical, Natural and Financial**	• **Do you have space to grow valuable plant species?** • **Do you own any form of large cauldron, stirring spoon, etc?** • **Are you affiliated with SHG or any community-level institutions?** • **Do you have prior experience in food processing and value addition?** • **Do you practice a monthly savings plan?**
Insights gained from the training	**Awareness and new techniques learnt during the training**	• **Were you aware of this NTFP's market value pre-training?** • **Is it easy or difficult to adopt?** • **From which location do you usually extract/collect the NTFP? Forest/ crop field/ residential premises/ common area**
Value-added products	**Saleable edible items and their benefits to health**	• **List the benefits of each item based on your traditional knowledge** • **Does this item have significance in your culture?**
Vulnerability context	**Vulnerable factors of NTFP collection and livelihood**	• **Specify which factor is leading to a problem in your collection of NTFP. Resource depletion/ Protected Area laws/ Negative interaction with wildlife/ Limited value addition knowledge/ Market access/ Price fluctuation?**

Source Primary Data Collected through Semi-Structured Interviews

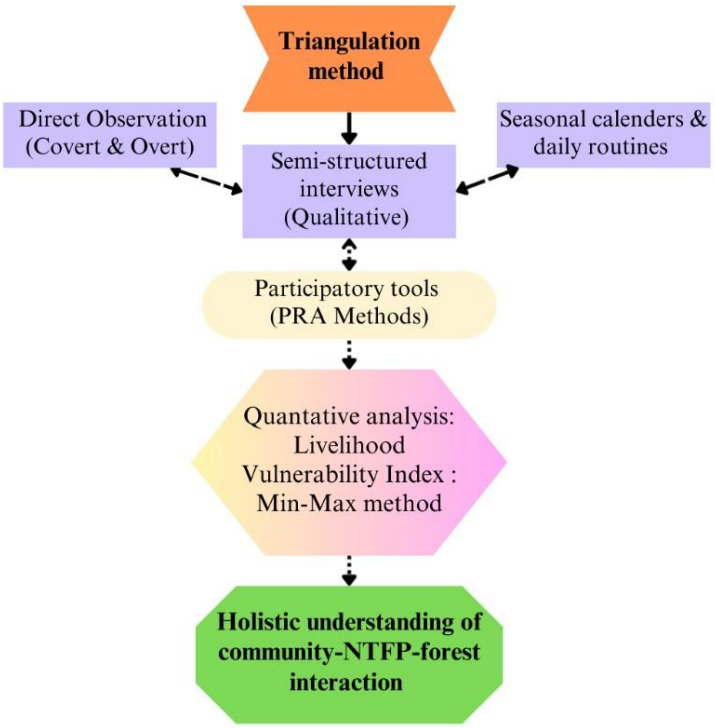


Figure 1: Methodological Triangulation Method Adopted in the Study
Source: Authors' Own Compilation Based on Creswell (2003)

For calculating the LVI related to NTFP collection, the current study has generated a vulnerability livelihood diagram, similar to the one by Hahn et al. (2009) to assess risks from climate variability and change in Mozambique in Africa. This study outlines the methodology for calculating the Livelihood Vulnerability by normalisation of indicators using the minimum-maximum method, aggregation of normalised scores, and the final calculation of the LVI. Once the indicators are identified, the next step is to normalise each indicator using the minimum-maximum method to ensure comparability across different units and scales. The normalised value for each indicator was calculated using the formula:

$$Index_i = \frac{X_i - X_{min}}{X_{max} - X_{min}}$$

Where,
X_i= observed value of the indicator for a given area
X_{min} and X_{max} = minimum and maximum values of that indicator across all study units
This transformation scales all indicator values between 0 and 1. Now, normalised indicators are aggregated by computing the average value of indicators within each component to derive a component score. This provides a composite view of vulnerability under each component/indicator. Finally, the LVI is calculated by taking the average of all component scores, using the formula:

$$LVI = \frac{\sum_{j=1}^{n} Component\ Score_j}{n}$$

where,
n = total number of components considered in the analysis
j = each individual major component used to compute the LVI
Component Score$_j$ = standardised score for each major component(j)

The resulting LVI value lies between 0 and 1, where values closer to 1 represent higher vulnerability. By quantifying vulnerability, stakeholders can help prioritise areas for targeted interventions and policy planning.

The need for this training in this landscape evolved through observation of the daily activities of people and their interaction with the forest at different time (season) scales. This resulted in the development of crop seasonal calendars and non-farm employment routines. Most of the time, we conducted opportunistic observation (covert) while gathering information as we passed through the NNTR corridor villages. Some observations were made through knowledge of those being observed (overt) as we joined them as members of their group while entering the forest and crop field to extract NTFPs. The respondents were selected from a list of 196 trainees of sustainable collection and value addition of NTFP across nine villages in three forest ranges: Deori, Sadak Arjuni and Goregaon (Figure 2).

Out of 196 trainees in the training, 50 respondents were selected using purposive sampling. These 50 individuals were chosen based on their willingness to further their learning from the training. The remaining trainees either did not give consent or were hesitant to participate due to fears related to Protected Area guidelines, potential displacement, or general scepticism. After receiving the verbal willingness of the respondents, the questionnaires were administered in *Marathi* (the native language of the respondents) with the aid of three field staff who were cognisant of conservation issues. Each interview took 30-45 minutes. A few responses from the Key Interviews are directly quoted.

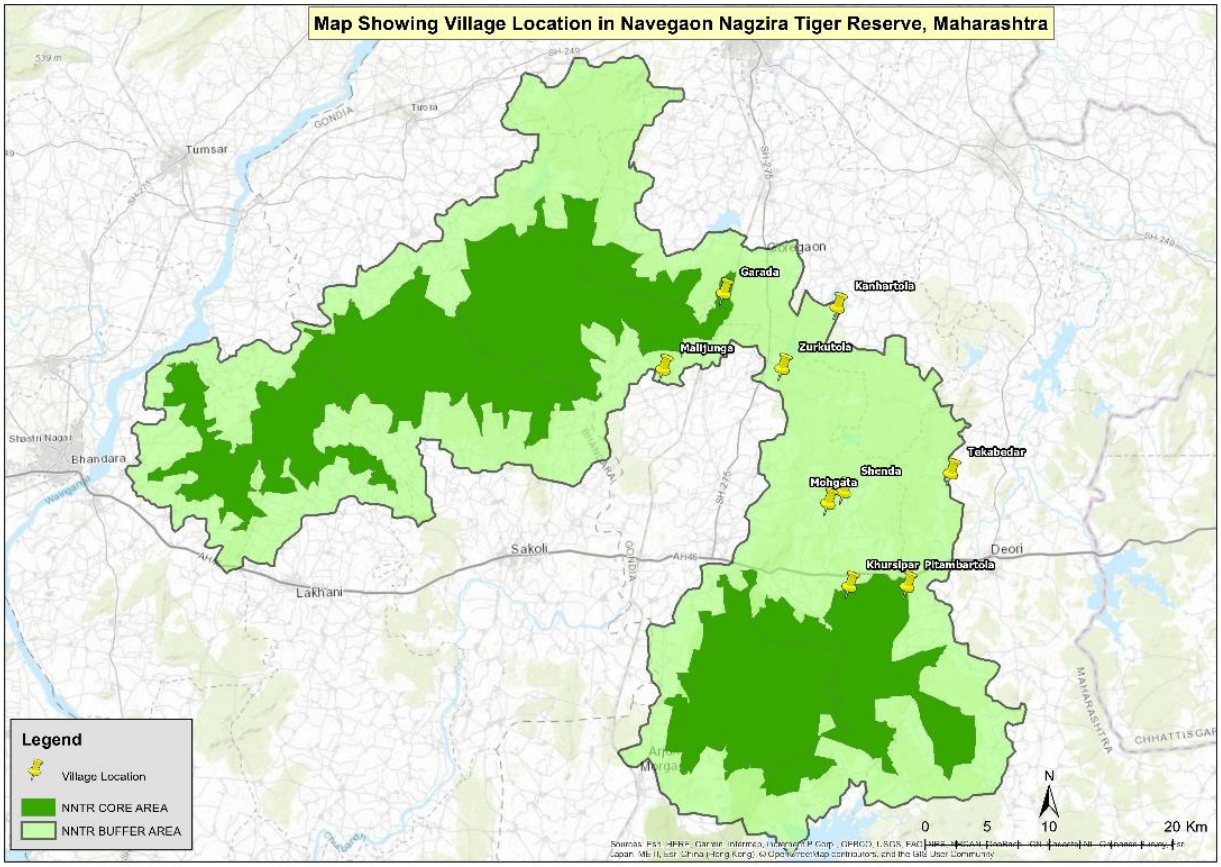


Figure 2: Forest Connectivity and the Location of the Study Villages in the NNTR Corridor
Source: Authors' Own

Results and Discussion

Socio-Economic Scenario

The data indicates that the average age of the respondents is 35. The average household size is 5, which is slightly higher than the average Indian household size of 4.44 people in 2021(Global Data, 2022) . Table 2 presents the total population in the nine study villages as 1,372 across 6,153 households. The land size of the study villages ranged from 60 hectares (Pitambartola village) to 844.5 hectares (Garada village).

Table 2: Household Population, Human Population and Land Area of Study Villages

Serial No	Village	Household#	Population#	Area*
1	Garada	53	224	844.5 hectares
2	Shenda	510	2415	349.99 hectares
3	Zurkutola	100	455	65 hectares
4	Malijunga	218	894	641.65 hectares
5	Pitambartola	75	375	60 hectares
6	Kanhartola	60	245	62.83 hectares
7	Mohghata	71	328	232.51 hectares
8	Tekabedar	188	787	307.98 hectares
9	Khursipar	97	430	879 hectares

Sources: # https://censusindia.gov.in/ (as per Census Data of 2011) and the *Gram Panchayat*
https://villageinfo.in/ and the *Gram Panchayat

Among the respondents, 70% are female and 30% are male. Only 10% of the houses have concrete/*pucca* (cemented) structures. Around 50% of the houses are *kutcha* (built using materials such as grass, thatch, bamboo, plastic, polythene, metal, asbestos sheets, and walls made of materials like grass, thatch, bamboo, polythene, mud, burnt brick, and wood), and 40% of the houses are semi-*kutcha*. The average annual income per household (in USD) is 832.3 ± 333.7 (SD). It comprises income from agriculture, livestock rearing, wage labour, the sale of bamboo, *Diospyros melanoxylon*, and *Madhuca longifolia*, as well as businesses such as retailing groceries and garments. Table 3 shows that 26% have completed a higher secondary level of education (classes 11 and 12), followed by 24% who have attained secondary education and 22% who have acquired elementary education. Eighteen per cent of the respondents have not gained any formal education.

Table 3: Level of Education Attained by 50 Respondents (in %)

Level of Education	No. of Respondents (n=50)
No formal education	18 % (n=9)
Elementary Education (Class 1 to 8)	22% (n=11)
Secondary Education (Class 9 & 10)	24% (n=12)
Higher Secondary (Class 11 & 12)	26% (n=13)
Graduation(B.A./B.Sc./B.Com/B.Tech/B.E/BBA or any other equivalent degree)	10% (n=5)
Postgraduation and Above (M.A/M.Sc./M.Com/M.Tech. /MBA or any other professional courses	Nil

Source: Primary Data Collected by the Authors

The Impetus for Livelihood-Based Intervention

A psyche of fear and apprehension was observed, as the age-old interactions of local communities with nearby forests were expected to be dismantled due to the notification of the NNTR buffer zone in 2016. It would impact in mainly three aspects: (i) ban on firewood collection; (ii) ban on major NTFP collections like *Diospyros melanoxylon* and *Madhuca longifolia*; and (iii) introduction of tigers in the forest, with their villages getting fenced and thus prohibiting the community from strolling inside the forest. Citing a similar case from the Sundarban Biosphere Reserve, Sen (2019) argues that by legitimising forested landscapes as 'protected' and inviolate, the survivability of local communities is at risk. Fear related to (i) and (iii) was addressed by WTI through the introduction of improved energy-efficient cook-stoves in selected villages and awareness programmes at school and village levels, respectively. Fear associated with NTFP collection has a direct link to jeopardising livelihoods and socio-cultural values, thus evoking a negative perception towards the forest department and wildlife. These apprehensions triggered the need to create awareness about the improved collection of NTFPs and to navigate avenues for strengthening supplementary forms of livelihood.

Need for Training on Sustainable Collection and Value Addition of Natural Resources

The crop seasonal calendar (Table 4) indicates that the local community is primarily agrarian, engaging in multi-crop cultivation that spans 12 months.

Table 4: Seasonal Crop Calendar

Cash Crops	Sowing Time	Growth Period	Harvesting Time
Rice (autumn)	June-July	August-October	November
Rice (winter)	November-December	January-February	March-April
Sugarcane	February-March	April-October	November-December
Black chickpea	December	January- February	March
Maize	May-June	July-August	September
Banana	October-November, February-March	12-15 months from plantation	-
Chilli	April	May-July	August
Garlic	November	December-February	March
Potato	December	January	February
Turmeric	June-August	September-November	December-March
Roselle (*Hibiscus sabdariffa*)	October	November	December- January
Split pigeon peas	July- August	September-February	March

Sources: PRA tools such as direct observation by the authors during transect walks, village visits and interacting with the community

Migration for seasonal employment was recorded in the form of agricultural and construction labour in nearby districts of Amravati, Nagpur and Chandrapur or work in manufacturing and packaging companies in metro cities. *Madhuca longifolia*, *Cassia tora*, and *Diospyros melanoxylon* are the three natural resources identified for annual collection across the nine villages (Table 5).

We observed that during April and May, the undergrowth is burnt to enhance the visibility of fallen mahua flowers. Ideally, flowering starts in February to April, depending on climatic conditions. The mahua flower's collection period lasts about 20 to 25 days a year. Similarly, for the luxurious growth of *Cassia tora* leaves, undergrowth is burnt, thus contributing to one of the major reasons for forest fires and

sabotaging the herb growth. In a similar situation, Sharma et al. (2022) highlighted the need for sustainable collection practices and value addition of mahua in Odisha to prevent forest fire. Again, golden apple (*Aegle marmelos*), cuddapah almond (*Buchanania lanzan*), Indian blackberry (*Syzigium cumini*), Indian gooseberry (*Phyllanthus emblica*), black- or chebulic myrobalan (*Terminalia chebula*) and bastard myrobalan (*Terminalia bellirica*) are a few NTFPs that receive the fate of their branches being lopped or cut for domestic and commercial purposes.

Table 5: Farm and Non-Farm Employment Routine

		Engagement Period										
Non-farm activity	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Madhuca longifolia collection												
Cassia tora collection												
Diospyros melanoxylon collection												
Wage labour under the Mahatma Gandhi National Rural Employment Guarantee Act 2005												
Cotton harvesting labour (seasonal migration)												
Soybean harvesting labour (seasonal migration)												
Construction labour (seasonal migration)												

Sources: PRA tools such as direct observation by the author done during transect walks, village visits and interacting with the community

To bolster the community's natural and financial capital based on existing resources and skills, off-farm training on sustainable collection and harvesting of natural capital was conducted through the Madhya Pradesh Vigyan *Sabha* (hereafter referred to as MPVS). The value addition of natural resources was taught by another organisation, the Centre for Science for Villages (hereafter, CSV), located in Wardha district, Maharashtra. Established in 1992, MPVS is a National Award-winning NGO, recognised by the National Council for Science and Technology Communication, Department of Science and Technology, Government of India, for its efforts in science popularisation through research and development in natural resource management. CSV began operating in 1976 to develop suitable rural technologies and promote rural off-farm activities, supported by the Department of Science and Technology, Government of India.

Techniques of NTFP Collection

Mahua flowers are a rich source of sugar, which is responsible for their sweet taste and is used to make indigenous or modern alcoholic beverages. The communities are entitled to collect flowers only from specific trees in the forest (except for Protected Areas for wildlife), a tradition that everyone follows. Most people collect between 5 kg and 10 kg of fresh flowers per day, which lasts for 2 to 3 weeks depending on climatic conditions. A key informant in his 60s from a village under the Sadak Arjuni forest range stated:

> Traditionally, we used to clean the ground below the tree canopy with a broom and systematically sprinkle cow dung on the bare ground to prevent dust from accumulating on the fallen flowers. Nowadays, people do not have much time, so the easy technique is to directly burn the undergrowth and make the ground visually clear.

The two-day training in each village practically demonstrated the spread of discarded mosquito nets or sarees beneath the canopy of the mahua tree (Figure 3).

Figure 3: Discarded Cloth Spread Beneath the Canopy of a Mahua Tree
Source: Authors

This would facilitate an environment-friendly, time-efficient, and neat collection, yielding better monetary returns for mahua flowers. Mishra and Poonia (2019) state that the main obstacle to mahua flowers being used as a potential industrial ingredient is post-harvest spoilage caused by improper collection and handling techniques, as well as unhygienic storage conditions. The training reintroduced these collection methods for fruits like *Aegle marmelos*, *Buchanania lanzan*, *Syzigium cumini*, *Phyllanthus emblica*, *Terminalia chebula*, *Terminalia bellirica*, *Ziziphus mauritiana* and drumstick and its leaves (*Moringa oleifera*), etc. An unused plastic bottle was split into two halves. Then a stick was inserted inside the bottle's mouth. Instead of cutting the branch or shaking the tree trunk, the stick was stroked around the fruit, and it was collected directly inside the bottle. Traditionally, this tool is known as '*Sitodi'.*

The adoption of NTFP-based training rightly coincides with the availability of the required skills and assets related to value addition and food processing under the SLA (Table 6). A Community Resource Person (hereafter CRP) from a social development institution, who was also one of our key informants, stated that:

> Until now, mangoes, golden apples, Indian blackberries, and drumsticks have been wasted because people were unaware of their market value after processing. These training courses are

like eye-openers. Without risking their lives to wild animals, local people can now sustainably harvest this product outside the Protected Area and gain some income.

Table 6: Relevant Assets and Capital Endowments Possessed by 50 Trainees of NTFP Sustainable Collection and Value Addition Training

Assets	Indicator	Access to assets
Natural	Access and collection of natural resources	100% (n=50)
	Space for growing turmeric	78% (n=39)
Physical	Community hall	12% (n=6)
	Large utensils	2%(n=1)
	Village connected to the Highway	12%(n=6)
	Spacious residential compound	4%(n=2)
	Personal mode of transportation	12% (n=6)
Financial	Below Poverty Line (hereafter BPL) category	48% (n=24)
	Pensions	0
	Fixed Deposit	0
	Monthly credits	0
Social	Possesses great community mobilising skills	30%(n=15)
	Member of the Joint Forest Management Committee	4%(n=2)
	Considered a 'go-to person' in the community	12%(n=6)
	Shares strong communication among the Self-Help Group (hereafter SHG) members	50% (n=25)
Human	Possess culinary skills at home	74% (n=37)

Source: Primary Data Collected through Semi-Structured Interviews

It was recorded that all respondents have access to natural resources, including those from crop fields and forests. Respondents did not want to reveal whether they produce liquor from mahua flowers. Currently, they sun-dry the flowers and sell them at the village market. It was later exported for various purposes, including country liquor due to its restricted availability at limited locations for a short period, as well as vanguard technologies for the creation of numerous valuable food products (Chacko & Narvekar, 2023). Table 7 shows that the respondents collected only seven natural resources before the training was imparted. It was recorded that 78% of respondents own space for growing turmeric at their house. However, there was no record of processing the turmeric into powder form and selling it for supplementary income. Only 2% of respondents own large utensils with a capacity for cooking for over 30 people. This indicated material support required in the form of a large cauldron, stirring spoon, etc. In terms of easy transportation, only 12% of the population owns motorised transport, and villages are well connected to Highway 6.

It was recorded that 4% of respondents have large residential compounds where 10-15 people can gather for collective food processing and manual packaging. Around 48% of respondents fall under the Below Poverty Line (income is less than INR 6,400 per month in rural areas). We did not record any respondents who had fixed deposits, were pension holders, had salaried jobs, or had definite businesses with monthly credit. Social capital was recorded as being strongest among 30% of respondents who occupied positions as CRP and coordinators of social development institutions/missions, such

as the Maharashtra State Rural Livelihoods Mission (hereafter MSRLM) and the Maharashtra *Arthik Vikas Mahamandal* (hereafter MAVIM). These individuals had a positive influence that also brought mobilising skills. Around 4% of respondents are members of the Joint Forest Management Committee, which serves as a bridge between the forest department and the community, and typically takes a leading role in conservation-related activities. While 50% of respondents reported having strong communication and trust among their SHG members, this was also validated through direct observation over a three-year period. Through a similar method, we affirmed that 12% of respondents are considered a 'go-to person' in the community due to their helpful and amicable nature. More than half of the respondents, that is, 74%, possess culinary skills at home, such as pickles, juices, jam, and various condiments. None was recorded to be involved in manufacturing these items for commercial purposes.

Table 7: Usage of Accessible Natural Resources by 50 Respondents Pre-training

S.no	Natural resources (Scientific name)	English name	Commercial use
1	*Madhuca longifolia*	Indian butter tree/Mahua	Dried flower is sold at USD 0.19-0.23 per kg
2	*Diospyros melanoxylon*	East Indian ebony	Dried leaves are sold for USD 2.04-2.84 per kg for preparing *beedi* (a thin cigarette)
3	*Buchanania lanzan*	Cuddapah almond	Leaves used for making plates USD 0.23-0.47 for 100 plates
4	*Phyllanthus emblica*	Indian gooseberry	Fruit sold at USD 0.23-0.35 per kg
5	*Butea monosperma*	Flame of the forest	Leaves are stitched into plates to be used during festivals/weddings USD 0.23 -0.47 for 100 Plates
6	*Ziziphus mauritiana*	Indian jujube	USD 0.11-0.23 per kg
7	*Cassia tora*	Sickle senna/Coffee pod	Seeds are sold at no fixed rate

Source: Primary Data Collected through Semi-Structured Interviews

Value Addition of Selected NTFPs

During training in CSV, Wardha, on value addition, the trainees decided to adopt sustainable harvesting and value addition of 15 available resources (Table 8).

Table 9 lists 15 value-added products for commercial purposes that were taught during the training. Traditionally, people used to make mahua syrup, but none of the respondents reported preparing it now. Similarly, a key informant from the Goregaon range mentioned:

> Earlier in the summer, we would often drink golden apple juice after school. But natural juice has been gradually replaced by packaged drinks available on the market.

It is interesting to note that value addition of dried sponge gourd (Figure 4) and cultivating fenugreek seeds by a few respondents was done voluntarily post-training. Gubbi & MacMillan

(2008) argued that obstacles to a prosperous NTFP-based livelihood included a lack of resources for processing, storing, and marketing their produce, and poorly developed skills.

Table 8: Natural Products Selected by 50 Trainees for Value Addition

S.no	Natural Resources	Aware of its Market Potential Pre-training	Collection Locations*				Taught Collection Techniques
			A	F	R	C	
1	*Madhuca longifolia*	Yes	■	■			Spreading a *saree* beneath the tree
2	*Aegle marmelos*	No	■	■	■	■	Stick with a sharp knife tied on its tip
3	*Andrographis paniculate*	No		■	■		Plucked from its stem
4	*Buchanania lanzan*	Yes		■			Stick with a sharp knife tied on its tip
5	*Syzigium cumini*	No	■	■	■	■	Stick with a sharp knife tied on its tip
6	*Terminalia bellirica*	No		■			Picked up from the ground
7	*Luffa aegyptiaca*	No			■	■	Dried ones are plucked
8	*Cassia tora*	Yes		■		■	Stems are cut with sharp knife
9	*Mangifera Indica*	No		■	■	■	Plucked with '*Sitodi*'
10	*Curcuma longa*	No			■		Deliberately grow without chemical fertiliser
11	*Moringa oleifera*	No		■			Stick with a sharp knife tied on its tip
12	*Hibiscus sabdariffa*	No	■		■	■	The plant is uprooted (traditional technique)
13	*Luffa aegyptiaca*	Yes	■	■	■	■	Stick with a sharp knife tied on its tip
14	*Tamarindus indica*	No	■	■	■	■	Stick with a sharp knife tied on its tip
15	*Terminalia chebula*	No		■			Picked up from the ground

***A: Agriculture Field, F: Forest, R: Residential Compound, C: Common Area**
Source: Primary Data Collected through Semi-Structured Interviews

Apart from handholding in the collection and processing of natural resources, the seriousness of meeting statutory requirements was facilitated by WTI through the Food Safety and Standards Authority of India (FSSAI) license. Respondents representing four SHGs, namely *Maa Gayatri* SHG (Garada village), *Birsa Munda* SHG (Shenda village), *Jai Maa Durga* SHG (Zurku

tola village) and *Malabai Jungadada* SHG (Malijunga village) and four individual male respondents from Pitambar tola, Kanhar tola, Mohghata and Tekabedar villages obtained FSSAI license for the sale of products. Storage food-grade containers of 20 Litre capacity, glass jars (Figure 5), a hand-sealing machine for plastic pouches, and an induction sealing machine for jars were provided as seed capital.

Table 9: Value-Added Products and Their Use for Commercial Purposes

S.no	Natural Resources	Trained Edible Products	Value/Usage
1	*Madhuca longifolia*	Squash (concentrated syrup), pickle, *Raab* (a traditional spread)	*Raab* is given during post-natal care for increasing hemoglobin in body
2	*Aegle marmelos*	Squash, powder	Useful for bowel movement and microbial infection
3	*Andrographs paniculata*	Dried and crushed	Helpful for cough, cold, sinusitis and body pain
4	*Buchanania lanzan*	The cover is peeled off to obtain the fruit	Consumed as a dry fruit
5	*Syzygium cumini*	Vinegar, seed powder	Beneficial for bronchitis and diabetes
6	*Terminalia bellirica*	Powder	One of the major components of *Triphala* (an ayurvedic antioxidant-rich preparation for digestion)
7	*Luffa aegyptiaca*	Seeds are removed & used as a body scrubber	Natural body scrubber
8	*Cassia tora*	Dried and grinded	Can be used as a tea/coffee powder
9	*Mangifera indica*	Pickle and ground powder (*amchur* in *Hindi* language)	Amchur (ground powder for increasing sourness and tangy flavour)
10	Fenugreek leaves	Dried and crushed	Garnishing spice in the form of *Kasuri methi*, popularly used in Indian dishes
11	Turmeric	Dried and grinded	Spice
12	Drumstick	Leaves are sun-dried and ground or crushed	Garnishing spice for strengthening immune system
13	*Hibiscus sabdariffa*	Squash	Refreshing drink during summer and helps in digestion
14	*Phyllanthus emblica*	Dried and ground or crushed	Excellent source of vitamin C. Can be applied in hair and an ingredient of *Triphala*
15	*Terminalia chebula*	Powder	One of the major components of *Triphala*

Source: Primary Data Collected through Semi-Structured Interviews

Figure 4: Natural Body Scrubber Made of Dried Sponge Gourd
Source: Authors

Figure 5: Packaging of Products
Source: Authors

Navigating the Three-Tier Marketing Strategy

While Shahabuddin & Prasad (2004) have rightly pointed out that the encouragement of NTFP collection from Protected Areas could also have substantial negative impacts on tigers and other threatened species, Rai & Uhl (2004) expose the fact that, along with the ecological effects of harvest, there is inconsistent economic output. According to the respondents, the apathy in leveraging the value addition of available natural capital is related to its transportation, price

fixing by small traders, and inadequate processing and storage facilities. Respondents opined that the sale of the above products should initially be limited to the village level, similar to the rural women in Southwestern Nigeria who sell in informal local markets, roadside, or door-to-door channels (Ekanayake et al., 2005). Opportunistic sales are conducted during annual village festivals and institutional events, such as *Mandaai*, weekly markets, *Gram Sabhas*, and school committee meetings. Additionally, training is provided to other interested SHG members from different villages and to other groups upon request by NGOs (Figure 6). Serving both as a selling and purchasing centre for the producer and consumers, a micro-enterprise under the name '*Nisarg* store' in the Goregaon administrative block was established by WTI under the leadership of two trainees. *Vandhan Jhandhan* shops, operated under the Maharashtra Forest Department in cities such as Nagpur and Mumbai, serve as central sales points for these products.

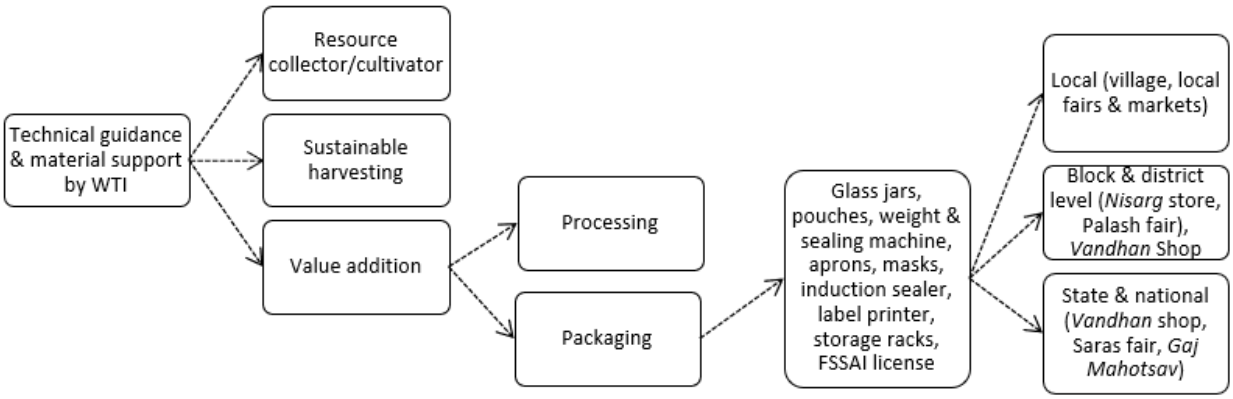


Figure 6: Flow Chart Depicting the Process from Raw Material Collection to Three-Tier Marketing Stages
Source: Compiled from Primary Data Collected by the Authors

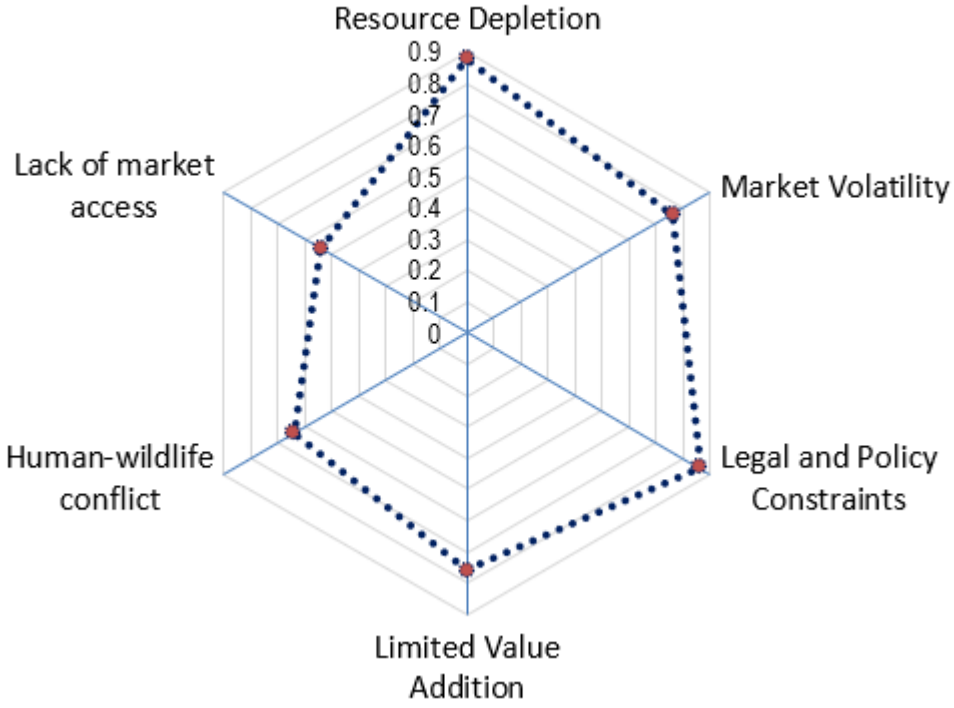
Assessing the Vulnerability Context

The major vulnerability components presented in Figure 7 provide information that resource depletion and changes in climatic patterns pose a threat to NTFP-based livelihood. More than 80% of the respondents opined that their natural capital-based livelihood might be impacted by drought and famine, leading to resource decline. For instance, a study conducted in 2023 by Magry et al. revealed that an increase in maximum temperature in Khunti district of Jharkhand in India has decreased lac (*Kerria lacca*) yield significantly by 31.60 tonnes/year. With the notification of the NNTR buffer in 2016, the constant fear of patrolling by the forest department and displacement contributes to LVI at 0.86. All respondents expressed a strong fear of mobility restrictions due to the potential activation of Protected Area laws at any time. A key informant from the Deori forest range explained:

> The mahua collection from the forest is an integral part of culture and lifestyle. With the notification of the NNTR buffer, our livelihood will be significantly affected, as we are deeply concerned that our traditional access rights will be curtailed without consultation and alternative arrangements.

NTFP prices often fluctuate in local and global markets, making income uncertain for harvesters. In recent years, the cost of lac has dropped from USD 4.1 to USD 1.7/kg, that of mahua from USD 0.26 to USD 0.23/kg, and that of tamarind from USD 0.26 to USD 0.21/kg. Although no wild animal attacks were recorded,

respondents formed groups to prevent harmful interactions with wildlife (LVI: 0.64). Remote forest communities often lack access to larger markets, forcing them to sell NTFPs at lower prices to middlemen, limiting their income potential. A fear among 66% of respondents could be attributed to the potential for establishing companies for resource extraction and the mechanical processing of country liquor and pickles. A meagre section of the respondents, that is, 24% feared political unrest that could lead to civic war and curb human mobility. Just like Walker et al. (2001), the current study, which documents the historical evolution and emerging patterns of livelihood strategies for the successful implementation of community-based environmental planning in Molas village near Bunaken National Park, Indonesia, opens the avenue for decision-making aptitudes among the local people through these trainings.



***0=Least vulnerable**
0.5=Most vulnerable
Figure 7: Vulnerability Spider Diagram of the Major Components of the Livelihood Vulnerability Index for NTFP-based Livelihood
Source: Authors' Own Analysis Based on Primary Data

Conclusion

The training did not introduce the collection of some alien species or preparation of some exotic dishes, but only reintroduced the traditional techniques which, with time, have been eroded. It is highly recommended that the monetisation of forest resources as a conservation strategy in Protected Area should be carefully done by addressing harmful practices such as burning and excessive timber-cutting (Saha, 2002). Similar to WTI's approach as discussed in the current study site, Kumar and Choudhury (2016) and Verma et al. (2019) mention interventions of government, NGOs and corporations through various schemes and programmes for bringing a change in terms of the various practices related to NTFP collection and livelihood enhancement among the forest and fringe dwellers in Bero block of Ranchi and Thethaitangar block of Simdega in the state of Jharkhand, India. Nair et al. (2021) point out that NTFP collection in the Vidarbha region is one of the trigger points for human-wildlife conflict. Excessive pressure on a particular patch can deplete the soil nutrients in the long run and ultimately impact the

effectiveness of forest sites. In this context, the current study suggests more frequent capacity-building training and encourages the plantation of commercially valuable natural resources in village common areas and residential backyards. This would optimise their profit generation while minimising the involvement of intermediaries and the risk of wildlife encounters. The awareness on the necessity of sustainable extraction and value addition practice for securing social, ecological and economic security is a byproduct of a multi-stakeholder approach at the landscape level for the conservation of this critical tiger connectivity corridor in the Vidarbha landscape. Adopting and functioning of the natural capital-based livelihood shall be a driving force in changing the negative perceptions of the community towards Protected Area management. Considering the current state of the tropical rainforests in Sri Lanka, Ekanayake et al. (2005) agree that the extraction of natural resources for social well-being should be based on scientific principles. It is preferable to encourage extraction as an additional source of income rather than the primary livelihood for peripheral communities. To establish effective value chains, it is advisable to encourage producer companies or cooperatives to consolidate their products and establish market connections with both local and external markets. To achieve lasting conservation outcomes, conservationists and policymakers must integrate the community's traditional ecological knowledge, while also addressing legitimate concerns related to restrictions imposed by Protected Areas (Berkes, 2004). There is significant potential to lead the community towards a structured marketing system, Indigenous technologies, institutional backing for training and skill development, suitable extension and communication networks, and the exploration of novel livelihood opportunities based on natural resources, all without heavily relying on forest exploitation. The National Medicinal Plant Board supported a project in Kerala's Silent Valley and Peechi Wildlife Divisions to promote sustainable harvesting and value addition of medicinal plants through Eco-development Committees. The project aimed to implement Good Collection Practices, build infrastructure, and train local collectors in sustainable harvesting, semi-processing, and market linkage for prioritised medicinal plant species, including *Acacia concinna*, *Piper longum*, *Hemidesmus indicus*, and *Asparagus racemosus*. Through participatory methods, Local "Task Teams" were formed to monitor resource collection, issue collector IDs, and manage procurement centres. Market linkages with Ayurvedic industries were established, supported by MoUs and revolving funds to ensure fair pricing and discourage middlemen. The project has not only improved livelihoods and empowered collectors but also institutionalised conservation-based enterprise models in biodiversity-rich areas (Mark et al., 2017). Recognising these issues at the grassroots level can help policymakers develop enabling frameworks that promote the sustainable harvesting and value addition of NTFPs through targeted capacity-building programmes, improved market access, and the promotion of local institutions to ensure fair economic opportunities. However, as highlighted by Sahoo et al. (2010) in the context of community dependence on bamboo, rattan, and certain medicinal plants around Dampa Tiger Reserve, in the Mizoram state of India, improvements in rural economies and effective forest management can only be achieved when local communities actively cultivate NTFPs on private lands to reduce pressure on forests, while simultaneously driving innovation in value chains to maximise economic returns (Arnold & Pérez, 2001).Therefore, a landscape-level, multi-stakeholder approach, one that integrates ecological integrity with socioeconomic development, is critical for achieving both conservation goals and livelihood improvements in ecologically sensitive regions, such as the Vidarbha Tiger Landscape.

References

Arnold, J. E. M., & Pérez, M. R. (2001). Can non-timber forest products match tropical forest conservation and development objectives? *Ecological Economics*, *39*(3), 437–447.

https://doi.org/10.1016/S0921-8009(01)00236-1

Barrett, C. B., Reardon, T., & Webb, P. (2001). Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications. *Food Policy*, *26*(4), 315–331. https://doi.org/10.1016/S0306-9192(01)00014-8

Berkes, F. (2004). Rethinking Community-Based Conservation. *Conservation Biology*, *18*(3), 621–630. https://doi.org/10.1111/j.1523-1739.2004.00077.x

Carney, D. (1998). *Sustainable Rural Livelihoods: What contribution can we make?* Department for International Development.

Chacko, S. I., & Narvekar, V. N. (2023). Unlocking the Power of Mahua: A Comprehensive Guide. *IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB)*, *9*(2), 1–5.

Choudhari, A. (2025, May 13). 5th Woman Killed in Tiger Attack in 3 Days in Chandrapur . *The Times of India*.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). SAGE.

DFID. (1999). *Sustainable livelihoods guidance sheets*.

Ekanayake, S., Angammana, D., Fernando, S., Samarawickrama, P., Perera, N., & Perera, S. (2005, November). Sustainable extraction of non-timber forest products in Dipterocarp dominant lowland rain forests: a case study in southwestern rain forest in Sri Lanka. *Eighth Round-Table Conference on Dipterocarps. Dipterocarpus- Enhancing Capacities in Sustainable Development and Poverty Alleviation.*

Elasha, Balgis. O., Elhassan, N. G., Ahmed, H., & Zakieldin, S. (2005). *Sustainable livelihood approach for assessing community resilience to climate change: case studies from Sudan*. www.aiaccproject.org

Frankenberger, T. R., Drinkwater, M., & Maxwell, D. (2000). *Operationalizing Household Livelihood Security: A Holistic Approach for Addressing Poverty and Vulnerability*.

GlobalData. (2022, October). *Average Size of Households in India (2010 - 2021)*. Https://Www.Globaldata.Com/Data-Insights/Macroeconomic/Average-Household-Size-in-India-2096125/.

Gubbi, S., & MacMillan, D. C. (2008). Can non-timber forest products solve livelihood problems? A case study from Periyar Tiger Reserve, India. *ORYX*, *42*(2), 222–228. https://doi.org/10.1017/S0030605308071111

Habib, B., Nigam, P., Mondal, I., Hussain, Z., Ghaskadbi, P., Govekar, R. S., Praveen, N. R., Banerjee, J., Ramanujam, R. M., & Ramgaonkar, J. (2021). *Telemetry based tiger corridors of Vidarbha Landscape, Maharashtra, India.*

Haggblade, S. (2007). *Alternative Perceptions of the Rural Non-Farm Economy* (S. Haggblade, P. Hazell, & T. Reardon, Eds.). Johns Hopkins University Press.

Hahn, M. B., Riederer, A. M., & Foster, S. O. (2009). The Livelihood Vulnerability Index: A pragmatic approach to assessing risks from climate variability and change—A case study in Mozambique. *Global Environmental Change*, *19*(1), 74–88. https://doi.org/10.1016/j.gloenvcha.2008.11.002

Jakson, W. J., & Ingles, A. W. (1988). *Participatory Techniques for Community Forestry: A Field Manual*.

Jhala, Y. V., Gopal, R., & Quershi, Q. (2011). *Status of tigers, co-predators and prey in India*.

Kaul, R., Hilaluddin, Jandrotia, J. S., & McGowan, P. J. K. (2004). Hunting of large mammals and pheasants in the Indian western Himalaya. *Oryx*, *38*(4), 426–431. https://doi.org/10.1017/S0030605304000808

Kumar, S., & Choudhury, A. (2016). Enhancement of livelihood activities through non-timber forest products: A study in Jharkhand's Ranchi and Simdega Districts. *Jharkhand Journal of Development and Management Studies*, *14*(1), 6919–6930. https://www.researchgate.net/publication/303

303237_Enhancement_of_Livelihood_Activities_through_Non-Timber_Forest_Products_A_Study_in_Jharkhand%27s_Ranchi_and_Simdega_Districts#fullTextFileContent

Leary, N., & Kulkarni, J. (2007). *Climate Change Vulnerability and Adaptation in Developing Country*. www.aiaccproject.org

Lepcha, L. D., Shukla, G., Pala, N. A., Vineeta, Pal, P. K., & Chakravarty, S. (2019). Contribution of NTFPs on livelihood of forest-fringe communities in Jaldapara National Park, India. *Journal of Sustainable Forestry*, *38*(3), 213–229. https://doi.org/10.1080/10549811.2018.1528158

Magry, M. A., Cahill, D., Rookes, J., & Narula, S. A. (2023). Climate change impacts on non-timber forest products: NTFP-dependent community responses from India. *Climate and Development*, *15*(9), 738–751. https://doi.org/10.1080/17565529.2022.2152639

Mark, A. S., G.B, D., & Rao, J. R. (2017). Sustainable harvesting, value addition and marketing of wild medicinal plants: designing participatory methods and process of field implementation - case study from Silent Valley and Peechi Wildlife Divisions in Kerala. In *Medicinal Plants - benefit sharing, development and conservation*. Kerala Council for Science and Technology and Environment, and Kerala Forest Research Institute.

Maske, M., Mungole, A., Kamble, R., Chaturvedi, A., & Chaturvedi, A. (2011). Impact of non timber forest produces (NTFP's) on rural tribes economy in Gondia District of Maharashtra, India. *Applied Science Research*, *3*(3), 109–114.

Melese, S. M. (2016). Importance of Non Timber Forest Production in Sustainable Forest Management and Its Implication on Carbon Storage and Biodiversity Conservation in Case of Ethiopia. *Journal of Biodiversity & Endangered Species*, *4*(1). https://doi.org/10.4172/2332-2543.1000160

Mishra, A., & Poonia, A. (2019). Mahua (*Madhuca longifolia*) flowers: review on processing and biological properties. *Nutrition & Food Science*, *49*(6), 1153–1163. https://doi.org/10.1108/NFS-12-2018-0358

Nair, A. K., Raut, M. B., Ashraf, M., & Thanekar, R. (2021). Collection and Distribution of Mahua (<I>Madhuca longifolia</I>), Tendu (<I>Diospyros melanoxylon</I>) and other NTFP's in Critical Tiger Connectivity Corridor of Maharashtra. *Indian Forester*, *147*(4), 374. https://doi.org/10.36808/if/2021/v147i4/151892

National Tiger Conservation Authority, G. of I. (2014). Bi-monthly outreach journal of National Tiger Conservation Authority, Government of India . *Stripes*, *5*(3).

NNTR Official. (2023). *About Nawegaon Nagzira Tiger Reserve*. Nawegaon Nagzira Tiger Reserve Conservation Foundation.

Pandey, A. K., Tripathi, Y. C., & Kumar, A. (2016). Non Timber Forest Products (NTFPs) for Sustained Livelihood: Challenges and Strategies. *Research Journal of Forestry*, 1–7. https://doi.org/10.3923/rjf.2016

Pinjarkar, V. (2019, May 11). Nagzira tigers suffer as buffer area still out of park's control. *The Times of India*.

Qureshi, Q., Saini, S., Basu, P., Gopal, R., Raza, R., & Jhala, Y. (2014). *Connecting Tiger Populations for Long-term Conservation*.

Rai, Nitin. D., & Uhl, Christopher. F. (2004). Forest product use, conservation and livelihoods: the case of Uppage fruit harvest in the Western Ghats, India. *Conservation & Society*, *2*(2), 289–313. https://www.jstor.org/stable/26396630

Saha, N. (2021). *Tropical Forest and Sustainability: An Overview* (pp. 1052–1059). https://doi.org/10.1007/978-3-319-95981-8_37

Saha, S. (2002). Anthropogenic fire regime in a deciduous forest of central India. *Current Science*, *82*(9), 1144–1147. http://www.jstor.org/stable/24106801

Sahoo, U., Lalremruata, J., Lalramnghinglova, H., Lalremruata, J., & Lalliankhuma, C. (2010). Livelihood generation through non-timber forest products by rural poor in and around Dampa Tiger Reserve in Mizoram. *Journal of Non-Timber Forest Products*, *17*(2), 147–161. https://doi.org/10.54207/bsmps2000-2010-4UV335

Sen, A. (2019). Human–wildlife conflicts in the Sundarban Biosphere Reserve and the politics of forest conservation. *Decision*, *46*(4), 321–333. https://doi.org/10.1007/s40622-019-00224-7

Shahabuddin, G., & Prasad, S. (2004). *Assessing ecological sustainability of non-timber forest produce extraction:The Indian Scenario*. http://www.conservationandsociety.org.in

Sharma, V., N, S. K., Dimri, R., Kumar, S., & Babu, R. (2022). Madhuca longifolia: only cause of forest fire ? *Indigenous Traditional Knowledge and Advancement in Medicinal Pants Research*, 26–32. https://doi.org/10.5281/zenodo.6543675

Singh, Virat. A. (2016, September 18). Buffer zone for Navegaon-Nagzira Tiger Reserve declared. *Dnaindia.Com*.

Thapa, A., & Singh, K. (2021). Women's Role in Non-Timber Forest Product Management: A Review. In *Role of women in nation development* (pp. 116–121). Mantech Publications. https://doi.org/10.47531/MANTECH.2021.13

Verma, S., Verma, S. K., Sujit, D., & Paul, K. (2019). *Sustaining the Non-Timber Forest Products (NTFPs) Based Rural Livelihoods of Tribals in Jharkhand: Issues and Challenges*. https://www.researchgate.net/publication/334319641

Vidhyarthi, A. K., & Gupta, H. S. (2002). Non-wood forest Produce in Village Economy - a Case Study in Chotanagpur Region. *Journal of Tropical Forestry*, *17*(2), 18–23.

Walker, J., Mitchell, B., & Wismer, S. (2001). Livelihood strategy approach to community-based planning andassessment: A case study of Molas, Indonesia. *Impact Assessment and Project Appraisal*, *19*(4), 297–309. https://doi.org/10.3152/147154601781766925

Yaro, Joseph. A. (2013). *Building resilience and reducing vulnerability to climate change : implications for food security in Ghana*.

Ethical Approval and Conflict of Interest

This study adhered to the ethical principles outlined in the Declaration of Helsinki, as it involved human subjects primarily. The research protocol was reviewed and approved by the Wildlife Trust of India, the implementing agency. Participation in the study was entirely voluntary, and only community members who provided verbal consent were included in the interviews. Additionally, the authors declare that they have no known competing financial interests or personal relationships that could be perceived to influence the work reported in this study.

Author Contribution Statement

MA: conducting empirical research, developing the first draft and editing

SS: guidance, supervision and reviewed the manuscript

AKN: conceptualisation, methodology, and contributed to the analysis

Informed Consent

Prior to participation, the purpose of the study was explained to all potential respondents in *Marathi*, respondents' native language. Community members were informed that their participation was voluntary, that they could withdraw at any time without any consequence, and that their responses would remain confidential and used solely for research purposes. Only those individuals who provided verbal consent were interviewed.

Funding

The German Cooperation funded the study via KfW Development Bank through the project titled 'Integrated Tiger Habitat Conservation Programme (ITHCP)' [Grant No. 1487].

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. To safeguard the privacy and confidentiality of participants, raw interview transcripts are not publicly shared.

Acknowledgements

We are grateful to the Maharashtra Forest Department, the International Union for Conservation of Nature (IUCN), the German Cooperation, and KfW Development Bank for their generous support, without which this study would not have been possible. We are grateful to our field assistants, Mr. Nitin Rawate, Mr. Hivraj Raut, and Mr. Sanjay Ghasle, for their valuable support in collecting data and information. We extend our immense gratitude to Dr. Rahul Kaul of the Wildlife Trust of India and Dr. Mayukh Chatterjee of Chester Zoo for their intellectual support. Finally, we also extend our profound gratitude to the anonymous reviewers for their critical input, which helped us to improve this study.