



From Within and Without: Gender, Agency and Sustainable Management of Non-Timber Forest Products in Two Indian States

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Abstract

Non-timber forest products (NTFP) from trees are often collected using unsustainable practices, which contributes to the species' decline and affects the livelihoods and wellbeing of the most forest-dependent groups, such as women, ethnic minorities and the landless. Here we assess opportunities to improve the sustainability of NTFP collection practices across two landscapes in India, using an agency perspective where male and female NTFP collectors themselves identified and evaluated practices and potential interventions for species of their choice. We developed a framework for identifying community-based solutions for NTFP management and carried out participatory exercises in gender-segregated groups in ten rural communities across two states. Unsustainable collection practices such as cutting branches to collect fruits were somewhat more common among women than men, and more common in the more degraded landscape with weaker forest management institutions. Participants described ecological and economic impacts of collection practices in detail, including impacts on future yields, regeneration and product prices. Proposed solutions to improve NTFP management in the less degraded landscape were focused on incentivising sustainable use and working through village institutions, external actors, or both in collaboration. In the more degraded landscape, participants emphasised sanctions and did not frequently propose the existing village institutions to take action. Women proposed collaboration with external actors less often than men. The results indicate that agency perspectives are useful in stimulating discussion about locally relevant NTFP management options, but that social and gender norms and poor relationships with forestry authorities constrain the agency of vulnerable groups in identifying opportunities for change.

Keywords Community forestry · Food tree species · Harvesting practices · Rural livelihoods · Village institutions

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Introduction

There is no shortage of recommendations on how to improve the sustainable use of non-timber forest products (NTFPs), including the thousands of tree species used as food and medicine – and yet the populations of these species continue to decline across the developing countries much more rapidly than the overall forest cover (e.g. Muraleedhan et al. 2005; Rasul et al. 2008; Varghese and Ticktin 2008). Poor harvesting practices threaten the species providing NTFPs, but also the livelihoods of the hundreds of millions of forest-dependent men and women who continue to rely on these products for food security and nutrition, healthcare, income, and a safety net at times when crop harvest fails (Sakai et al. 2016; Mipun et al. 2019; Tata et al. 2019). Non-timber forest products are vital especially for marginalised social groups, such as women of lower social classes, ethnic minorities, and the landless, because access rights to NTFPs are commonly granted or tolerated, at least for subsistence use, in otherwise tightly regulated forest management regimes (Johnson et al. 2013; Zhu et al. 2017).

Collectors of NTFPs differ in their preferences for species, access to land resources, knowledge and skill in applying different practices, mobility, and time available for the effort (Kusters et al. 2006; Shackleton et al. 2011; Ingram et al. 2014). Social and gender norms constrain the options available to marginalised groups. Across Asia, women depend significantly more than men on communal lands for sourcing forest products (Sunderland et al. 2014), and are, therefore, more vulnerable to the dynamics of use of common pool resources that often result in overexploitation. The social, political and economic dynamics that shape NTFP collection practices are reflected in the collectors' wellbeing as reduced income opportunities, drudgery, time poverty, safety concerns, and deterioration of environmental quality (Kusters et al. 2006; Shackleton et al. 2011).

Trees yielding consumable fruits and seeds are key NTFPs for subsistence and commercial uses (Jansen et al. 2020; Lamers et al. unpublished). These species respond differently to extraction, depending on the collection techniques, the plant part extracted (Shahabuddin and Prasad 2004) and the species biology such as pollen and seed dispersal patterns (Vranckx et al. 2012). Damage to the trees during collection can reduce yields and increase mortality, subsequently reducing population size and viability. Collection of unripe fruits can reduce regeneration as fewer fruits develop into maturity (Rai and Uhl 2004). Selection (collecting systematically from the most productive trees) could result in the more fecund genotypes to be damaged and reproduce less. Extensive collection without leaving aside seed sources negatively affects genetic diversity and gene flow and can reduce fecundity, germination, and survival and productivity of the offspring, with long-term impacts on populations (Graudal et al. 2014). Traditional ecological knowledge can be a source of sustainable practices (Donovan and Puri 2004; Rist et al. 2010; Thomas et al. 2017) and support the governance of common pool resources (Mutenje et al. 2011), but such knowledge and practices are vulnerable to erosion in contexts of rapid rural transformation (Baldauf and Maes Dos Santos 2013).

Suggestions to improve NTFP collection range from conducting more research on sustainable harvesting levels and training collectors on better practices, to promot-

ing tenure security and income generation through value addition (e.g. Tangirala et al. 2013; Choudhary et al. 2014; Dinda et al. 2020). Proposed interventions to help women participate and benefit from NTFP management include supporting them in cultivating NTFPs affected by overharvesting, addressing traditional norms that restrict their access to valuable species, using entrepreneurial women as role models, fostering collective action and group formation, and improving women's access to credit (Ingram et al. 2014). The high specificity of contexts where NTFPs are used (Kar and Jacobson 2012) makes it difficult to generalise solutions across landscape contexts, collector groups and species.

Perspectives on agency can help unpack the role of context in NTFP management and identify locally relevant solutions. Since agency and wellbeing are interdependent, improving people's agency to act and make own free choices on matters they value also improves their wellbeing (Drydyk 2013). Participation and public reasoning by marginalised groups play a key role in enhancing agency, shaping values, policies and practices (Sen 1999). Women's active participation in forest user groups fosters greater participation of also other community members (Lise 2000), helps reduce conflicts (Coleman and Mwangi 2013) and contributes to a more sustainable resource use (Leisher et al. 2016). Attention to context also helps uncover social structures and power relations that constrain the agency of vulnerable groups to aspire for and effect change (Koggel 2013) and consider the social costs and benefits such groups incur from current and potential practices and interventions (Nandigama 2020).

The objective of this study was to assess opportunities to improve NTFP collection practices for tree species across two landscapes in India, using the agency perspective where male and female NTFP collectors themselves identified and evaluated practices and potential interventions. Specifically, we sought to answer the following questions: (1) What types of NTFP collection practices do collectors use and what motivates the use of specific practices, (2) what ecological and socio-economic impacts of specific collection practices do the collectors recognise, and (3) what types of barriers and solutions do they identify and prioritise for improving the sustainability of NTFP management? To address these questions, we developed a framework for identifying community-based solutions for NTFP management and conducted participatory exercises in gender-segregated groups in ten rural communities. Through comparing perceived challenges in and solutions for improving NTFP management between men and women, and between two landscapes of differing degradation and socio-economic contexts, we shed light on how gender norms and social structures influence agency in NTFP management.

Materials and Methods

Study Area

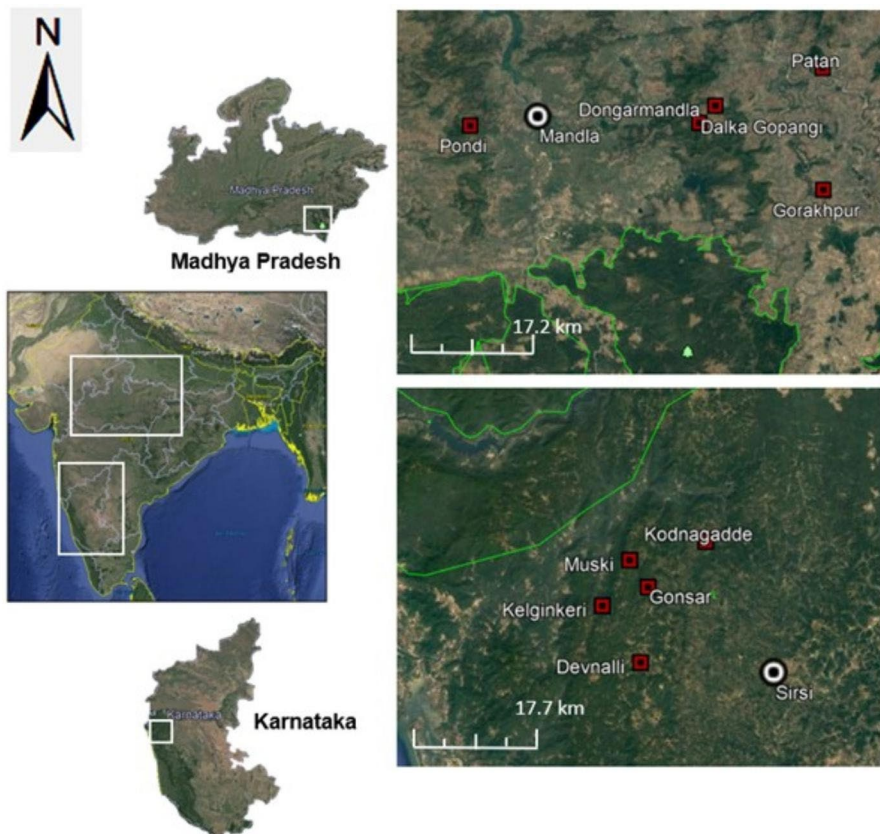
The first study site was in Uttara Kannada district, Karnataka state, in Western Ghats that are recognised as an important biodiversity hotspot and retain a relatively high

Table 1 The study sites in India

	Uttara Kannada, Karnataka	Mandla, Madhya Pradesh
Population	1.147 million ^a	1.055 million ^b
Ethnic groups	Havyak Brahmin; Khare-Vokkaliga and Marathi (Other Backward Class), Siddhi (Scheduled Tribes)	Gond (Scheduled Tribes), Panka, Yadav (Other Backward Class), Baiga (Particularly Vulnerable Tribal Groups)
Average income of forest-dependent groups^c	US\$90 per month	US\$ 25 per month
Forest types (% of total land area)	Dry deciduous (1%), moist deciduous (16%), and evergreen forests (32%) ^d of which in total 86% are classified as very to moderately dense, and 14% is open forest ^e .	Dry deciduous and moist deciduous (49%) forest ^f , of which 69% are classified as very to moderately dense, and 31% is open forest ^e .

^a Census Operations India (2011a); ^b Census Operations India (2011b); ^c Jalonen et al. (2018);

^dRamachandra et al. (2016), ^e FSI (2019), ^f Jhariya and Jain (2014)

**Fig. 1** Map of the study sites

forest cover (Table 1; Fig. 1) (Hanumantha et al. 2019). Local men and women rec-

ognise more than 200 NTFP species (Lamers et al. unpublished), and NTFPs are widely used for home consumption and commercial purposes. The lowest-income groups, mainly belonging to Scheduled Tribes, own little or no land and typically obtain 20–50% of their income from NTFPs. They collect NTFPs mainly from Minor Forests (small, discontinuous, state-owned forests around villages, experiencing a lot of human activity) and Reserve Forests (in theory strictly protected by the Forest Department) (Elias, unpublished). Non-timber species are also found in *bettalands*, private lands allocated to individual families for the production of green manure, fuelwood and fodder. Village Forest Committees (VFC) were established in 1990s by the State Government and have management rights over agroforestry plantations and NTFP harvesting within their area. The Forestry Department delineates a community forest for each village with a VFC, and the VFC and the Department are expected to jointly develop a micro-management plan for the forest (Elias, unpublished). Most households sell their NTFPs to local traders, who then sell them on to the few large traders who have been granted NTFP concessions by the Forest Department (Jalonen et al. 2018). Some VFCs organise village-level auctions for *Garcinia gummi-gutta* to enable households to sell fruit to traders through an open bidding process.

The second study site was in Mandla district, Madhya Pradesh state (Fig. 1). Madhya Pradesh has the highest forest cover and the largest tribal population in India. Mandla district has 428 villages, 405 of which are within 5 km of forest. Compared to Uttara Kannada, the landscape is drier, and people are poorer and have less formal schooling. In total 73 NTFP species were identified in the landscape by villagers, much less than in Uttara Kannada (Lamers et al., unpublished). Persistent poverty, human population growth and high NTFP dependency together with extreme drought and forest fires have resulted in widespread land degradation over the past decades. This has affected the relations between the villagers and the Forest Department, seen as a policing force that restricts people's search for basic subsistence (Elias et al. 2020). At the time of the research, only 285 of the 428 villages in Mandla had a Joint Forest Management Committee (JFMC), the equivalent of the VFCs in Karnataka – and only 30 JFMCs were considered active by the Forest Department staff.

The research was conducted as part of a project *Innovations in Ecosystem Management and Conservation* (IEMaC, 2014–2017), the objective of which was to promote new models for sustainable NTFP collection and related income generation in the two study landscapes. The project was coordinated by IORA Ecological Solutions Ltd. with funding from the USAID-India Programme. The research was carried out in five villages in each study landscape (Fig. 1). The villages were selected randomly among the 50 target villages of IEMaC that had been chosen based on their vicinity to natural forests, people's high forest and NTFP dependency and relatively easy access to markets.

Conceptual Framework

The framework was developed by the authors to facilitate collective inquiries into local knowledge about NTFP collection practices and their impacts on the species' populations and forest users' incomes and wellbeing, to foster reflection and visioning of alternative trajectories (Fig. 2). The framework is based on the concept that

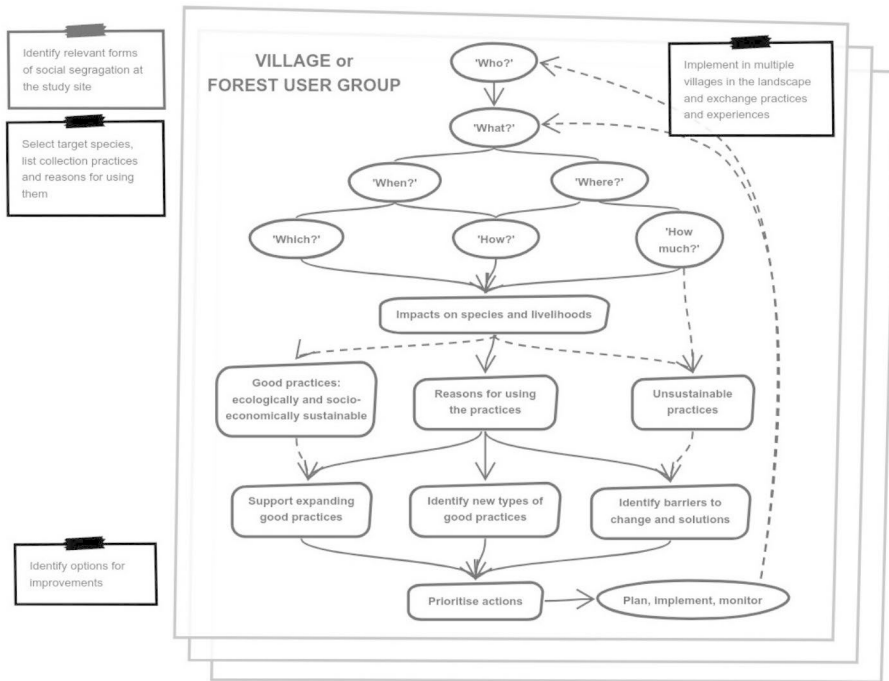


Fig. 2 Conceptual framework for the identification of existing NTFP collection practices and their impacts, and for identifying locally relevant solutions for improving sustainable resource use

people have agency and can be agents of change in their daily life and community and for sustainable transformation. Participatory methods engage local resource users in finding solutions and setting priorities, making the resulting solutions locally relevant and more acceptable or attractive than externally identified solutions (Rist et al. 2010). Qualitative and participatory methods can also be an inexpensive way to rapidly generate information about resource status (Rist et al. 2010) and help target and complement quantitative assessments (Thomas et al. 2017). However, the agency for proposing and enacting solutions is facilitated or constrained by social structures, practices and norms which influence the opportunities available for particular social groups (Koggel 2013). The approach proposed here should be used in groups of relevant social segregation for the context, e.g. gender, ethnicity, or land ownership as a proxy for forest dependency.

Simple guiding questions facilitate the identification of practices with differing impacts on the species populations, and good practices already applied by the participants. 'How' refers to the method of collection and the potential damage to the trees. 'When' refers to the timing of collection in relation to reproductive cycles. 'How much' refers to the amount collected that influences the size of the remaining population. 'Which' refers to selection between individuals that can affect the genetic composition of the population over time. 'Where' refers to the extent of collection and its distribution across the populations, for example, whether some populations are left unharvested and act as genetic reserves. Once the practices and their ecologi-

cal and socio-economic impacts are identified, three approaches can be followed to improve the current situation: (i) expanding existing good practices that offer quick wins and build the participants confidence in their agency, (ii) identifying new types of practices not currently applied, related e.g. to space ('where') or time ('when') restrictions, and (iii) identifying the underlying barriers to more sustainable resource use and context-relevant, inclusive solutions to overcoming those. Participants then prioritise the solutions based on their expected impact and feasibility, following the principle of 'start small and grow it' (Ghate and Nagendra 2005), and develop concrete action plans for implementing those. The field application of the framework described in the following covers these initial steps. The implementation stages can benefit from adaptive collaborative management (CIFOR 2014) that incorporates monitoring and reflection for learning. When applied at a landscape level, participants from different villages can share good practices and solutions that may be applied at landscape level for broader impacts. Although the framework was developed and applied here to study tree species, the process could well be used also for other types of NTFPs, including wildlife.

Data Collection and Analysis

Community meetings were organised in each village to explain the project purpose and obtain a Free and Prior Informed Consent of the villagers to participate in the activities. Two participatory exercises were then carried out in gender-segregated, mixed-ethnicity groups in each village from November 2015 to February 2016. Facilitators organized 8–12 forest-dependent participants in each group, aiming that they represent the diversity of residents in the village by ensuring a good mix of ages, ethnicities, and income levels. In the Option Domain exercise (adapted from Chevalier and Buckles 2008), participants were asked to select three tree species per gender group collected as NTFP, and describe practices that they knew for collecting or managing these species, using the guiding questions of the conceptual framework. As the focus of the study was not on specific species but rather on the process for identifying NTFP collection practices and behaviours, the species were selected rapidly through consensus, with some participants volunteering species names and others voicing support. Participants then explained the reasons for using each practice, estimated the proportion of NTFP collectors using the practice, identified good or neutral vs. harmful practices, their impacts on the NTFP species and product prices, and finally prioritised practices that would be the easiest to improve. The Vision and Action Plan exercise (authors; variation of Problem Tree, see e.g. Chevalier and Buckles 2008) was implemented to gather insights about the broader problems surrounding the availability and use of NTFPs and related livelihood issues. Participants were asked to identify and prioritise solutions for solving the problems they perceived the most important in their lives.

The exercises were facilitated by local civil society organisations LIFE Trust (Uttara Kannada) and the Centre for Advanced Research and Development (CARD, Mandla). Each research team had both male and female facilitators who had been working with the study communities for several years. Activities were conducted in Kannada language in Uttara Kannada and mainly in Hindi in Mandla, while using

some terms and concepts in local dialects. To foster information sharing, including on less sustainable practices, facilitators were asked to be careful not to criticize participants, independent of what practices they described, and to thank them for sharing their views also on problematic practices. At the end, the male and female groups were asked to present their findings to each other. Although facilitators noted that men and women often listened attentively to each other's presentations, in most cases there was no discussion between groups about the results. Women were often visibly uncomfortable to speak up in front of men, especially in Mandla.

In total 217 men and 226 women participated in the group discussions in the ten study villages, of whom 56% in both participatory exercises. In Uttara Kannada, participants were mainly of Havyak Brahmin (highest social class, the majority group in the area), Khare Vokkaliga and Other Backward Class, and in Mandla of Gond, Panka and Yadav ethnicity.

Village names were coded to protect the identity of respondents (UK for Uttara Kannada and M for Mandla, followed by numbering in random order). The transcripts were analysed thematically and coded with a qualitative data analysis software, QDA Miner Lite (v2.0.5) (Provalis Research 2016). Themes related to practices were established deductively based on the conceptual framework, while themes related to the perceived impacts of the practices and solutions were identified inductively during the analysis. Quotations were selected to illustrate issues expressed by several participants. In each landscape, data on the prevalence of collection practices for species discussed by at least two groups of the same gender was aggregated between villages, using median values of the reported prevalence across groups. The practices were categorised based on how widespread they were reported among and within the villages: used by few (<35%) to many (>65%) collectors and in few (<35%) to many (>65%) villages. Secondary data was used for an overview of the species' conservation status in the study landscapes (IORA 2016). Final results were shared back to the participants through follow-up workshops in 2016.

Results

Research participants selected in total 12 NTFP species for discussion during the Option Domain exercise (Table 2). All species were used mainly for fruits or seed and were among the ten most common NTFP species reported for home consumption, commercial use, or both, across 53 villages in the two study landscapes (Lamers et al. unpublished). Male and female groups chose a similar number of species valued for commercial and home uses (Table 2). Results are reported in the text separately for men's and women's groups where differences were observed.

Collection practices were generally more sustainable in Uttara Kannada than Mandla (Fig. 3). In Uttara Kannada, typically only few collectors in each village reportedly used unsustainable collection practices such as cutting branches. In contrast, cutting down branches or even entire trees was commonly reported for several species in Mandla by both men and women's groups. In both landscapes, women reported using unsustainable practices, especially cutting branches, somewhat more than men (Fig. 3).

Table 2 Non-timber species selected for discussion on harvesting practices by community members in the two project landscapes

A. Uttara Kannada, Karnataka							
Species (local name)	Characteristics	Conserva- tion status ^a	Average density ha ⁻¹ (< 10 cm dbh) ^b	Main parts collected	Main uses	No. of groups select- ing the species	
						M	W
Kokum (Murugalu) <i>Garcinia indica</i>	Small to medium-sized tree up to 15 m tall, dioecious, insect-pollinated.	Vulnerable (2015)	3.5	Fruit, seed	Home and commercial use: beverages, edible butter, medicinal value	5	5
Cam- bodge tree (Uppage) <i>Garcinia gummi-gutta</i>	Small to medium-sized tree up to 15 m tall, dioecious, wind- or insect-pollinated.	Least concern (2020)	24.6	Fruit	Home and commercial use: pickle, flavouring, dietary supplements	4	4
Wild nutmeg (Rampatre) <i>Myristica malabarica</i>	Medium-sized to large trees up to 25–30 m tall, dioecious, insect-pollinated. Found in peat swamps and evergreen forest.	Vulnerable (1998)	2.3	Seed, aril	Commercial use: spice, medicinal value	3	3
Cinnamon (Dalchini) <i>Cinna- momum malabatrum</i>	Medium-sized trees up to 15–20 m tall, insect-pollinated.	Least concern (2020)	6.9	Fruit, leaves, bark	Commercial use: spice, sweets, medicinal value	1	1
Wild In- dian mango (Mavu) <i>Mangifera indica</i>	Medium-sized to large trees 10–25 m tall. Irregular, often supra-annual flowering. Pollinated by bats and insects.	Data deficient (1998)	6.2	Fruit, leaf	Home uses: edible fruit, dry leaf used as manure	1	1
Chebulic myrobalan (Anale) <i>Terminalia chebula</i>	Medium-sized to large trees up to 25 m, insect-pollinated.	Not assessed	0.8	Fruit	Commercial use: traditional ayurvedic medicine (not properly marketed)	1	1
B. Mandla, Madhya Pradesh							
Pot cassia (Chakoda) <i>Senna tora</i>	Shrub up to 2 m tall. Grows at forest edges, wastelands	Not assessed	N/A	Seed	Commercial use: beverages	5	5

Table 2 (continued)

A. Uttara Kannada, Karnataka						
Species (local name)	Characteristics	Conservation status ^a	Average density ha ⁻¹ (< 10 cm dbh) ^b	Main parts collected	Main uses	No. of groups selecting the species
						M W
Almondette tree (Char) <i>Buchanania lanzan</i>	Medium-sized tree up to 18 m tall. Insect-pollinated.	Not assessed	8.9	Seed	Home and commercial use: edible seed, flavouring	3 3
Honey tree (Mahua) <i>Madhuca longifolia</i>	Medium-sized trees up to 15–20 m tall. Found scattered on farmland. Coppicing.	Not assessed	2.3	Flower, seed	Mainly home use: wine (flower) and cooking oil (seed); also marketed	3 3
Chebulic Myrobalan (Harra) <i>Terminalia chebula</i>	Large trees up to 25 m, insect-pollinated.	Not assessed	0.8	Fruit	Home and commercial use: traditional ayurvedic medicine	2 2
Marking Nut Tree (Bhilwa) <i>Semecarpus anacardium</i>	Small to medium-sized tree up to 10–15 m tall, dioecious. Pollinated by bees and other insects. Seed shell contains poisonous irritant.	Not assessed	1.2	Fruit	Home and commercial use: edible fruit and seed, medicinal value	2
Indian gooseberry (Aonla) <i>Phyllanthus emblica</i>	Small to medium-sized trees up to 10–15 m tall. Pollinated by wind and insects.	Least concern (2020)	4.2	Fruit	Home and commercial use: food, medicinal and cosmetic value	1
Bedda nut tree (Baheda) <i>Terminalia bellirica</i>	Large tree up to 35–40 m tall. Pollinated by bees and other insects.	Not assessed	4.2	Fruit	Home and commercial use: cooking oil, medicinal value	1

^a IUCN 2020^b density within 1–3 km of villages, IORA (2016)

Uttara Kannada Landscape

Practices

Collection methods varied between tree species and between male and female collectors (Fig. 3). Collecting using a long bamboo stick, often with a hook attached at the end, was common, mentioned by nine of the ten groups, especially

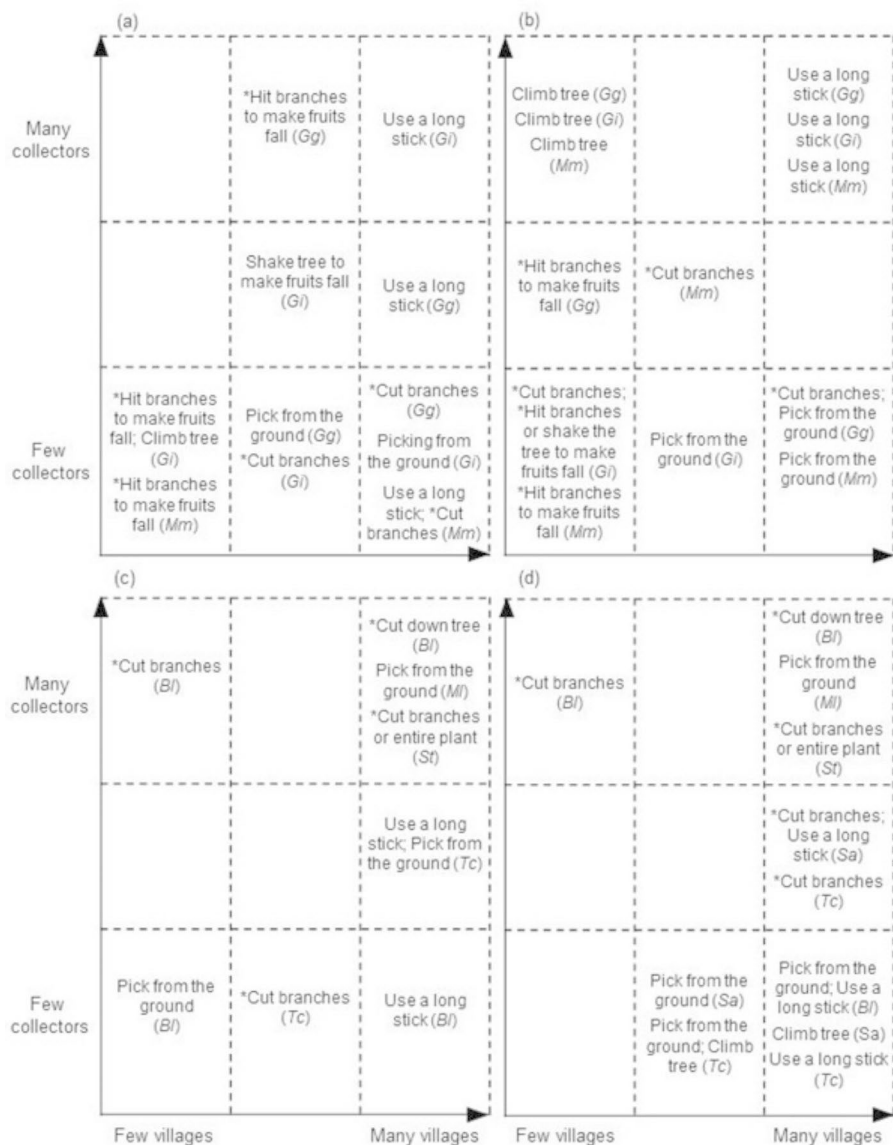


Fig. 3 Prevalence of NTFP collection practices among (a) men's groups and (b) women's groups in Uttara Kannada and in (c) men's and (d) women's groups in Mandla. Data is based on median values reported by groups and shown for species discussed at least three groups for either gender. Practices identified as harmful are marked with asterisk (*). Letters in parentheses indicate NTFP species: Gg=*Garcinia gummi-gutta*, Gi=*Garcinia indica*, Mm=*Myristica malabarica*, Bl=*Buchanania lanzan*, Ml=*Madhuca longifolia*, St=*Senna tora*, Tc=*Terminalia chebula*, Sa=*Semecarpus anacardium*

for *Garcinia indica*. Women frequently used sticks to harvest fruits of also other species, as they were reportedly easy to use, helped avoid climbing and damaging trees. Cutting branches during collection was most common among women

for *Myristica malabarica*, but occasionally reported also for other species by both men and women (Fig. 3). Main reasons given for destructive practices were that climbing trees and especially tall trees such as *Myristica* was difficult, and harvesting by cutting branches was much faster. Intensifying competition had contributed to destructive harvesting.

Collecting unripe fruits was common for all species but most for *Myristica malabarica*, for which all men's groups reported that less than 20% of fruits were collected ripe. They explained this mostly stemming from increased market demand since the 1990s, which had led into higher prices, more collection and competition, and a breakdown of traditional norms such as courtesy to leave some fruit behind for others. Other reasons included a lack of market mechanisms that would reward sustainable practices (mentioned only by men's groups), the difficulty of monitoring collectors' practices, and using unripe fruits for specific products such as pickles. Men and women in one village described a time restriction imposed by the Forest Department since 2005 to reduce the collection of unripe fruits. In the participants' experience, the imposed collection time varied widely from the actual fruiting time. Competition among collectors added to the problem and less than 10% of collectors were said to abide by the restriction.

Six groups (four men's and two women's groups) perceived that leaving some fruits in each tree or some trees unharvested would benefit regeneration and wildlife. One men's group indicated that harvesting all fruits from each tree was relatively recent and had started in the 1990s when market demand increased. Male participants in one village observed that *Garcinia gummi-gutta* trees yielding poor quality fruits were often left unharvested and had more progeny than the other trees, which they feared could reduce the populations' productivity over time. According to another men's group, the Forest Department had marked *Myristica* trees in their village forest as mother trees to obtain quality seed from ripe fruits. Nevertheless, this and three other men's groups opined that nobody in their villages were following the known good practices, because of higher time demand, loss of income, competition, and a lack of monitoring and communication between collectors.

Perceived Impacts

Five groups (including four women's groups) mentioned specific impacts of the collection methods on the species, including reduced yield, absence of fruiting in two to three subsequent seasons, and reduced size and quality of fruits. These were often based on observations of trees in bettaland compared to those in the forest.

Six groups (four women's and two men's groups) explained that the quality and yield of product from unripe fruits were low for *Garcinia gummi-gutta* and *Myristica malabarica*. According to one women's group, many more unripe than ripe fruits of *Myristica* were needed to obtain the same amount of mace. Six groups (four men's and two women's groups) mentioned that the price of unripe fruits was less than for ripe fruits, whereas three other groups opined that the differences were small or non-existent unless the product quality was clearly

inferior because of too many unripe fruits, high moisture content, contamination with sand, or dull or faded colour. The four men's groups who felt prices differed based on quality estimated those to range from 25% lower price for unripe than ripe cinnamon fruits, to 40–50% lower price of *Kappehuli* (product made of unripe fruit rinds of *Garcinia indica*).

Identified Barriers and Solutions for Improving Practices

Villagers identified the following good practices for wider adoption, starting from the most frequently mentioned: (i) harvesting only ripe fruits as it would yield better quality product and help maintain future yields, (ii) using bamboo sticks with hooks, as the tools were simple to use and easily available, helped avoid climbing and damaging the trees, (iii) collect *Garcinia indica* by shaking the trees as it was considered easy yet not widely practiced (reported only by three men's groups), (iv) planting trees on private land as it would reduce competition, allow owners to wait until fruits ripen, save time, and reduce dependency on the dwindling forest resources (two women's groups), and (v) monitoring forest use to prevent outsiders from cutting branches and damaging trees (two women's groups). When asked to prioritise practices for adoption, four men's and two women's groups chose collecting only ripe fruits, one men's and one women's group prioritised collecting fruits using sticks with hooks, one women's group prioritized tree planting and one monitoring.

Table 3 shows the barriers to more sustainable use of forest resources identified by the groups. The difficulty of harvesting NTFPs and the lack of market information were mentioned more frequently by women's than men's groups. Women also identified more solutions than men to help control destructive harvesting by outsiders. Men's groups identified clearly more issues and solutions related to local institutions and forest governance, including some very detailed recommendations and actions requiring collaboration among stakeholders:

A comprehensive list of all the NTFP collectors in the village should be made and then form a separate group of NTFP collectors. These people should be assigned the proper responsibility of NTFP collection and entire revenue sharing with the VFC should be provided only to the members of this NTFP collectors' group. (UK4 men)

...contractors and traders should be contacted and we need to convince them to refuse poor quality products collected adopting inappropriate collection methods. (UK2 men)

Following the research process, the Federation of the VFCs in the study area took the initiative to write a letter to the State Forest Department, outlining several recommendations for improving forest management that had been identified in the group discussions. These included giving VFCs a permission to allocate villagers rights to harvest large dead and fallen trees for construction, as an incentive for the members to commit to the forest rules set by the VFCs; and requesting funding to support planting and domestication of NTFPs.

Table 3 Barriers and solutions for improving sustainable use of forest resources, as identified in men's and women's groups in 5 villages in Uttara Kannada (subset). Solutions prioritised for implementation by at least one group are shown in bold

Theme	Barriers	Villages	Groups		Proposed solutions (no. of groups)
			M	W	
<i>Decline in species populations and yields</i>	Decline of plant species' populations	4	4	3	<ul style="list-style-type: none"> ● Encourage tree planting (4 M, 1 W) ● Conserve seed trees (1 M) ● Promote domestication of NTFPs (3 M)
<i>Unsustainable harvesting</i>	Poor harvesting practices of NTFP species	5	5	4	<ul style="list-style-type: none"> ● Awareness raising and education on proper harvesting (1 M, 1 W) ● Strict rules against cutting trees and collecting unripe fruits (1 M, 1 W) ● Form a group of all NTFP collectors in the village, assign them responsibility to harvest sustainably and share VFC revenue only with group members (1 M) ● Convince traders to refuse product collected using improper methods (1 M)
	People from other villages harvest resources	3	2	3	<ul style="list-style-type: none"> ● Give villagers responsibilities to monitor forest (for payment) (1 W) ● Villagers together warning outsiders not to harvest from their forest (1 M, 1 W) ● VFC and Forest Department to restrict outsiders from entering forest by imposing sanctions (1 W)
<i>Limited market access</i>	Difficulty of harvesting and processing NTFPs	4	1	3	<ul style="list-style-type: none"> ● Family members to assist women in harvesting (1 W) ● Training on processing, value addition and marketing (1 W) ● Establish value addition units (1 W) ● Market NTFPs through VFCs (2 M, 1 W)
	Lack of market access	3	2	2	<ul style="list-style-type: none"> ● Market NTFPs through VFCs (2 M, 1 W)
	Lack of collective marketing	2	2		<ul style="list-style-type: none"> ● Reduce tax for products marketed through the VFC (1 M)
	Lack of market information	1		1	<ul style="list-style-type: none"> ● Gain information about alternative market avenues and market prices (1 W)
<i>Institutions, rules and regulations</i>	Difficulty of monitoring/ rule enforcement	3	2	2	<ul style="list-style-type: none"> ● Strengthen VFC by selling NTFPs through it, which would make the VFC better placed to manage and monitor forest (1 M)
	Weak or no VFC	3	3		<ul style="list-style-type: none"> ● Establish VFCs in the two villages that didn't yet have those (2 M)
	Lack of rights to harvest construction wood	4	4		<ul style="list-style-type: none"> ● Provide villagers harvesting rights to encourage them to actively participate in forest management and monitoring (5 M, 1 W)
	Erosion of customary laws related to forest use	1	1		<i>No solutions discussed</i>

Mandla

Practices

Collection methods in Mandla also varied between the gender groups, but somewhat less than in Uttara Kannada. Both men and women collected *Senna tora* by cutting down the entire bush, and *Madhuca longifolia* by picking flowers fallen on the ground (the flowers are only usable after they ripen and fall). Cutting branches was reported relatively widespread and more common among women than men (Fig. 3). Five of the ten groups mentioned that entire trees were sometimes cut to harvest NTFP, and the practice was common among both men and women for *Buchanania lanzan*. Reasons given for destructive practices included competition among collectors (two men's groups), that it was difficult to otherwise reach fruits in big trees, that fruits of some species were delicate and easily damaged if they fell on the ground, and a lack of awareness about sustainable practices. Using even simple harvesting tools such as bamboo sticks was common only for *Terminalia chebula*. Although eight groups reported using bamboo sticks to harvest some species, different groups used sticks for different species. Attaching hooks to the sticks to help pull down the fruits, a practice common in Uttara Kannada, was not mentioned by any group. Collection of *Madhuca longifolia* was more sustainable than for the other species because of the species' biology, but also because the trees were typically owned by individual families due to the species' cultural importance, which reduced competition.

Harvesting of unripe or semi-ripe fruits was most common *Buchanania lanzan* for which 90–100% of harvest was reportedly collected unripe, followed by *Senna tora* and *Terminalia chebula* ($\geq 70\%$ unripe). The most common reasons given for collecting unripe fruits were time consumption (three women's groups), competition and species characteristics (e.g. that ripe fruits fall and break easily or that ripe seeds shatter on the ground and are difficult to collect). One elderly woman described traditional but now abandoned time restrictions for the onset of harvesting:

It was a tradition earlier that harvesting of Char (Buchanania lanzan) was only done after local Hindu festival (Akshat Tritiya, Akti) by the end of April. But now, the young generation, because of high market demand and competition from local and outside villagers, start collecting unripe fruits since the last 10 years. (Gond woman, 60, M5)

Perceived Impacts

Both men and women perceived that widespread collection of unripe fruits had contributed to the decline of NTFP species:

When I walk inside the forest I don't find any regeneration of old trees. (Panika woman, 45, M5)

The forest started depleting. Earlier we were walking 1–2 kms to collect the forest resources but now we must walk about 5–7 kms to collect. (M5 women)

Some participants felt that they had no alternatives:

We already know that whatever we are doing is not right. The forest is decreasing rapidly and we fear that it will vanish in the coming few years. But we are left with no other option. We do not know how we can put a stop on this. We don't know if there is any other harvesting technique other than the technique we are practicing. (Gond man, 36, M1)

All groups reported that unripe fruits fetched a lower price than ripe fruits, e.g. because of lower weight, smaller size, inferior quality or different colour than ripe fruits. Eight groups gave an estimate for price reduction which ranged from 10 to 50%.

Identified Barriers and Solutions for Improving Practices

Villagers identified the following good practices that could be adopted more widely: (i) using bamboo sticks to harvest fruits, as it is easy, bamboo is easily available, the practice does not harm the trees (five women's groups), it gives better price for *Buchanania lanzan*, and helps improve the availability of NTFPs (two men's groups); (ii) harvesting only ripe fruits as it is easy and results in a better price, (iii) leaving some fruits unharvested as it would be easy to implement, and (iv) collecting fruits with nets or sarees as it would be easy, gives better price and sarees are easily available. When asked what good practices would be the most feasible for wider adoption, seven groups (two men's and five women's groups) prioritised using bamboo sticks to collect fruits and three groups each collecting ripe fruits, leaving some fruits unharvested, and using a net or a saree to collect *Madhuca longifolia* flowers or fruits of other species. However, the groups, and sometimes the participants within the groups, disagreed on the feasibility of some practices. According to three groups, collecting with bamboo sticks was difficult because the trees were tall and far from the villages, and because competition among collectors hindered the adoption of more time-consuming practices.

In general, men's and women's groups suggested similar types of activities to overcome the barriers (Table 4). Five groups from five different villages called for a complete ban on poor harvesting practices, with four groups opining that cutting trees to collect NTFPs should be prohibited. However, only individual men's groups spoke about applying sanctions against poor practices, preventing outsiders from entering village forest, adopting premium pricing for sustainably collected fruits, planting trees and the need for alternative income opportunities. Groups also identified barriers related to a lack of fuel and construction wood and grazing land, poor road conditions that made it difficult to access forest, and human-wildlife conflict (data not shown).

Promoting planting of NTFP species was the most proposed solution across the landscapes and the gender groups. There was a greater consensus on solutions between men's than women's groups across the study villages (Table 4). In both landscapes, men's groups proposed incentives for sustainable forest management more often than women's groups, while women proposed establishing or enforcing forest

Table 4 Barriers and solutions for improving sustainable use of forest resources, as identified in men's and women's groups in 5 villages in Mandla. Solutions prioritised for implementation by at least one group are shown in bold

Theme	Barriers	Villages	Groups		Proposed solutions (no. of groups)
			M	W	
<i>Environmental change</i>	Invasive species (Lantana, Van Tulsi)	5	5	5	<ul style="list-style-type: none"> ● Uprooting of invasive species by Forest Department or by villagers with the Department's authorization (5 M, 5 W)
	Water shortage	5	5	5	<ul style="list-style-type: none"> ● Construction of stop dams to alleviate water crisis (1 M, 2 W) ● Construction of water source inside the forest (stop dam, well, pond or stream) (4 M, 1 W) ● Cleaning existing streams and building ponds (1 W)
<i>Harvesting of NTFPs</i>	Difficulty of harvesting	3	1	3	<ul style="list-style-type: none"> ● Collect NTFPs with bamboo stick (1 W) ● Use ladders to climb trees (1 W) ● Rub ash on body to avoid ants biting when climbing trees (1 W)
	Poor harvesting practices of NTFP species	5	4	2	<ul style="list-style-type: none"> ● Ban cutting of fruit bearing trees (3 M), timber or fuelwood (1 M) ● Ban collection of unripe fruits (1 W) ● Training on NTFP collection (1 M, 1 W) ● Provide harvesting tools (2 M, 1 W) ● Form committee to oversee NTFP collection (1 M) ● Plant NTFP species (5 M, 3 W) ● Market incentives (better price by collecting only ripe fruits) (1 M)
	People from other villages harvest resources	4	2	4	<ul style="list-style-type: none"> ● Ban outsiders from entering forest or collecting products (3 M, 3 W) ● Establish a committee to monitor forest (2 W)
<i>Limited market access</i>	Lack of market access	1	1	1	<ul style="list-style-type: none"> ● Establish a self help group to help sell NTFP (1 W)
	Low prices		1		<i>No solutions discussed</i>
<i>Institutions, rules and regulations</i>	Difficulty to monitor and protect forest	5	4	1	<ul style="list-style-type: none"> ● Ban illegal trespassing by outsiders (2 M, 2 W) ● Ban cutting of trees (3 M, 1 W) ● Allocate forest right declaration (Van Patta) only to original residents of the area, not to migrants (1 M) ● Establish a monitoring committee to monitor illegal trespassing and harvest (1 M, 1 W) ● JFMC to recruit forest guards to protect and monitor forest (1 M, 1 W) ● Strict action against those who breach rules set by JFMC (1 M, 1 W)
	Weak institutions	1	1		<ul style="list-style-type: none"> ● Establish a new, proactive JFMC (1 M) ● Honorarium for JFMC members to encourage them to monitor and protect the forest (1 M) ● Forest Department to establish Welfare Fund for the village (1 M) ● Give employment and professional training to village youth to reduce forest dependency (2 M)

Table 5 Types of proposed solutions for improving sustainable management of NTFPs by gender groups in the study landscapes. Solutions may be categorised to one, several or none of the themes

A. Uttara Kannada					
Gender	Solutions proposed	Solutions related to (% of all)			
		<i>Incentives</i>	<i>Rules, enforcement or sanctions</i>	<i>Village organisations (formal or informal)</i>	<i>External actors</i>
Men	24	11 (46%)	3 (13%)	13 (54%)	9 (38%)
Women	11	3 (27%)	4 (36%)	9 (82%)	5 (45%)
B. Mandla					
Gender	Solutions proposed	Solutions related to (% of all)			
		<i>Incentives</i>	<i>Rules, enforcement or sanctions</i>	<i>Village organisations (formal or informal)</i>	<i>External actors</i>
Men	36	4 (11%)	12 (33%)	12 (33%)	11 (31%)
Women	31	0 (0%)	12 (39%)	11 (35%)	5 (16%)

rules more than men. In Uttara Kannada, women spoke more often than men about working with specific village organisations or external actors, however in terms of external actors they only mentioned the Forest Department and civil society organisations, while men also spoke about working with other government organisations and traders. In Mandla, women mentioned external actors clearly less often than men (Table 5).

Discussion

Through applying the proposed conceptual framework, detailed information could be generated about the NTFP collection practices applied by male and female collectors in rural India, their motivations for using specific practices, perceptions about the ecological and economic implications of the practices, and the opportunities they identified and valued for improving the sustainability of NTFP collection. The reported practices and their ecological impacts were in line with the results of a detailed ecological survey conducted in the study landscapes at the time of the research that showed a declining population status and absence of regeneration in many NTFP species (IORA 2016; Table 2). The practices, motivations and identified solutions varied depending on the extent of forest degradation and the strength of local institutions between the two distinct landscapes, as well as between male and female participants within each landscape, highlighting the need for context-specific and gender-responsive solutions (Shackleton and Panday 2014).

According to our results, the choice of collection practices for NTFPs depended mainly on the species' market demand and the resulting competition among collectors, tenure security, the collectors' capacities influenced by gender, and the species' traits that made some methods impractical for certain species. Commercialisation of NTFPs can result in a breakdown of traditional practices (Prakash Kala et al. 2005) and a widespread collection of unripe fruits (Rai and Uhl 2004); in our study, participants also reported in this context an erosion of traditional knowledge and changing social norms. The importance of tree tenure in fostering sustainable collection practices is widely recognised (e.g. Varghese and Ticktin 2008; Delgado et al. 2016; Soe

and Yeo-Chang 2019). Unsustainable practices are partly facilitated by the nature of NTFPs as common pool resources – the same reason that makes NTFPs accessible and so important for marginal social groups. It is typically costly to develop institutions (rules) to exclude potential beneficiaries from using such resources, and limited resource availability creates competition among users (Ostrom and Schlager 1996). However, tree tenure arrangements can vary widely within landscapes (Rai and Uhl 2004; Yadav and Dugaya 2013), as also observed in our study. More sustainable collection practices on private lands show as better productivity, as recounted by our study participants, or as better regeneration as observed by Rai and Uhl (2004). The local diversity of tenurial arrangements provides opportunities for identifying and expanding existing good practices that have already been tested and accepted by resource users, and positive examples of relatively secure tenure could be found even in the contexts with weak village institutions and severe forest degradation (*Madhuca longifolia* in Mandla).

Although both men and women identified poor tenure security as a barrier to more sustainable NTFP collection, the proposed solutions differed: in both landscapes more men's than women's groups highlighted the need for tree planting, while in Uttara Kannada more women than men suggested resource monitoring and regulations to exclude outsiders from using the village forest (Table 3). The responses reflect gendered differences in the control of land (Agarwal et al. 2021), without which tree planting is not a viable alternative. Intra-household differences in land and tree tenure must be considered in NTFP planting and domestication initiatives, especially for species grown for commercial use where conflicts of interest are more likely than for species for home consumption only (Prakash Kala et al. 2005). Men tend to control higher-value NTFP resources or may appropriate resources previously managed by women if their commercial value increases (Ingram et al. 2014).

Women's forest user groups are less effective in enforcing sanctions and excluding other forest users than men's or mixed-gender groups (Suna et al. 2011). In India, patrolling in communal forests is usually carried out by a jointly hired guard or an all-male patrol, and although women are often active in patrolling, their role is usually informal (Agarwal 2017). Male-led patrolling may focus on different areas, species, or types of infringements than those important to women and especially the most forest-dependent women of lower social classes. Obtaining men's support for better protecting these NTFP resources is important (Suna et al. 2011) but requires concerted efforts, considering that the issues of gender, ethnicity and class that influence forest-dependency also thwart women's opportunities to influence decision-making. Highlighting the benefits of gender-responsive approaches to households and communities as a whole (e.g. in terms of nutrition, climate adaptation, or social harmony; Deering 2019; Gumucio et al. 2019) could contribute to reducing inequality in access to and control of resources.

Depending on the species, helping forest-dependent women improve their collection practices may affect the species' population status more than targeting men, given that they reported using destructive practices somewhat more commonly than men. Additionally, such improvements could help reduce women's drudgery, demands for their time and safety concerns during collection, important goals on their own (Kusters et al. 2006; Shackleton et al. 2011). Although

species traits were reported to make sustainable collection of some NTFP particularly difficult, improved collection techniques were not always used even when available, or were used only on private lands or for higher-value products such as jams or juices. This diversity again illustrates existing good practices that can be built on but shows that tenure security and product value are generally more important reasons for choosing collection methods than the availability of techniques as such. Training on sustainable collection practices needs to be implemented in this broader context to be effective (Muraleedhan et al. 2005; Tangirala et al. 2013). Technology-centered development interventions that overlook local norms and power relations may in fact reproduce and reinforce existing inequalities (Gonda 2016).

As the collective inquiries moved to the broader barriers that underlie sustainable forest resource use, the research participants provided suggestions that were overall strikingly like those identified in previous studies, typically through expert-led approaches. These suggestions included defining rules for collection (Choudhary et al. 2014), focusing on better quality products associated with more sustainable collection practices (Varghese and Ticktin 2008), issuing harvesting permits (FAO 2017), organising collectors as semi-professional groups that receive skills training (Dinda et al. 2020), monitoring collection practices (Rai and Uhl 2004; Setty et al. 2008), working with other value chain actors to develop product standards (Choudhary et al. 2014), value addition (Muraleedhan et al. 2005; Johnson et al. 2013; Tangirala et al. 2013), setting up producer cooperatives (FAO 1995; Reyes 2008; Hanumantha et al. 2019), improving producers' market position through changes in taxation and reducing barriers to trade (Shrestha et al. 2020), and developing alternative income sources (Kusters et al. 2006; Soe and Yeo-Chang 2019). Women in Uttara Kannada repeatedly referred to women's self-help groups from other villages as role models (as recommended by Ingram et al. 2014), for initiating value addition activities. Women in one group wanted to convince their family members to help them in NTFP collection for processing, thus seeking recognition for their roles in NTFP value chains and even challenging norms of family division of labour (*ibid.*). Common suggestions in literature not mentioned by any groups included specifying penalties (Ghate et al. 2009), monitoring of forest condition (Boissière et al. 2014; Chamberlain et al. 2019) and product certification (Hiremath 2004; Varghese and Ticktin 2008).

The men's groups in Uttara Kannada provided the most detailed and complex solutions, including several institutional reforms and collaboration among multiple actors. The responses illustrated their privileged position compared to the other groups, them being the majority group in the VFCs and experienced in interacting with stakeholders outside of the village. High-status households derive more benefits from forest use than others (Mukherjee et al. 2017), which may explain their preference for incentives rather than sanctions to guide sustainable forest use. Although many Indian states have established quotas for women's participation in VFC Executive committees, women are typically not participating actively in VFC meetings, e.g. due to lack of information about the meetings, time constraints and the underlying restrictive social norms (Elias et al. 2020). Our results are in line with these findings, as women did not identify solutions

involving the VFCs except in one village. Also, when the VFCs in Uttara Kannada approached the State Forestry Department to bring up their suggestions following the group discussions, they did not include recommendations from women's groups such as support for forest patrolling and processing of NTFPs. When men and members of the community elites dominate decision-making, the resulting rules and incentives are unlikely to represent the needs and interests of vulnerable social groups, yet their access to resources may be affected and they may incur costs of lost opportunities (Agarwal 2017). It is also worth looking at the interplay of ethnicity (Rai and Uhl 2004; Nguyen et al. 2019) and gender (Hegde et al. 2017) that was beyond the focus of this study. Women of wealthier social groups are typically less involved in NTFP collection yet may be nominated to fill the quotas for women in VFCs (Elias et al. 2020). Having separate quotas for men *and* women of ethnic minorities can facilitate the participation of forest-dependent women in decision-making processes, as already done in some Indian states. Inclusive rules have a significant impact on women's participation in forest user groups. Women's attendance at group meetings does not yet translate to perceived fairness of rules and sanctions (Coleman and Mwangi 2013), yet formal participation opens space to renegotiate gender norms, and marginalised men and women have been observed to actively use such opportunities to reconstitute power relations in their communities (Agarwal 2010; Nandigama 2020).

Producer organisations can play an important role in linking producers to markets, improving their price awareness and bargaining power (Reyes 2008). However, in Uttara Kannada, where VFCs were already involved in selling some NTFPs, participants notably saw this as an important strategy also to strengthen the VFC in the villagers' eyes and thereby help impose rules on sustainable use. Such institutional and conservation outcomes could not be achieved through establishing separate producer organisations. A study on participatory NTFP monitoring in Lao PDR found that linking monitoring to existing administrative structures helped reduce administrative complexity and facilitated the acceptance and sense of ownership by local stakeholders (Boissière et al. 2014). Where separate producer organisations are created, they should collaborate closely with existing VFCs or JFMCs to ensure that commercialisation is based on sustainable collection – a necessity for sustaining incomes – and that producer organisations do not undermine other village institutions.

Comparison between the two landscapes points to two main differences in the proposed solutions. Firstly, the overwhelming emphasis in Mandla was on addressing broader-scale land degradation, beyond just managing NTFP species – particularly eradicating invasive species and improving water availability. The overall poorer collection practices in Mandla also indicate rapid deforestation (Uma Shaanker et al. 2004; Hiremath 2004). Secondly, while the proposed solutions imply villagers' recognition that there is space for their own initiative in many areas, compared to Uttara Kannada they suggested few activities involving the existing village organisations. Instead, they saw interference from authorities as important, for example to authorise and compensate villagers' actions towards resource conservation, manage tensions between original and migrant residents or providing employment. The relationship between the Forestry Department and

forest users in Mandla is poor, with the Department adopting a strict approach to law enforcement and leaving little space for participation despite villagers' high forest dependency (Elias et al. 2020; Ghate and Nagendra 2005) observed how the most remote villages in Maharashtra, India, had the least access to support from the Forestry Department, and hence the weakest village forest institutions – a situation that compared to that between the villages in Uttara Kannada and Mandla. People's participation in forest user groups has been observed to be the greater, the more dependent they are on the forest for income and the better the condition of the forest (Lise 2000). This resembles the situation in Uttara Kannada, but not that in the much more degraded Mandla landscape. The finding also highlights the difficulty in turning the tide in contexts where local institutions are weak.

Conclusion

Our results demonstrate the gendered patterns of NTFP collection practices and their impacts on NTFP resources and collectors' wellbeing across two distinct landscapes in India. Practices applied by forest-dependent women need more attention, as they tend to be less sustainable than those by men and have implications for the long-term availability of key NTFP resources as well as for women's incomes, drudgery and safety. The results illustrate the value of participatory methods in soliciting locally relevant recommendations for improving NTFP management and imply their potential to catalyse action in contexts where local institutions are already relatively strong, and people have relatively more agency. Nevertheless, the results also demonstrate how social structures and norms can constrain or facilitate agency. Such structures limit the capability of marginalised groups to perceive opportunities and identify actions to improve their wellbeing, as well as tap onto and develop social networks – such as family members, patrol groups and inter-village networks – to help exercise their agency. Projects aimed at improving the sustainable management of NTFPs need to consider these interactions between agency and social structures to support marginalised NTFP collectors.

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Availability of Data and Material Data is available upon request.

Code Availability Not applicable.

Declarations

Conflicts of Interest/Competing Interests None to declare.

Ethics Approval The research design conformed to the ASA Ethical Guidelines (ASA 2011).

Consent to Participate Free, Prior and Informed Consent was obtained from all research participants.

Consent for Publication All authors agreed with the content and gave explicit consent to submit the work.

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