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ORIGINAL RESEARCH

Understanding the Commercialization Patterns of Non-timber Forest Products and Their Contribution to the Enhancement of Tribal Livelihoods: An Empirical Study from Paschim Medinipur District, India

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Abstract

Non-timber forest products (NTFPs) provide multiple opportunities for the rural economies and are considered a valuable source of income for tribal livelihoods, especially in India. A large number of rural people in India are dependent on NTFPs for fulfilment of their basic needs. Accordingly, this study assessed the role of various NTFPs, their commercial behaviour and future potential. In particular, this article assesses the contribution of NTFPs to the enhancement of livelihoods of Santal tribes of the Paschim Medinipur district of India and examines the commercialization pattern vis-a-vis highlighting the suitable management strategies. Ethnobotanical data, household survey from the forest dwellers and market survey were the primary data sources, used in this research. The use value of different species was calculated to determine the multipurpose use, as well as the importance of various NTFPs. The method of collection, marketization, and economic value of various NTFPs was determined through participatory appraisal techniques and market survey. The market channel, net return, and price spread modelling were adopted to determine the commercialization patterns of NTFPs. Multiple regression models were run to determine the price and marketization factors of NTFPs. It was observed that tribal dwellers are selling their products to local agents or intermediaries due to a lack of knowledge of value additionality, lack of restoration potentiality and lack of access to market. Consequently the price spread of the NTFPs is higher in metropolitan and global markets than in the local markets Participatory community-based development strategies can be used achieve maximum benefits from NTFPs for local communities.

Keywords Use value of NTFPs · Price spread analysis · Multiple regression model · Commercialization potential · Santal livelihoods

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Extended author information available on the last page of the article

Introduction

Forests are an important source for many products including timber, food, fodder, and medicine and construction material for subsistence. Forest plays an important role in enhancing livelihoods for rural communities, particularly for the tribal people in many developing countries and act as a 'safety net' in times of hardship (Wollenberg and Ingles 1999). According to the FAO (2005), about 80% of the population in the developing countries fulfil their basic needs, especially foods, housing materials and primary health care through the utilization of non-timber forest products (NTFPs) (Lax and Köthke 2017). Therefore forests have multipurpose benefits, including monetary and non-monetary assistance (Mugido and Shackleton 2018). Indigenous tribal people often benefited from the forest because they used forest products to fight for survival (Nuesiri 2015). NTFPs collection and marketing is a traditional economic activity in many regions of the world. In particular, NTFPs play a vital role for tribal people and provide a vast source of subsistence, income, spiritual and livelihood security (Peters et al. 1989; Harbi et al. 2018). Indigenous tribal people known as 'ecosystem people' (Saha and Sengupta 2014) use traditional ecological knowledge (TEK) to sustain these forest products. Moreover, there is a significant percentage of the rural population that is highly dependent on forest resources (Piya et al. 2011; Khosravi et al. 2017). The Scheduled Tribes, who are located in the vicinity of forest, depend on forest-based earnings (Zhu et al. 2017).

Forest dwellers can extract variety of forests-based products like timber (Kumar and Jain 2002), non-timber (Senaratne et al. 2003; Howell et al. 2010; Khosravi et al. 2017) and medicinal components (Kandari et al. 2012; Saha and Sengupta 2014) for earnings and upholds their livelihoods. Forest-based products are often transformed into secondary products through processing to earn more returns (Jha 2016). Usually, tribal peoples are not so well-known with this system (Obayelu et al. 2017). Therefore, they are mainly selling the raw materials directly to local markets or through the intermediaries and sustaining their livelihood (Nuesiri 2015). Currently, it seen that, NTFPs provides more benefits by the process of value addition, i.e. transforming into secondary products (Neumann and Hirsch 2000; Mahapatra and Tewari 2005; Tewari 2014). In India, over 53 million tribal peoples and around 60% of the rural communities directly or indirectly benefit from NTFPs and it is estimated that NTFPs generate 3 billion rupees (approximately USD$40 million) yearly (FAO 2005). Shaanker et al. (2004) estimated that over 50 million people in India depend on NTFPs for their livelihood as well as for sustenance. According to the National Commission on Agriculture (NCA 2005), utilization and marketization of NTFPs brings an economic revolution in the economy of Scheduled Tribes (GoI 2006). NTFPs are considered less ecologically destructive than timber harvesting and way of sustainable use of forests (Shackleton and Pandey 2014). Moreover, India has a monopoly over some non-timber forest products such as Karaya gum (*Sterculiaurens Roxb.*), Sandalwood (*Santalum album*), and Myrobalan (*Terminalia chebula*) (Yadav and Basera 2013). Therefore, the mercantile of NTFPs is considered a

very potential economic source, especially for the forest dwellers. But, the process of marketization of NTFPs is mainly limited in local area, specifically the rural market (Senaratne et al. 2003) due to a lack of knowledge and opportunities. Many indigenous tribal people are increasingly exposed to the outside world and they are modifying their livelihood status to more fully take advantage of market opportunities related to NTFPs (Senaratne et al. 2003; Howell et al. 2010; Mukul 2011). Households having farming as their major occupation and are located near forest areas have the opportunity to collect and sell forest products as another source of income and thus enhance their livelihoods (Ongle 1996; Rueff et al. 2008; Khosravi et al. 2017).

In the case of tribal peoples, they often mainly depend on forest products and there is an uncertainty due to seasonality, deforestation and the nature of forest composition (Dash et al. 2016). Tribal people, constitutionally known as 'Schedule Tribes' in India, have the right to collect forest products, access the forest areas, use forests as grazing grounds and the right to protect as well as safeguard community forest resources by the Forests Right Act, 2006 (GoI 2006). As per the 'Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006' (GoI, 2006), the tribal forest dwellers, specifically Scheduled Tribes, get some special rights on the utilization of forest resources and harvesting in the forests for livelihood purposes. As per the 'Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Amendments Rules, 2012', the forest dwellers need the approval of the Forest Rights Committee only for the utilization of timber based forest resources. So Scheduled Tribes have the special constitutional opportunities over the utilization and harvesting of NTFPs. However, due to development activities, uncontrolled and unscientific deforestation, mainly for timber extraction from the dense forests area in India, the forest has become fragmented or lost completely (Dutta et al. 2017) and consequently minimizing the collection of NTFPs.

NTFPs have a huge economic potential through which they can be a part of the rural GDP, but many of the tribal people who are the primary collectors of NTFPs are deprived of these benefits and get only a slight share of money (Sarker and Das 2007; Lax and Köthke 2017). A review of the literature indicated that collection and marketization efficiency of NTFPs depends on several factors including distance to market, seasonality, age, sex, cost and conservation practices (Omiti et al. 2009; Byron et al. 2014; Egbetokun et al. 2017). Market channels are determined in part by the value of NTFPs which is basically controlled by intermediaries' middleman (Jha 2016) who are the most dominating factor of controlling the price of NTFPs and their marketization behaviour. It was found that there has been a huge price gap for NTFPs across different markets (Obayelu et al. 2017; Mugido and Shackleton 2018). Mahapatra and Tewari (2005) noted that, in India the middlemen or local lenders were collecting NTFPs from tribal collectors at very low costs and selling them in urban markets for much higher prices. Sometimes they sold these products after value addition, i.e. cleaning, processing and packaging and earned more benefits (Shackleton et al. 2008). There has been lots of previous research highlighting the price differentiation of NTFPs among various markets (Jensen 2009; Mugido and Shackleton 2018), but in this study, we employ the concept of use value

(Phillips 1993) as a controlling factor of NTFPs marketing and categorize the price of NTFPs in local, urban, metropolitan and global markets through a primary market survey and price spread analysis (Parihari and Chatterjee 2015). Gadgil et al. (1993) stated that tribal people have traditional ecological knowledge (TEK) and it should be incorporated into the sustainable management of NTFPs. The future market potential should be considered for the improvement of tribal economies (Arvola et al. 2019). From this standpoint, this study uses the analytic hierarchy process (AHP) to select the most suitable NTFPs to manage and add value for marketing with local tribal collectors.

This article highlights the role of NTFPs in the contribution to livelihood support of tribal people in India and major issues regarding the potential collection and marketization of NTFPs (GoI 2006). There are two major hypotheses which are considered in this study: first, the benefit and values of NTFPs depend on their use value, and second, there is a huge variety of the prices of NTFPs in different markets. Therefore, this study focuses on the role of value addition for NTFPs which will be enhancements for economies of the tribal people, as well as rural livelihood. Therefore, three specific research questions emerge: how far do NTFPs contributes to the tribal livelihood, what are the factors that control the price of NTFPs and what are the major problems related to the marketization of these NTFPs. The article concluds with a discussion of its findings and recommendation for community development appraisal approach to the maximum benefits from community forest.

The Study Area

The study area (Fig. 1) is, Garhbeta-II block located in Paschim Medinipur district of India. It is the part of the belt of the Chotannagpur Plateau that gradually slopes down towards the east, creating an undulating surface with infertile, lateritic soil. The landscape changes from dense dry deciduous forests in the west to marshy wetlands in the east. In Garhbeta-II block, about 90% of the area has lateritic soils and 10% has alluvium soils. It has an average elevation of 38 m. The Santal community is the major Scheduled Tribes in this area (Census 2011). The Paschim Medinipur district has a forest cover of 1,71,935 ha, among them Garhbeta II block has forests that cover 15,712 ha, which is 41% of the reporting area (State Forest Reports 2012). The forest of this area is characterized by tropical dry deciduous forest and major species are Sal (*Shorea robusta*), Teak (*Tectona grandis*), Babla (*Vachellia nilotica*), Mahwa (*Madhuca longifolia*) and Amla (*Phyllanthus emblica)*. Sal is the dominant species in terms of ecological, environmental and socio-economic aspect. The forest composition of the study area is shown in Fig. 2. The forest-based earnings are one of the primary economic sources for local communities due to a lack of job opportunities, a deficiency of economic development, poor literacy, scantiness of production opportunities for agricultural development and antagonistic environment. Therefore, most of the households in this area are compelled to be involved in NTFP collection as part of their livelihoods.

Recently in India, an NTFP harvesting strategy was importance in order to increase the earnings for Scheduled Tribes who are dependent on NTFP harvesting (Parihari

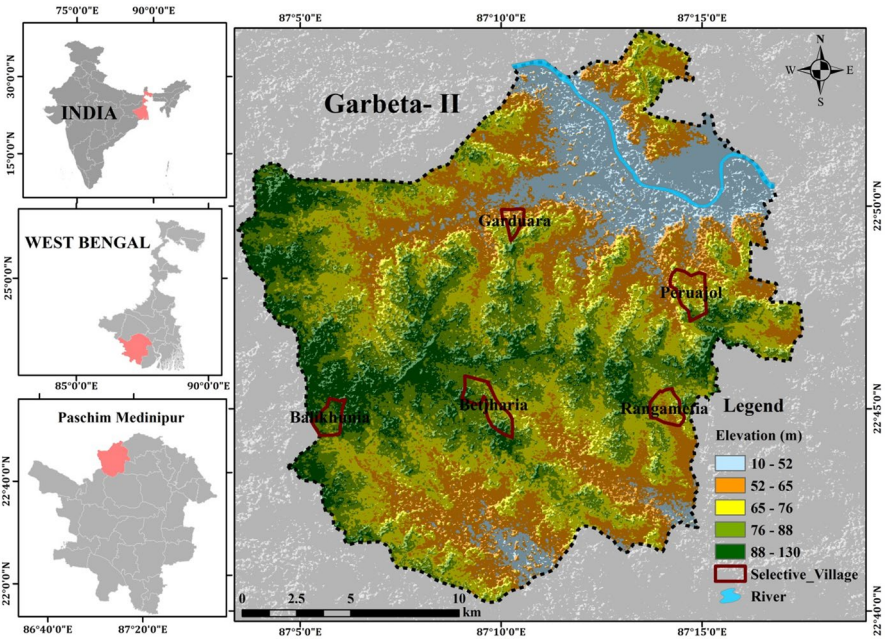

Fig. 1 Location of Garbeta—II block and the location of case study villages in Paschim Medinipur district, India

and Chatterjee 2015). There have been numerous of studies regarding the NTFPs based economy of this area (Ghosal 2011; Shit and Pati 2012; Dolui et al. 2014; Parihari 2018) and it has been highlighted that tribal people have been collecting forest products from their time of their ancestors. This reliance on NTFPs is ongoing because they are very close to nature, they have the legal rights to utilize forest resources, and they have traditional ecological knowledge in the collection of various NTFPs and use them for subsistence and commercial purposes (Ghosal 2014; Parihari 2018). Therefore, they differ from other forest-dependent rural communities in India in terms of utilization of NTFPs. In 1976, the National Commission of Agriculture (NCA) recommended the scientific study and utilization of NTFPs from community forests to increase the overall well-being of forest dwellers (Jewitt 2002). The Government of West Bengal has also taken an initiative to promote NTFPs collection from community forests and to protect forests from illegal timber extraction (Ghosal 2014). From this viewpoint, the selected study area lagging behind to implements these initiatives. So it is necessary to understand the inherent inertia that hinders the productivity and utilization of NTFPs.

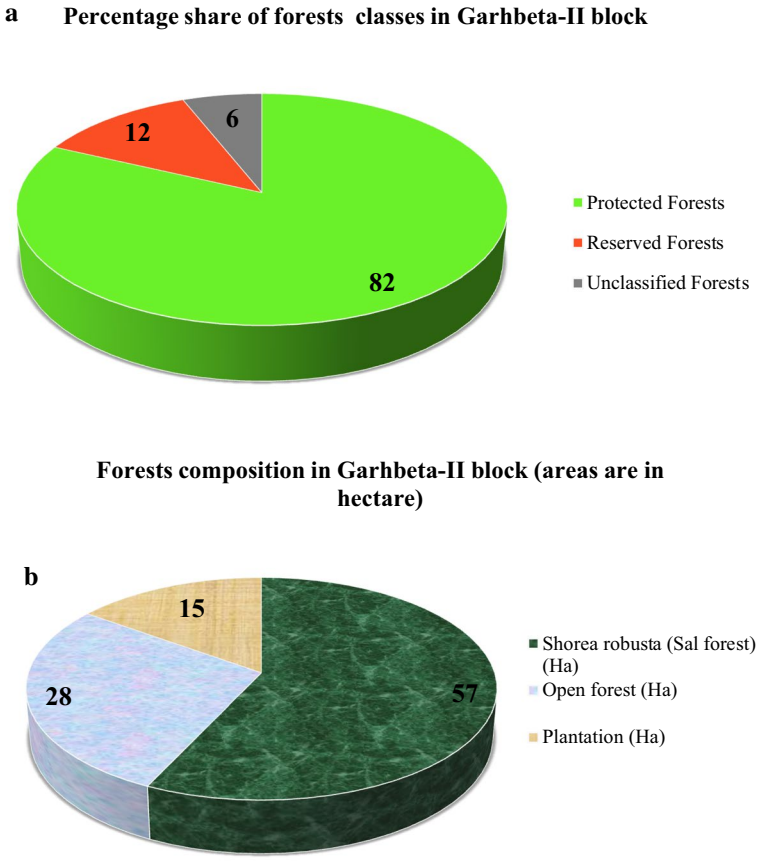

Fig. 2 **a** Forest class and **b** forest composition of study area

Methodologies

On-site Survey and Collection of Ethno-botanical Data

The data adopted for this study are both qualitative and quantitative in nature. A structural questionnaire was prepared based on previous literature and expert opinions. The data were collected using the questionnaire, observations, interviews, and information from community elders about the distribution of forest resources, species composition, NTFPs utilization and their economic benefits. The five villages selected for field survey were Garduara, Peruajol, Balikhunia, Betcharia and Rangametia which are dominated by Scheduled Tribes (Census 2011) in particular the Santal tribes. The collection of ethno-botanical and traditional ecological knowledge (TEK) based data required approval from the relevant authorities and

initially, for this purpose, we took approval from the local administrative authority (Rural Panchayats) of selected villages. Moreover, we also obtained permission from the interviewees. A random sampling technique was used for household survey ($n = 186$) by convenient zoning method using roads as the settlement pattern of these areas are dispersed in nature. The opinion survey involved community elders who have a strong association with the traditional uses of forest resources and indigenous methods of forest preservation. Among the total respondents, 60.52% were female and 39.48% were male. It is noteworthy that female members of selected households were questioned more frequently because women are the main collectors as well as carriers of NTFPs in the study area. The concentration of tribal population and literacy rate were collected from the Census of India (2011). A market survey was adopted to determine the monetary value of each NTFP. The existing forest cover and forest density were determined from Landsat OLI-8 satellite data (USGS; 2017).

Measurement of Use Value

The benefits and use of different species were identified using field observations, as well as expert opinion. Phillips (1993) designed the following statistic to analyze the use value of various species:

$$UV_{i,s} = \frac{\Sigma U_{i,s}}{N_{i,s}} \tag{1}$$

$UV_{i,s}$ stands for the use-value (UV) attributed to a particular species *(s)* by one informant *(i)*. This value is calculated by summing all of the uses mentioned in each event by the informant ($U_{i,s}$) and dividing by the total number of events in which that informant gave information on the species ($N_{i,s}$). The higher the use value indicating the more the demand for that particular NTFPs (Parihari and Chatterjee 2015).

Price-Spread Analysis

The market survey was done to calculate market channels and price spread. Price spread is the difference between the market price and producer price. Price spread is related to retail price and marketing input price (Wohlgenant and Mullen 1987). Three local markets, three urban markets, two metropolitan markets and four global markets were surveyed (online market viz. www.amazon.in, www.flipkart.com, www.ebay.in, and www.bigbasket.com, accessed on 16th November 2017 and 10th January 2018) and values averages by market type. Price spread can be calculated as:

$$Ps = \left(\frac{Pm - Cp}{Cp}\right) \tag{2}$$

where Ps is the price spread of a particular product, and Pm and Cp represent market and collectors' prices for a specific products, respectively.

Factor Analysis and Correlation Statistics

Multiple correlation coefficients were used in this study to find out the correlations between factors and their role in determining the price of various NTFPs. Initially, the variables were determined through relevant literatures and field survey. Factor analysis was carried out to find relevant factors. The internal consistencies of variables were evaluated through Cronbach's alpha statistics. Sampling adequacy of every variable was measured with KMO (Kaiser–Meyer–Olkine) and Bartlett's test for factor analysis (Cerny and Kaiser 1977). The distance factors (Byron et al. 2014), cost factors (Omiti et al. 2009; Obayelu et al. 2017), opportunity factors (Mahapatra and Tewari 2005; Mugido and Shackleton 2018) and management factors (Sarker and Das 2007; Tewari 2014) and their 11 sub-factors were considered as controlling factors. The importance of each factor was determined through multiple regression analysis. The dimensions of all variables were evaluated using principal component analysis (PCA) with Varimax rotation. Variable with factor loadings of more than 0.5 were considered relevent (Hair and Anderson 1998). The IBM SPSS Statistics 20 and R Studio were used for analyses.

Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) (Saaty 1980, 2008) was used to determine sustainability weights of various NTFPs. This methodology is a numerical assessment of alternatives, based on a systematic assessment of a set of decision alternatives (Dash et al. 2016; Zhu et al. 2017; Oses et al. 2018; Ghosh et al. 2018, 2019). On the basis of the results, the most effective alternative can be established to improving rural livelihoods. The relative importance of the parameters (Supplementary Table 1) can be determined through the AHP and pair-wise comparisons of parameters. This judgement can be represented by the introduction of an appropriate scale (Saaty 2008) to build and explain the judgment matrix V (V represents the variables), as expressed by the following equation:

Matrix containing weights

$$V = \begin{pmatrix} \boldsymbol{v_1} & \boldsymbol{v_j} & \boldsymbol{v_n} \\ v_1/v_1 \ \ldots & v_1/v_j \ \ldots & v_1/v_n \\ \vdots & \vdots & \vdots \\ v_i/v_1 \ \ldots & v_i/v_j \ \ldots & v_i/v_n \\ \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots \\ v_n/v_1 \ \ldots & v_n/v_j \ \ldots & v_n/v_n \end{pmatrix} \begin{pmatrix} v_1 \\ \vdots \\ v_j \\ \vdots \\ \vdots \\ v_n \end{pmatrix} = n \begin{pmatrix} v_1 \\ \vdots \\ v_i \\ \vdots \\ \vdots \\ v_n \end{pmatrix} \tag{3}$$

where v is the values of variables that represents the importance of ith factors on jth factors therefore, $v_{ij} = 1/v_{ji}$, for $v_{ij} \neq 0$ and $v_{ij} = 1$, for $i = j$, where $j = 1, 2, 3, 4, \ldots, n$. The relative weights, called Eigenvectors are designated as $w = [w_1\ w_2\ \ldots\ w_n]$ and

Lambda Max (λ_{max}) for each matrix of order n and therefore, the weights are calculated as:

$$Vw \cong nw \Rightarrow (\mathrm{V} - \lambda_{\max}\mathrm{I})\mathrm{w} = 0 \Rightarrow \lambda_{\max} = \frac{1}{n}\sum_{j=1}^{n} W_{ij}\frac{(Vw)}{Wi} \tag{4}$$

where V is the comparison matrix, w is weight matrix and λ_{max} is eigen-values. Then, the consistency index (CI) for each matrix of order n was calculated using following equation:

$$CI = \left(\lambda_{max} - n\right)/(n-1) \tag{5}$$

The consistency ratio of the overall assessment it can be calculated using the equation:

$$CR = \frac{CI}{RI} \tag{6}$$

where RI represents the random consistency index obtained from a large number of simulations and varies depending upon the order of the matrix (Saaty 2008) (Supplementary Table 2). If the CR is less than 0.10, then the judgment matrix is considered as satisfactorily consistent, otherwise, the judgment matrix should be adjusted (Saaty 2008).

Results

Forest Composition and Variety of NTFPs

The dependency and income from NTFPs are highly related to the composition and nature of the forest (Hawkes 1990). The study area is dominated by a dry deciduous forest dominated by Sal along with Mohua and others associated species such as medicinal plants. Plantation in the area includes Akashmoni, Bamboo and Cashew nut (Supplementary Table 3). These forests occur in separated patches of varying sizes and in many instances as islands surrounded by cultivated fields and habitations. Normalized Difference Vegetation Index (NDVI) was applied to determine the existing forest cover, as well as forest density. There were two types of forests found including dense forest and open forest. The area of dense forest is 94.36 Sq. km and the area of the open forest is 127.16 Sq. km. The concentrations of tribal peoples in this area are proportional to the forest density (Fig. 3). The tribes of these areas have substantial indigenous knowledge about health care using NTFPs. They use different parts of plants as medicine as they are readily available, safe and cost-effective (Supplementary Table 4). Most of the ethnic forest villagers are still bound to rely on herbal drugs. The seasonal availability of NTFPs has a significant role in income as well as the market potentiality. It is seen that the availability of different NTFPs have different collection periods, i.e. seasonal collection. The maximum availability of NTFPs indicated a higher value of market potentiality and higher economic value

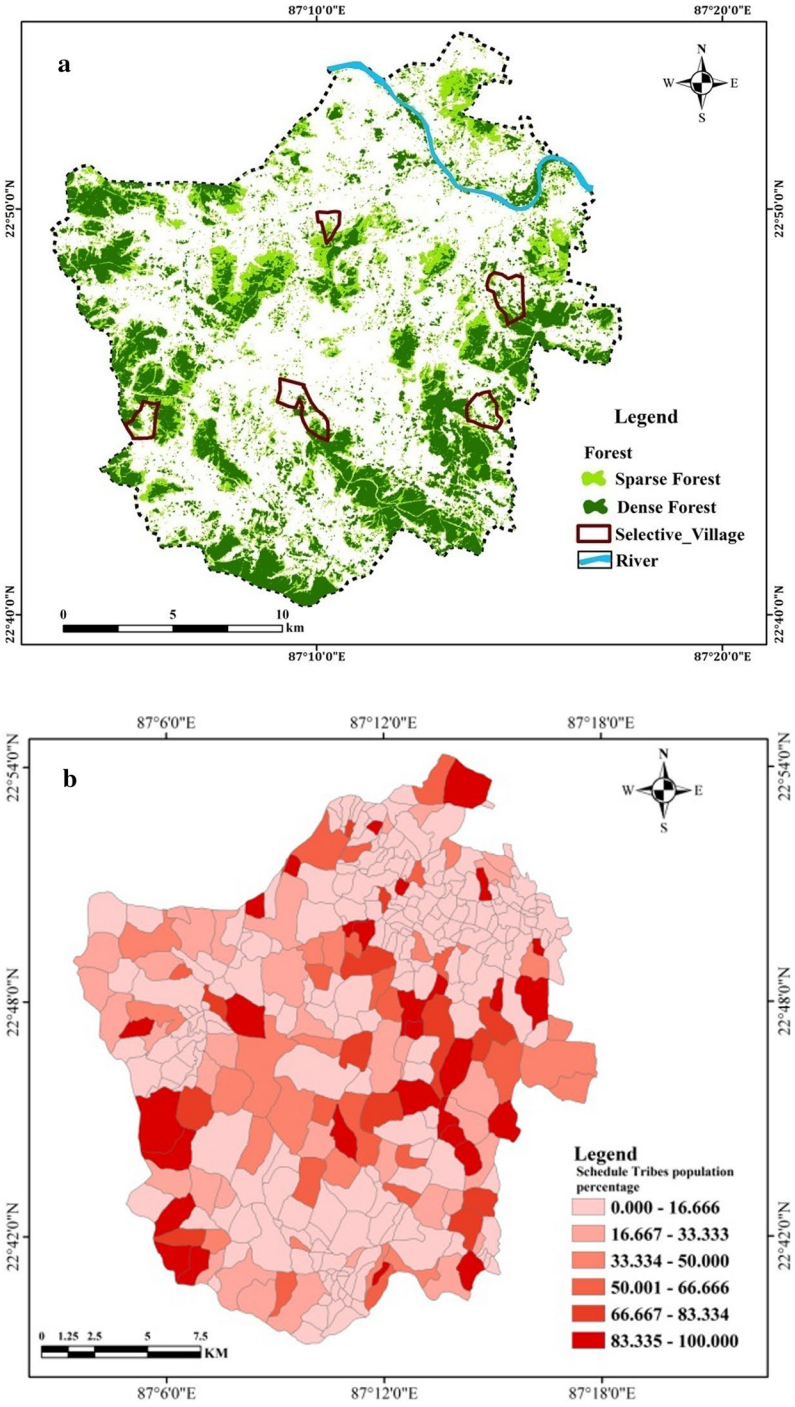

Fig. 3 Relation between **a** forest density and **b** tribal concentration in Garbeta Block-II, Paschim Medinipur

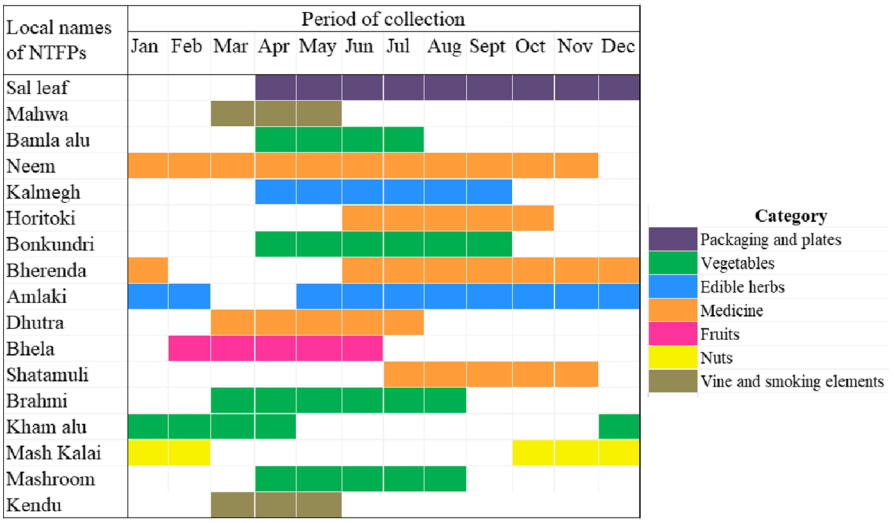

Fig. 4 Seasonal variation of collection of various NTFPs and their caregories in Garbeta Block-II, Paschim Medinipur

(Mugido and Shackleton 2018). The NTFP calendar of these areas is represented in Fig. 4.

Both men and women are actively involved in the collection of NTFPs, but in many cases it is seen that, women are spending more times collecting and processing the products. It is also seen that, females are mainly collecting products which are easily available in forests and mainly retails in local markets. These products have lower market value and not provide higher returns, for example Kalmegh, Dhutra and Brahmi. But males are typically involved in products that required more human labor or have higher market values, for example Bamla alu, Kham alu and Mahwa.

The Use Value of NTFPs

The use value of NTFPs was calculated to determine the economic importance of these species (Fig. 5). It is seen that among the species, the Sal trees have the highest use value ($UV_{Sal} = 3.5$) because Sal are used for several purposes including as medicine, fodder, firewood, agriculture tools, building materials, material culture and also furniture. The lowest use value species are for Mushrooms, Bamla alu, and Kalmegh ($UV_{Mushroom} = 0.5, UV_{Bamlaalu} = 0.5, UV_{Kalmegh} = 0.5$) because they are only used for food and medicine. Mahwa, Kendu, Neem, and Amlaki have use values of $UV_{Mahwa} = 2.5, UV_{Kendu} = 2.2$, and $UV_{Amlaki} = 2.0$, respectively. Production ranking of the NTFPs is from (highest to lowest) $Sal > Mahwa > Kendu > Neem > Amlaki > Mash\ Alu > Bonkudri > Horitoki > Khamalu > Bamlaalu > Kalmegh > Mushrooms$.

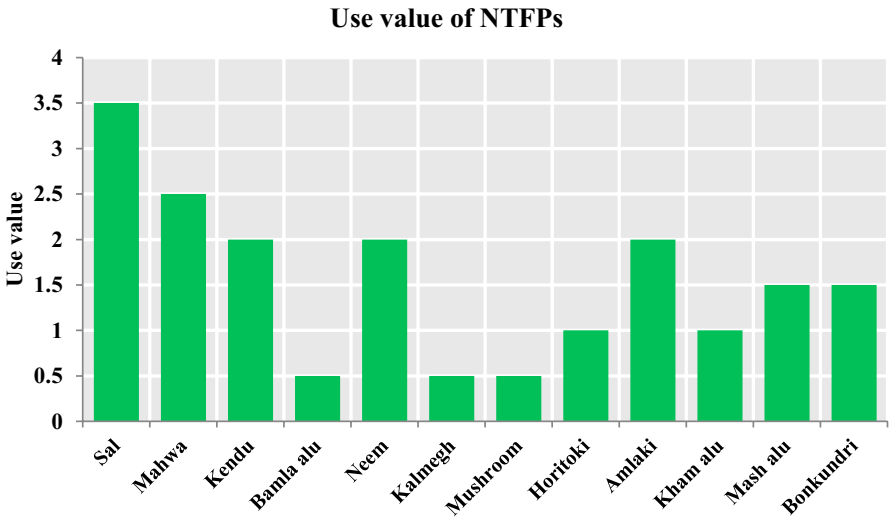

Fig. 5 Use values of various NTFPs in the study area

Table 1 NTFPs and their economic importance

Sl. no.	Local name	Parts used	Availability (in months)	Commercial importance	Monetary value
1	Sal leaf	Leaf	9	Yes	INR 300/1000 plates
2	Sal seed	Seed	3	Yes	INR15/Kg
3	Firewoods	Woods	Entire year	Yes	INR 6/Kg
4	Kendu	Leaf	3	Yes	INR 30–40/bundle
5	Mahwa	Bark, flower,	2	Yes	INR 15–20/Kg
6	Bamla alu	Tuber	4	Yes	INR 20/Kg
7	Neem	Leaf	11	No	INR 5–10/kg
8	Kalmegh	Leaf, whole	6	Yes	INR 10/bundle
9	Horitoki	plant	5	Yes	INR 50–70/kg
10	Amlaki	Fresh Latex	8	Yes	INR 30/kg
11	Dhutra	Leaf, fruit	5	No	INR 20–30/kg
12	Bhela	Seed	4	No	INR 10–15/kg
13	Shatamuli	Leaf	4	Yes	INR 70–80/kg
14	Ban ritha	Fruit, seed	2	No	INR 30/kg
15	Kalmegh	Root	6	No	INR 10–15/kg
16	Brahmi	Leaf, fruit	5	Yes	INR 10–15/kg
17	Kham alu	Seed	4	Yes	INR 15–20/Kg
18	Mash-kalai	Leaf, whole	4	Yes	INR 30–40/kg

All price are in Indian rupees (INR) and come from primary market survey in 2017

(1 USD = 69.99 INR, according to Reserve Bank of India, for the month of January 2019)

The Economic Value of NTFPs

The monetary value of NTFPs is dependent on the demand and supply for products and marketization opportunities. Many of the collectors sell their products in the local market or through local agents. The forest products and NTFPs account for more than 40% of the economic contributions to the livelihoods of the Santals. The availability of the products, their monetary value, commercial importance and utilization is highlighted in Table 1, and is based on the participatory appraisal techniques. The economic importance of NTFPs includes the costs and returns involved in their collection and marketing. The opportunity cost of labor is estimated considering the average labor man-days involved in NTFP collection. The cost of labor is measured using the wage rate in the off-season (INR150 Rupees/day, according to the local Panchayat authority). The cost of time spent in NTFP collection is imputed from the opportunity wage rate prevailing in the study area. The gross income per household derived from the sale of products is calculated by considering the difference between the total quantity collected and sold. The costs and returns of different NTFP obtained during the collection season are shown in Table 2. Among them, Mahwa has the highest economic value in terms of net returns.

Marketization Behaviour of NTFPs

Factors Determining the Price of NTFPs

The factors which determine the prices of various products were asked from the collectors and are categorized into four groups for analysis. The distance (in km) covered for collection of NTFPs, distance of nearest market (in km), and distance of urban market (in km) are grouped under distance factors; labour costs (wages INR150 per day or 2.16 USD per day) for collection, transport costs for marketization and management costs (including labour and other processing costs) of products are grouped under cost factors; collection period (in days), collection time (in hours) and the time required for marketization are considered the availability factors; and knowledge of value addition and knowledge of conservation practices are considered the management factors (Pattanaik and Dutta 1997; Sakai et al. 2016). The practices of the preparation of secondary products, processed products, and packaging processes are considered as a measurement of value addition (Mukul 2011). In the same way, management practices of NTFPs are measured by some factors including available place for conservation (storehouse), duration for the conservation, and preservation tools. A 5-point weighted scale was used to grouping the collected data. Then, factor analysis techniques were employed for determining which factors are responsible for controlling the market price of NTFPs (Table 3). The overall Cronbach's alpha is 0.799. The value of the KMO is 0.803 and Bartlett's test has p value of 0.01 (at 95% significance level, $a = 0.05$) that accepted these factors. The loading factors of 0.5 or more are considered for further analysis. Factors including distance covered for

Table 2 Collection and marketization cost for NTFPs and their Net returns

Sl. no.	Local name	Average quantity sold	Monetary value (INR)	Gross return (INR)	Distance for marketiz-ation (Km)	Transport cost (INR)	Labour man day	Cost of labour[a] (INR)	Net Return (INR)
1	Sal leaf	20 bundle	INR 300/1000 plates	6000	5	20	25	3750	2150
2	Sal seed	10 kg	INR 150/kg	1500	5	10	5	750	700
3	Kendu	100 bundle	INR 40/bundle	4000	15	20	15	2250	1450
4	Mahwa	1.5 Qt	INR 20/Kg	4500	10	10	10	1500	2900
5	Bamla alu	30 kg	INR 20/Kg	600	5	10	2	300	250
6	Horitoki	2 kg	INR 250/kg	500	10	20	2	300	150
7	Honey	15 kg	INR 80/kg	1200	15	15	5	750	225
7	Amlaki	50 kg	INR 30/kg	1500	15	30	5	300	750
8	Shatamuli	5 kg	INR 80/kg	400	5	10	2	300	50
9	Brahmi	35 kg	INR15/kg	525	5	10	2	300	175
10	Kham alu	35 kg	INR15–20/Kg	700	5	10	2	300	250
11	Mash-kalai	30 kg	INR 40/kg	1200	10	20	5	750	250

All price are in Indian rupees (INR) and come from primary survey in 2017

(1 USD = 69.99 INR, according to Reserve Bank of India, for the month of January 2019)

[a]Cost of labour is calculated with mean INR 150 rupees wage per day

Table 3 Results of Factor analysis showing the importance of variables of NTFPs

Variables	Factor_1	Factor_2	Factor_3	Factor_4
Distance factors				
Distance cover for collection of NTFPs	0.851			
Distance of nearest market	0.797			
Distance of urban market	0.425 (excluded)			
Cost factors				
Labour cost for collection		0.627		
Transport cost for marketization		0.790		
Cost for management of products		0.407 (excluded)		
Opportunity factors				
Collection period in days			0.719	
Collection time in hours			0.709	
Time required for marketization			0.410 (excluded)	
Management factors				
Knowledge of value addition				0.670
Knowledge of conservation practises				0.422 (excluded)
Eigen value	4.751	4.102	3.921	3.521
Percentage of variance	22.671	21.327	18.651	16.650
Cumulative percentage	74.552	52.998	41.488	8.150
Cronbach's alpha	0.890	0.736	0.831	0.786

collection of NTFPs, distance to market, labour costs and collection period are achieved higher importance during factor analysis. Similarly, few factors including distance to urban markets, management costs and knowledge of conservation practises are gained weights below 0.5. Consequently, they are excluded from further analysis.

Multiple regression analysis was used to find out the significance and contribution of these factors to determining the price of NTFPs. Multiple correlations were run for each individual variable separately. The tolerance value of selected variables is more than 0.1 and VIF values are nearer to 2.5 indicating the values are within the accepted ranges (Supplementary Table 5). The Durbin–Watson value is 2.079. The results of the multiple regression analysis are displayed in Table 4. Distance factors ($p < 0.01$), cost factors ($p < 0.01$) and availability factors are significance ($p < 0.05$) for marketization oppurtunities for NTFPs, but management factors were not significant. The correlation coefficients of these factors were shown in Table 5. The price of NTFPs i.e. income is positively related to total days of the collection period, total hours spent for collection, knowledge of value addition and marketization distance and negatively correlated with

Table 4 Results of multiple regression analysis

Independent variables (factors controlling on the Price of NTFPs)	Dependent variables (Price of NTFPs)
All variables	$R^2 = 0.791$
	Durbin–Watson = 2.065
Distance factors	Beta = 0.871**
	t = 3.257
Cost factors	Beta = 0.769**
	t = 1.153
Availability factors	Beta = 0.683*
	t = 1.529
Management factors	Beta = 0.641*
	t = 2.486

**Correlation is significant at the 0.01 level ($p < 0.01$), *Correlation is significant at the 0.05 level ($p < 0.05$)

collection distance. Interestingly, distance of marketization is positively related to the price of NTFPs. The price of collected products is very less in the local market, but these products has huge demands in urban markets and this is the reason when the same product is sold in the urban market, it generally earns more benefits over its transport cost.

Price Spread of NTFPs

According to local collectors, tribal members sell most of their products either in local markets or through local agents who are working as middlemen or lenders in the marketization of NTFPs. The market survey was used to find the price differences of various NTFPs. Sal leaves (used as a biodegradable plates), Sal seed (used as oil), Mahwa (used in skin care products), Haritaki (used in medicine), Honey (used for medicine and food), Amlaki (used in medicine, drinks and others skin care products) have more price spread than other products. The highest price spread is calculated for Sal leaves (*Ps = 14.0*), Mahwa (*Ps = 19.0*) and Haritaki (*Ps = 11.8*) due to their huge market value (Supplementary Table 6). There was a significant difference in the price spread between nearest district markets and metropolitan markets (Fig. 6).

Discussions

Natural forests and indigenous people have symbolically evolved for thousands of years (Mukherjee 2002; Chatterjee and Das 2017). The indigenous Santals tribes in the study area, habitually practises subsistence mono-cropping cultivation (Mondal 2011). They are very much depending on the forest as the alternative sources of income as the opportunities of income from agriculture and daily wage-labor are limited (Delgado et al. 2016). Non-timber forest products (NTFPs) play a principal

Table 5 Result of correlations coefficients

	Income from NTFPs	Distance for collection	Distance for market	Transport cost	Collection Period	Total hours of collection	Knowledge of value addition
Income from NTFPs	1.000						
Distance for collection	− 0.395	1.000					
Distance for market	0.986**	− 0.375	1.000				
Transport cost	0.709	0.371	0.737	1.000			
Collection Period	0.894*	− 0.481	0.752	0.891*	1.000		
Total hours of collection	0.967**	− 0.356	0.597	0.867*	0.962**	1.000	
Knowledge of value addition	0.791*	0.710	0.418	0.678	0.749	0.714	1.000

**Correlation is significant at the 0.01 level ($p < 0.01$), *Correlation is significant at the 0.05 level ($p < 0.05$)

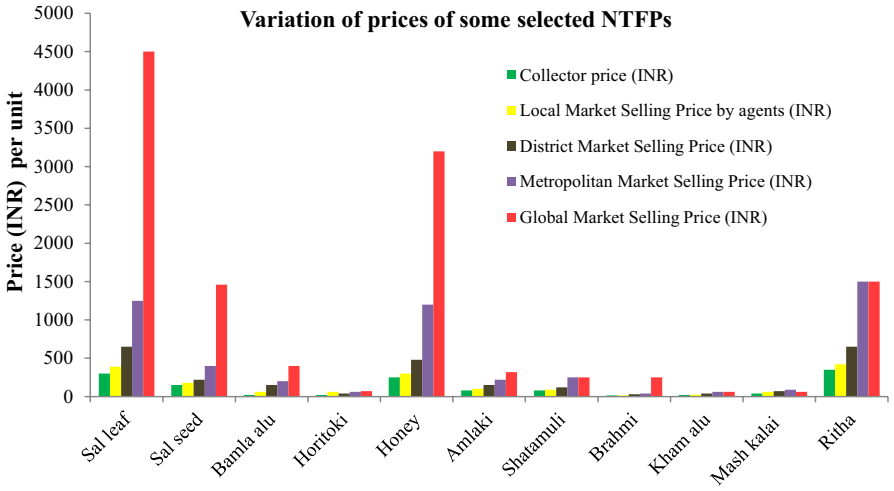

Fig. 6 Price-spread difference among different markets of various NTFPs

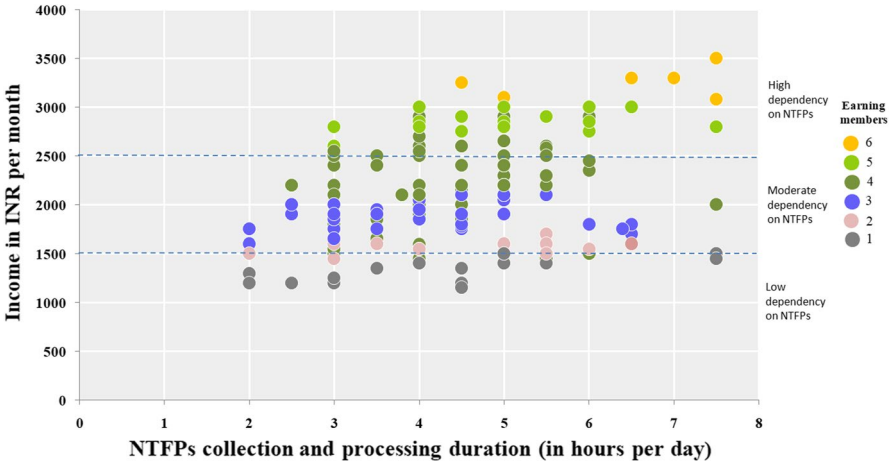

Fig. 7 Distribution of monthly income from NTFPs of surveyed households ($n = 186$)

role in the livelihood of the Santal community in the study area (Dolui et al. 2014). NTFPs provide essential subsistence during the lean seasons (Arnold 2001). Figure 7 is shows the monthly income (in INR) from NTFPs with the duration of involvement in collection and processing (in hours per day) and numbers of the earning member participate with that process. Overall, NTFPs contribute about 30–40% of the annual income to these tribal people. The majority of people gather NTFPs from the adjoining community forest (about 90%) while just 10% source these products from forest reserves. Almost Santal households are involved in NTFPs collection. Moreover, NTFPs collection is the most important activity in terms of labor input. The poorest

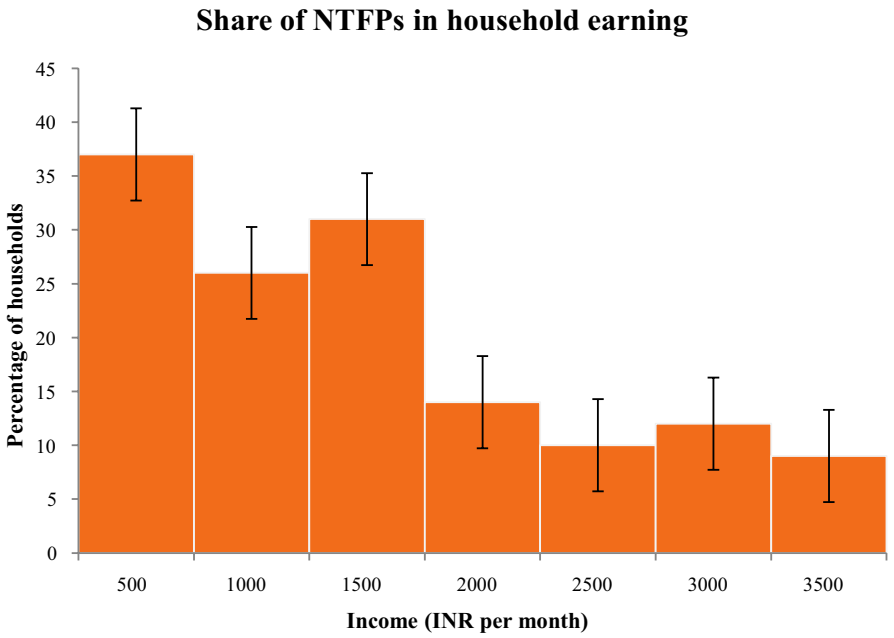

Fig. 8 Share of NTFPs in households earning with standard deviation

households earn money by selling honey, Mahwa, fuelwood, Sal leaves, bamboo, and other NTFPs. It has seen that NTFPs has a significant contribution to earnings and the contribution of NTFPs is included in the monthly income of each family in various proportions (Fig. 8). The incomes from NTFPs show differences depending on location, involvement of manpower, and marketization opportunity.

Although Santal people are aware of traditional knowledge and they have extensive experience in the collection of NTFPs, but there are also substantial limitations to utilization and management (Parihari 2018). Some products have a huge potential to contribute to increase in local livelihoods, but much the income is collected by middlemen who have better market access through various market channels (Obayelu et al. 2017; Arvola et al. 2019). Three types of the market chains were found in this study area:

Channel-1: Primary collectors → Local Development Group → Markets
Channel-2: Primary collectors → Local agents or middleman → Markets
Channel-3: Primary collectors → Markets.

Some edible products were marketed directly by collectors (channel-3) such as vegetables, and green products and they received maximum profits from these products. Transfers of green products are restricted to local markets and the nearest district markets. Similarly, dry products, such as Sal seeds, Mahwa, Shatamuli, Maskalai, and Ritha, are sold in the local markets and the nearest district markets by primary collectors and some of these products were marketed in

metropolitan markets by agents after processing. In the same way, medical products were marketed in the urban markets through the secondary aggregators or agents. However, NTFPs have a huge potential for generating income if the local people do some processing (Perez and Arnold 1996; Tiwari et al. 2010; Pangging et al. 2011). This practice is deficient due to illiteracy, deprivation from infrastructural and organizational facilities, lack of economic self-sufficiency and lack of public collaboration. According to the GoI report (2006), poor accessibility and connectivity, remote location, and lack of food processing industries in this area are also a major issues regarding development of NTFP based economy. Some families in the study area have adopted value addition techniques such as direct marketing of Sal leaf-plates, packaging of honey, packaging of Amlaki and extraction of Mahwa oil (Ghosal 2011; Parihari and Chatterjee 2015).

Many commodities are sold in the market at very low prices in the form of raw materials, but after processing they have the capability to earn 2–3 times more, for example, the ratio of price of raw to processed Mahwa oil, Haritaki powder and Amla juice are about 1:5 per 100 ml, 1:12 per 100 gm, and 1:7 per litter juice, respectively. Local entrepreneurs, local administrators, and the government should take steps to give training to the Santal people about the processing of NTFPs. And price spread can also be reduced through better marketing and stronger managements (Jha 2016). However, it shows a clear idea that NTFPs have a vast potentiality for the economic generation. But needs proper management and creates a scope of value addition of NTFPs through the direct involvement of tribal collectors and the management authorities.

Integrated Value Model for Assessment of Sustainability and Future Potential of NTFPs

The major issues regarding the management of NTFPs according to the tribal community are:

(a) *Excessive bureaucracy and complexity*-although few government enterprises (like Aadivasi Multipurpose Societies and Samabai Samiti) are collecting NTFPs occasionally, it takes a few days to receive payment. Thus local people were going to private traders who pay on the spot (Alex and Vidyasagaran 2016).
(b) *Inappropriate price setting* the price paid for NTFPs varied substantially among traders and in a few cases, traders were obtaining products by deception.
(c) *Gap in participatory forest management* the current participatory forest management (Joint Forest Management scheme) is not always helpful to the local people (Mondal 2011). Forest conservation and timber extraction practices are mainly prioritized by the management authorities. So the process of non-timber products extraction becomes not so effective.
(d) *Knowledge gap* the lack knowledge on commercial processes, technology and industrial processes are key issues in this area.

An alternative approach is to use a multi-criteria decision-making process. This approach can allow priority to be given to those products which have maximum market potential and profits. Generally, the involvement of public or private organizations for the processing of NTFPs can generate higher earnings (Delgado et al. 2016; Chowdhury et al. 2018). The value of the NTFPs may be improved by suitable processing or by secondary products. Multi-criteria decision-making process is useful for such purpose and help to selecting such products. In this study, 10 criteria were selected for analysis of suitable NTFPs using the AHP model. Seasonal availability (*weight* = *0.75*), useable parts (weight = 0.89), income contribution (*weight* = *0.75*) and market potential (*weight* = *0.78*) are the most important criteria for prioritization and selection of NTFPs (Table 6). Selection of NTFPs with high market potential, training of the local Santal community and arrangements to help ensure the proper conservation should be all. However, management strategies should include: (a) determining the suitable and contemporary prices of NTFPs, (b) help to collectors through strengthening indigenous management systems (Dash et al. 2016), (c) improve the value of NTFPs through processing techniques (d) providing financial assistance through a rural bank, cooperative associations, and government enterprises and (g) promote forest management through agronomic practices (Harbi et al. 2018).

Notwithstanding, continuous loss of forests in different areas of the country, a recently published report by Department of Forests, Government of West Bengal highlights that, through community participation and the Joint Forest Management scheme, many degraded forests are being significantly revived and many new forests have arisen through afforestation (State Forest Reports 2018). These new forests can also be good sources for various NTFPs (Mondal 2011). There has a large availability of markets in the surrounding area that might be an opportunity of future development. Figure 9 highlights the possible markets within 10 km, 20 km, 50 km, 100 km and 150 km buffer radius from the study area. It is seen that, the area is well-connected with road networks, national highways and railways. There are more than 15 urban and semi-urban markets within the 20 km

Table 6 Criteria weights for sustainable management of NTFPs

Criteria of NTFPs prioritization	Criteria weights	Average (λ)	CI	RI	CR*
Availability time	0.7598	16.45	0.0092	For n = 10, RI = 1.45	0.006
Harvest time	0.5929				
Regeneration potential	0.6398				
Parts used	0.8906				
Income contribution	0.7954				
Employment creation Potential	0.4345				
Market potential	0.7869				
Competetion	0.4551				
Profit/margine benefit	0.5378				
processing technology place	0.5703				

*Acceptable range of CR is < 0.1

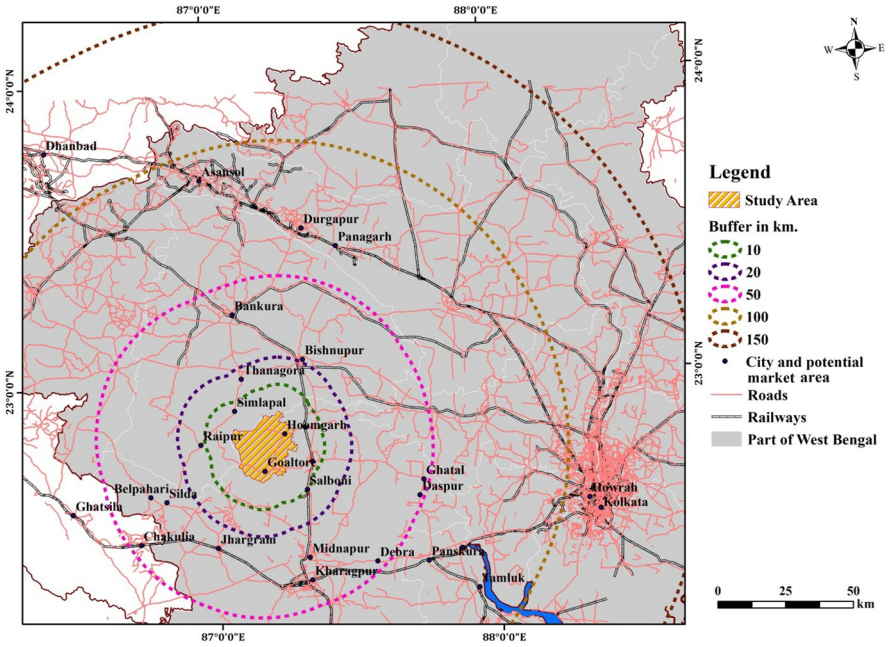

Fig. 9 Possible markets within 10 km, 20 km, 50 km, 100 km and 150 km buffer radius from the study area along with transport networks

buffer zones. Therefore, there is a high potential for marketing of forest products and increasing earnings from them.

Conclusion

Throughout this study it was seen that NTFPs have an enormous role in livelihood sustainability and at the same time tribal peoples are deprived of market prices due to their lack of knowledge, training and facilities and they sell them to local markets or local agents as primary products or unprocessed products. A participatory NTFP management programme should be implemented and be decentralized with equal input from local people and government agencies (Fig. 10). The market survey and price spread results indicated that, NTFPs have a huge potential for income generation, especially with addition of secondary processing by local people. The successful commercialization of NTFPs in the present case study area could be achieved through the implimentation of the food processing technique, proper management, and domestication of NTFPs. NTFPs of this area are mainly confined to the local market due to lack of skill, illiteracy, limited market size, and adequate market chain. The price spread of these products should be minimized in order to strengthen the tribal economy. Research and development activities should also be promoted to improve management, value addition and infrastructural support. However, unscientific exploitation of these products may be a potential risk

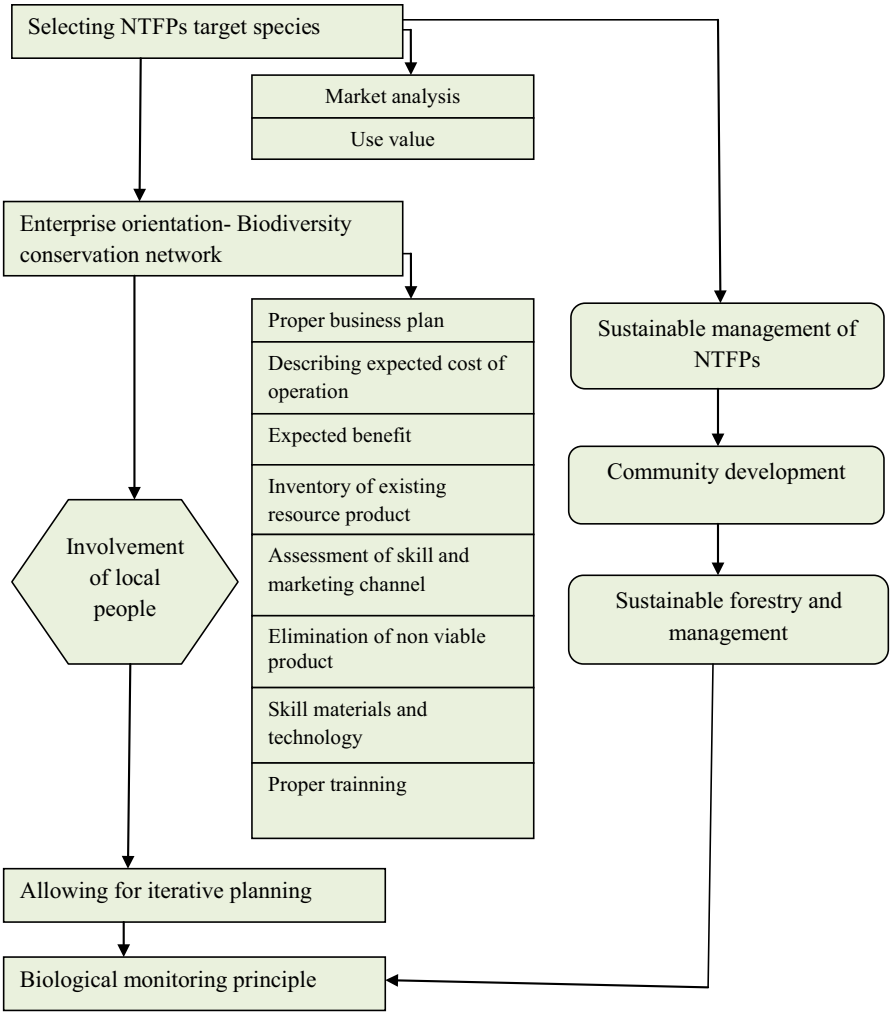

Fig. 10 Framework for participatory based tribal community development appraisal

in this area which can further exasperate price spread. Continuous loss of forests is another concern related to the future availability of those NTFPs, but the Joint Forest Management (JFM) scheme has significantly revitalized existing forests and many new forest areas have been established that can also be efficiently supply various NTFPs. Environment-friendly, sustainable NTFPs extraction practices should be implemented through awareness and knowledge building. The major focus should be given to the increased earnings from NTFPs through processing and suitable marketig rather than the selling of raw materials. Proper methods should be employed to select those NTFPs having maximum returns. Proper management and commercialization should be used to emphasize the conservation of natural forests as well as improving tribal economies which can be achieved through a systematic community

development process. The impact of NTFPs collection and markating on local economy, tribal livelihoods and ecological sustainability also requires further research. However, this study can helping to research on the development of rural livelihoods by optimum utilization of non-timber forest resources.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflicts of interest.

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