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A. Z. M. Manzoor Rashid
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Mahmood Hossain *Editors*

Non-Wood Forest Products of Asia

Knowledge, Conservation and Livelihood

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In loving memories of our fathers
who worked throughout their life for
forest-dependent and grassroots communities
in different capacities:

Late Mr. Mohammad Haroon Rashid
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Late Dr. Mozammel Hossain
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Foreword

This book provides a wide, but also deep, coverage of global and regional dimensions of non-wood forest products (NWFPs) as a crucial and integral dimension of sustainable development with a particular focus on Asia. This has been a significant gap in research and discourse, making this publication a timely and very valuable resource. It focuses on the ecosystem and human rights issues associated with NWFPs such as fruits and nuts, vegetables, fish and game, medicinal plants, resins, essences and a range of barks and fibres such as bamboo, rattans, and a host of other palms and grasses. Prior work in this area has been ad hoc with little attention to the Asian context. Earlier work highlighted the important role of NWFPs in poverty alleviation for forest dependent people. The scale of the problems and the potential for future governance and development strategies are reviewed in the introductory chapter of this book. The contributions of the three highly regarded editors and contributors are very significant in providing a more systemic approach to the Asian region that also draws on some comparative and global experiences.

More specifically, this book addresses the knowledge and research gap in NWFPs in relation to the integral connection between sustainable ecosystems, uses, livelihoods and the application of traditional knowledge and practices. It goes further to debate and reflects on approaches to comprehensive action on NWFPs, from conservation and livelihood perspectives. This draws on cases and illustrations of relevant knowledge and practices from different parts of Asia and South-east Asia such as Bangladesh, Bhutan, Vietnam, Philippines, Nepal, India and China.

Another contribution to the literature in this area is provided by the discussion and suggestions relating to crucial governance frameworks. Legal and institutional policies are critical in promoting sustainable conservation of biological resources as well as the current and future livelihoods of forest dependent communities. Legal and institutional policies are necessary for the sustainable conservation of biological resources and livelihoods of these communities. Appropriate attention is given to global and regional treaties and principles need to be implemented, enforced, updated and refined in order to face the massive challenge of forest destruction and the deterioration of ecosystems that NWFPs and their dependent communities rely upon.

I commend the contributors for their relentless dedication, work and resilience, undertaken in the face of huge obstacles (research and knowledge gaps, lack of research funding as well as legal, institutional and practical barriers). This book is evidence of their commitment to the public interest in biodiversity conservation and use in harmony with community development, poverty alleviation and livelihoods associated with NWFPs. It is a better future to envision and strive for.

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Preface

Historically, forests and their diverse biological resources have played an indispensable role in ensuring the conservation and sustaining the livelihood of the millions around the world, particularly the forest dependent rural and Indigenous communities. A substantial amount of forest area (1.15 billion hectares) is managed primarily for the production of wood and non-wood forest products (FAO 2020). The forest ecosystem and its multifaceted amenities are now extensively valued in achieving sustainable development goals, particularly in the forestry sector. In this context, generating knowledge on ecosystem services to address adverse impacts of climate change is meant to be the common agenda of the global community.

According to the World Bank (2002), more than 1.6 billion people rely heavily on forests for their livelihoods, of which about 350 million people exclusively depend on forests for their subsistence and income. The forestry sector creates employment for about 12.9 million people with a value addition of US$ 354 billion (FAO 2007). Thus, the conservation of forest resources is a recognized avenue to the reduction of poverty across the world. The situation is particularly critical in developing countries due to poverty and the rapidly increasing population, leading to a decreasing trend in the availability of livelihood support.

Non-wood forest products, widely dubbed as NWFPs, play a vital role in sustaining the livelihood of forest-dependent people. This form of livelihood supports the local, national and global conservation initiatives by reducing pressure on forests and their resources. Traditionally, a significant number of marginalized communities residing near the forested areas, to a varying extent has dependent on NWFPs for their life and living. On the other hand, NWFPs are also enriched and informed by a diverse range of traditional knowledge and local practices (Hansda, 2009). In this context, there has been a renewal of interests in non-wood forest products, both at regional and global levels. Research on the subject remains generally limited, while the existing studies are somewhat narrowly focused—mostly shedding light on poverty reduction and market dynamics of NWFPs, and confined to specific regions. The knowledge, practices, conservation and sustainability issues of NWFPs in the Asian context were found strikingly limited, hence the need to produce a knowledge repository in the form of a book on the said theme focusing on the Asian context,

one of the major hubs of diversified NWFPs. This book is important for several reasons: (i) notwithstanding the (limited) existing literature, we, however, still await a study that pulls together different strands and dimensions of NWFP by focusing on the nexus between conservation and livelihood from an Asian perspective, a very untouched dimension in the literally and/or scholarly world as a book form; (ii) the general significance of NWFPs for millions of forest dwellers of the world cannot be overemphasized; therefore, any academic pursuit on this subject may be considered worthwhile; and (iii) one clear gap in the existing literature is the focus on the nexus between conservation and livelihood and the traditional knowledge and practices underlying the nexus. This volume aims at addressing the above knowledge gap by bringing a group of prominent researchers, academics and field practitioners under a single platform to debate and reflect on a comprehensive action of NWFPs from a conservation and livelihood perspective drawing on cases and illustrations of relevant knowledge and practices from different parts of Asia. A total of eleven self-contained chapters delineating important aspects of NWFPs representing major Asian countries, including a 'Global-North' experience from Sweden (for the purpose of comparison), have been included in the book.

Enabling legal and institutional policies is critical in promoting sustainable conservation of biological resources and livelihood of the dependent communities. In the backdrop of massive destruction and deterioration of the forests and their major resources, non-wood forest products are receiving growing recognition and playing an applauding role due to their nature and value addition potentials. The introductory Chap. 1 attempts to shed some light on the major legal and institutional policies, particularly from a global perspective, with a view to aware, update and enforce the principles as and where applicable. Significant numbers of conventions, treaties, and protocols (popularly called ICTPs) are being developed and applied as binding and non-binding principles to expedite the process of conservation and sustainable livelihood.

The next Chap. 2 from the North (Sweden) is being considered in this edition with a view to adding further insights into the notion of traditional knowledge from the European national context. How these knowledge and practices are creating conflicting interest with industrial forestry and the possible mechanism for co-existence—constitutes the salient points of discussion in this chapter. Some suggestive measures have also been prescribed to create a win-win scenario between conservation and commercial utilization of forest resources.

The Chittagong Hill Tracts of Bangladesh, popularly known as CHTs, is the country's richest biodiversity hotspot and the treasure house of many NWFPs. Considering the immense potential of the NWFPs of CHTs, Chap. 3 attempts to describe the manifold roles of the NWFPs in promoting food security, health care and related livelihood supports. The significance of traditional ecological knowledge in addressing the depletion, degradation and institutional drawbacks having regards to NWFPs management has also been revealed in the chapter.

India is famous for herbal medicines and their traditional uses. Forest-dependent communities and indigenous people are all widely dependent on traditional medicines for their life and living. This Chap. 4 aims at revealing the ethnobotany of the major

medicinal plants used by the *Tangsa* tribe of Arunachal Pradesh of India. How the ethnobotanical knowledge of various medicinal plants is being preserved and embedded in the cultural and spiritual practices of the *Tangsa* tribe is the salient focus of the chapter.

Mangrove forests are crucial for their multidimensional roles such as biodiversity conservation, ecosystem services and supporting livelihood. The Sundarbans mangrove forest of Bangladesh is not an exception in this regard. Chapter 5 illustrated the utilization, significance and the value chain of the diverse NWFPs produced in Sundarbans mangrove forest. Some policy and sustainable management approaches have also been prescribed to enrich and expand the resources under the sustainability principles and practices.

Bhutan is famous for its environment-friendly development philosophy, and perhaps the only country having Gross National Happiness (GNH) index. Chapter 6 is based on the secondary review of Bhutan's existing contribution of NWFPs to the promotion of GNH. In addition to that, the chapter intended to create connectivity with knowledge, conservation and livelihood aspects of NWFPs in the context of Bhutan.

Bamboo is one of the major and widely popular NWFPs for millions of people, particularly in the South-east Asian countries; hence it is known as 'poor men's timber'. Forest-dependent communities to small and medium scale forest-based enterprises all are heavily dependent on this resource. Considering the immense significance of bamboos in the Philippines, Chap. 7 delineated the role of bamboo in environmental protection and livelihood support in the Philippines. How the government of the Philippines took initiative to promote the bamboo sector for community and economic development are the salient discussant issues of the chapter. Using bamboo to spur income- and job-creating enterprises in bamboo-rich regions of the country by addressing the challenges having regards to knowledge, supply and market information gaps have been reflected in this chapter.

The following Chap. 8 highlighted the significance of NWFPs in Nepal, particularly in the context of provisioning services. How various NWFPs are helping the people residing in remote mountainous regions of Nepal—has been documented in this chapter. Collection of NWFPs from wild and their utilization is supporting the local economy with less or no value addition. It is thus vitally important to shift from the traditional method of harvesting and processing to scientific ones in order to address issues of commercialization of NWFPs, access to the national and international markets, sustainable harvesting, and value addition activities.

Sustainable harvest and use of NWFPs can stimulate forest conservation. Considering this notion in mind, Chap. 9 investigated the NTFP-based product diversity, marketing pattern, challenges in a rapidly changing environment in an urban fringe of north-eastern Bangladesh. The chapter listed major NWFPs and related products and shed some clues for development considering the sustainability issues. Policy interventions, developing coherent marketing channels and supporting potential entrepreneurs—are some of the salient issues in ensuring the sustainability of resources and livelihood.

Vietnam is playing an active role in improving forest conservation by reducing dependency on NWFPs. How a local-level initiative has helped to reduce forest dependency, especially NWFPs, is the salient theme of discussion in Chap. 10. The *Talai* ecotourism venture at the Cat Tien National Park found to have considerably reduced the reliance on NWFPs by the incumbent community. Replication of such interventions demands many derivatives including the following: socio-cultural norms, local institutions, power structures, and ethnic differentiation.

The last Chap. 11 from China documented NWFP's role in poverty alleviation and the environment. The chapter also investigated the role of policy, technology, and market forces in promoting hickory production. Finally, it highlighted the significance of local farmer's cooperatives, government support and the expedition of research and e-commerce initiatives—as the facilitative factor to harness better outcomes.

The above chapters and messages contained herein amply brought home, once again, the crucial significance of NWFPs as a reservor of knowledge, conservation and livelihood. As editors, we hope this volume will prompt further research and academic investigation in this relatively less explored area of study.

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Contents

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Dr. A. Z. M. Manzoor Rashid is a Professor in the department of Forestry and Environmental Science at Shahjalal University of Science and Technology, Sylhet, Bangladesh. He led the School of Agriculture and Mineral Sciences as Dean and the Department of Forestry and Environmental Science as Head in the same university. Dr. Rashid achieved substantial working experience with local community while working in the country's leading development organization named PROSHIKA. Dr. Rashid achieved post graduate degrees in Forestry, Environment and Development and Environmental Science from University of Chittagong, Bangladesh, Imperial College, UK and Swedish University of Agriculture Sciences (SLU), Sweden and Ph.D. from Western Sydney University, Australia, respectively. More than two decades of teaching and working experiences, Dr. Rashid has enriched himself with contemporary issues and discourses of natural resources management (NRM) particularly focusing policies, protected area and NRM governance and community development. Several international competitive scholarships and research funds helped him in his research and academic career. His affiliations as researcher have contributed more than 40 articles in national and international peer-reviewed journals, two books and 12 book chapters.

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Dr. Mahmood Hossain is a Professor of Forestry and Wood Technology Discipline of Khulna University, Bangladesh. Currently he is the Vice-Chancellor of the same university. Dr. Mahmood is working for more than two decades on mangrove ecosystem, forest productivity and nutrient cycling and has set up commendable footmark on mangrove ecology. Some of his applied perspectives have focused on the stress ecology of mangroves, biomass estimation, and carbon sequestration by the forests. He has published 105 scientific articles and 3 books covering different aspects of mangrove ecosystem, forest inventory and nutrient dynamics. Dr. Mahmood has obtained professional degrees from the University of Chittagong, Bangladesh (B.Sc. Hons. in Forestry) and University Putra Malaysia (MS Mangrove Ecology and Ph.D. Mangrove Ecology).

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Abbreviations

APFRN	Asia-Pacific Forest Restoration Network
BFD	Bangladesh Forest Department
BFRI	Bangladesh Forest Research Institute
BLC	Boat Licensee Certificate
CBE	Community-Based Ecotourism
CF	Community Forestry
CHTs	Chittagong Hill Tracts
CMFPN	Chinese Model Forest Partnership Network
CoV	Certification of Verification
E. O.	Executive Order
ERDB	Ecosystem Research and Development Bureau
EU	European Union
FAF	Forest-garden Agroforestry
FAO	Food and Agriculture Organization
GDP	Gross Domestic Products
GNH	Gross National Happiness
HAF	Home Garden Agroforestry
IUCN	The International Union for Conservation of Nature
MAB	Man and Biosphere
NGOs	Non-government Organization
NTFPs	Non-timber Forest Products
NWFPs	Non-wood Forest Products
PBIDC	Philippine Bamboo Industry Development Council
RFC	Relative Frequency Citation
RGOB	Royal Government of Bhutan
TEK	Traditional Ecological Knowledge
TFRK	Traditional Forest-related Knowledge
UV	Use Value
VDF	Village Development Fund
WTO	World Trade Organization

Chapter 1
Legal and Policy Issues of Non-wood Forest Products (NWFPs) for Sustainable Conservation and Livelihoods: A Global Perspective

A. Z. M. Manzoor Rashid, Niaz Ahmed Khan, and Mahmood Hossain

Abstract Forests and the associated biological resources have historically played a crucial role in ensuring environmental conservation and sustaining livelihood especially for the forest dependent rural and Indigenous communities across the globe. Notwithstanding the growing recognition of non-wood forest products (NWFPs) in supporting local livelihood and contributing to environmental conservation, the legal and policy dimensions of NWFPs have received relatively less attention from both the academic and practicing quarters. In this backdrop, this article provides a critical overview of selected aspects and issues of NWFPs with special relations to the implications for community livelihood and conservation. After setting the scene in the introductory section, the second section summarizes the context and current status of the relevant key legal and policy instruments that globally implicate NWFPs and their propagation and utilization. The third section then identifies the important desired features (notably, financial incentives and exemption of taxes to promote NWFPs; secure tenural arrangements) of a 'supportive policy' that can facilitate community development and their sustainable livelihood based on NWFPs and related activities. In conclusion, the major challenges and problems are briefly recapitulated. Based on the overall observations and analyses, several recommendations are also made including the following: creating enabling conditions for the conservation and sustainable management of NWFPs; promoting wider stakeholder participation and 'co-creation' mechanism in the formulation and execution of the relevant policies; supporting a stable institutional framework (at the country level) with adequate technical and financial capacity; ensuring cross sectoral interaction and coordination; exploring indigenous knowledge and local practices.

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1.1 Introduction

Historically forests and their diverse biological resources continue to play crucial roles in ensuring the conservation and sustenance of livelihoods around the world. Of particular importance are the forest dependent rural and Indigenous communities (Charles 2021; Ghanbari et al. 2020). Thirty one percent of the global land areas have forest cover which stands at about 4.06 billion hectares (FAO 2020). Based on the climatic domain, the global forest is divided into four types (Fig. 1.1). These forests provide major resources such as timber, fuelwood and non-wood products whereby meeting the local, regional and national demand for ages (FAO 2014). However, the increase of demand has resulted in over extraction, illicit felling, shrinkage and conversion with overall deterioration of this major ecosystem and its services globally (CIFOR 2000; Curtis et al. 2018; Chinedu and Mbee 2013). The growing stock of the forests reduced from 560 million hectares to 557 million hectares between 1990 and 2020 (FAO 2020). Deterioration of forest occurs in various forms particularly in open forest formations with the active involvement of people. Profits and means of subsistence were the basic reasons behind such deterioration of forest resources (Conteras-Hermosilla 2000). Various efforts and interventions have been developed, applied and extended to curb the destruction of forests biological resources and to sustain the livelihood of the communities dependent on its vital resources.

Globally 1.15 billion hectares of forest are primarily managed for the production of wood and non-wood forest products. In addition to that, 749 million hectares are designated as multiple use of forest (FAO 2020). According to 2015 statistics, the value of NWFPs globally stands for 7.71 billion USD. Global Forrest Experts Panel also recognized the contribution of forests to food security and nutrition (FAO 2014). Edible fruits and plants are the major shareholder of NWFPs market (Fig. 1.2) followed by ornamental plants (22%), wild meat (9%), other plants (8%) and honey bees (7%) although they vary greatly from continent to continent. In this context, there has been growing recognition of non-wood forest products (NWFPs) in sustaining local livelihood and contribution to environmental conservation (Melese 2016; Pandey et al. 2016; IUCN 2008). Extraction of NWFPs can have used as an incentive for forest conservation as observed in many studies (Chou 2018). Non-wood

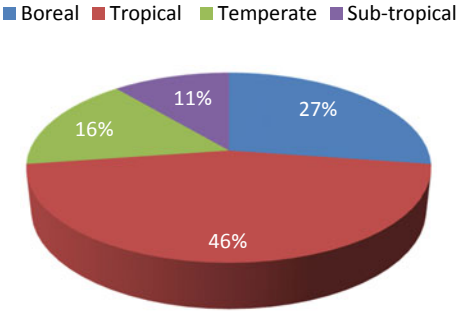

Fig. 1.1 Global forest area by climatic domain 2020 (*Source* FAO)

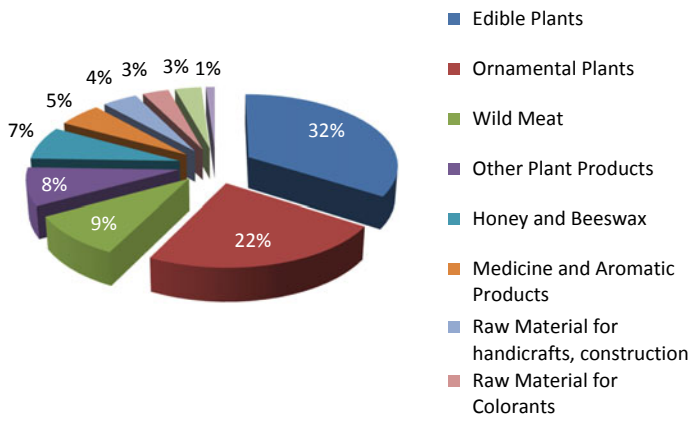

Fig. 1.2 Global NWFP categories based on reported economic value (FAO 2020)

forest products hereinafter called NWFPs are synonymous with non-timber forest products (NTFPs) they both include most of the resources derived from trees and or forest other than timber. However, in defining the terms NWFPs and NTFPs, FAO termed NWFPs as "All products consist of biological origin other than wood, derived from forests, other wooded land and trees outside forests which generally include all woody raw materials while NTFPs in contrast, generally include fuelwoods and small woods" (FAO 1999).

1.2 Policy and Legal Attributes of Conservation and Sustainable Development

The diversified value of NWFPs delivered by forest landscape is crucial for rural livelihood and its economy (Stryamets 2016). Sustainable conservation and livelihood of the local communities are now mutually inclusive and interdependent thus need effective policy and legal support to harness the best possible outcomes (Charles 2021; Rashid et al. 2013). However, this sector is infrequently supported by the forest policy and management interventions. Keeping these attributes in mind, each individual country develops various institutional, legal and policy tools in line with their national development goals to address multiple objectives such as productive functions, protective functions, socio-economic functions and legal, policy and institutional functions (Ghosh and Sinha 2016).

Sustainable forest management principles are being adopted by many countries in their forest related policies and laws. Promoting sustainable and multipurpose use of forest and trees are now at the center stage of their planning and implementation approaches (FAO 2020). Development of forest and biodiversity related

institutional policy and strategic documents are the outcomes of such national development visions that enable active and effective stakeholder participation (Mcdermott et al. 2007). Sustainable conservation of biological resources and their commercial utilization widely depends on the effective formulation and implementation of legal and policy instruments (Mukul et al. 2014).

Country specific institutional and legal policies are being developed with a view to ensuring sustainable management of the forest and other biological resources such as NWFPs. Forest policy, forestry sector master plan, national conservation strategy, national biodiversity strategy and action plan, forest and wildlife acts, protected areas rules are some of the commonly developed policy instruments formulated based on the notions of the international conventions, treaties and protocols (both legally and non-legally binding principles). Commercialization of NWFPs has been widely been promoted by scientists, practitioners, and development partners and most importantly by the individual governments as a means of livelihood improvement (Yildrim and Kose 2013; Belcher et al. 2005). However, local ecological, economic, cultural and political contexts must be taken into consideration while devising such initiatives and implementing any policy related to NWFPs (CBD 2001).

International conventions, treaties, protocols (ICTPs) and related attributes have active and passive influence in determining, prioritizing and endorsing legal and policy mechanisms related to forest management of an individual country (Rashid et al. 2013). This section attempts to synthesize some of the significant institutional and legal instruments that have substantial implications in generating knowledge and practices of NWFPs under the purview of the national forest, environment and biodiversity policies, plans and programs. Intensification of the NWFPs sector and related activities has direct connectivity with the conservation of biological resources. Consequently this sector is getting growing attention and recognition both nationally and globally.

1.3 Key Legal and Policy Instruments Related to NWFPs

Non-wood forest products (NWFPs) are diverse in nature and have significant economic and social impacts although production, trade and consumption related databases are scanty (FAO 2020). The governance of NWFPs is an integral part of sustainable forest management. Collation and standardization of data from various sources are also some potential limiting factors. Effective legal and institutional policies may contribute significantly i.e. conservation, poverty alleviation, economic development through sustainable management as revealed in many studies (Martinez de et. al. 2021; FAO 2020; Weiss et al. 2020).

The Stockholm Declaration-1972 widely dubbed as UNCHE is known to be the first global institutional effort that reiterated the need for common principles to act on preservation and enhancement of the human environment. Among the 26 principles, principle 11 and 12 specifically pointed out the importance of policy implication and resource conservation. With that global commitment, biodiversity conservation and

community development issues developed further momentum. After the UNCHE Conference, Rio Summit 1992 has manifested three interrelated conventions (CBD, UNFCCC and UNCCD) with a view to ensure sustainable development goals of the Agenda 21.

The Convention on Biological Diversity (CBD), is believed to be the most comprehensive legally binding convention that encompassed all ecosystem, species and genetic resources. It has direct relevance to the knowledge generation, conservation and livelihood issues related to NWFPs (Rashid et al. 2014). The convention signifies the importance of formulating policies and their practices taking into account local ecological, economic, cultural and political contexts. Conservation, sustainable use and growth of NWFPs sector largely depends on multidimensional attributes that make it challenging on one side while on the other side it has created potential avenues for the development of the sector that has been reflected through many important articles of the Convention (CBD 2001). To ensure the international exchange of plant and animal genetic resources, conservation and sustainable use of biodiversity, a comprehensive framework is being developed under this convention which may have a direct impact on NWFPs. Developing sustainable management and conservation policies for NWFPs may incur direct and indirect impetus from CBD.

Knowledge management particularly local and indigenous knowledge in respect to NWFPs is another important dimension attracting growing importance for many reasons such as sustaining livelihood, ensuring conservation and management and creating value addition to nature based products. Article 8(j) specifically mentioned indigenous knowledge, innovations and practices whereby contracting parties/state will respect and maintain these virtues rooted in the traditional lifestyle relevant for the conservation and sustainable use of the biological resources. Further implementation involves access to genetic resources and their fair and equitable sharing of benefits from their utilization manifested as one of the three major objectives of CBD. In response to the statement, a legally binding protocol called *Nagoya Protocol* was adopted in 2010 applicable for both user and provider countries. Legal, administrative and policy measures were given utmost importance to derive benefit from genetic resources while valuing customary law, community protocols and procedures. With the development of this protocol, CBD paved the route of conserving and utilizing NWFPs that have a potential role in sustaining community livelihoods.

Another crucial convention developed under the platform of the Rio convention *named United Nations Framework Convention on Climate Change* (UNFCCC) have urged towards taking policies and measures to protect the climatic system under a *common but differentiated responsibilities* by the parties in line with the national and regional development priorities, objectives and circumstances. Environmental, social and economic impacts of climate change and the importance of protecting fragile ecosystems, where NWFPs constitutes a significant portion, are the salient preambles of the Convention (UNFCCC 1992).

The third convention developed during the Earth Summit titled *United Nations Conventions to Combat Desertification* widely dubbed as UNCCD has given particular emphasis to drought prone African countries. NWFPs adhere to sustainable

economic growth, social development and poverty eradication in this region. UNCCD is a convention aware of land degradation, desertification and drought affect to natural resources, food security through coordinated efforts of the international community, national government and local organizations and play a vital role in synchronizing with other relevant international agreements like CBD, UNFCCC (Turpie et al. 2021; UNCCD 1994).

The International Treaty on Plant Genetic Resources for Food and Agriculture is known as *Plant Treaty* approved by the FAO member countries in 2001 intending to establishing international standards for the conservation and exchange of the plant genetic materials. This Treaty is a global initiative among the member countries to address the issues related to plant genetic resources for food and agriculture including issues ignored or unnoticed by the CBD (Baranski 2021). This treaty overcomes the long standing disagreement between different countries, institutions and interest groups hence opening up a promising window for the stakeholders to conserve, manage and utilize NWFPs on a sustainable basis (Marci 2001).

In the backdrop of massive degradation and deterioration of biological resources particularly forest resources, the importance of conservation received extra significance during a meeting of the IUCN members that led to the emergence of a new convention named Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). It is an international agreement between governments. The basic aim of the CITES convention is to protect the species in a manner that will not lead to extinction due to commercial trading. Commercial wildlife trade (whole or parts of the animal) has an extensive global market and the over extraction and utilization resulted in the extinction of many species while numerous became threatened and endangered (Wijnstekers 2018) Wild plant and plant parts having commercial, spiritual and other values have also suffered the same. This reiterated the need for a strong legally binding instrument to halt this fast decline while ensuring commercial utilization of the resources on a sustainable basis. In 1985, with resolution Conf. 5.14, the Conference of Parties recognized the need for greater efforts to enhance the enforcement initiatives having regards to plants listed in the Convention and to bring non-member countries under Convention engaged in trading species listed in CITES Appendices (Wijnstekers 2018).

Member countries may receive legal and policy direction under the purview of the convention in regards to commercial harvesting, sustainable conservation and management of NWFPs, where law enforcement agencies, scientists, practitioners and managers have crucial roles to play. To date, about 38,700 animal and plants species have been listed in the CITES appendices thus the effective implication of the Convention may pose long lasting impact on the conservation of the endangered and threatened species used as NWFPs (CITES 2021).

Ecosystem plays critical roles in poverty reduction, combating climate change and preventing mass extinction of the biological resources. Considering these features, the global community urged the need for putting visible efforts in restoring fragile ecosystem. Keeping in mind the growing deterioration and considering the status of

the community, the United Nations has *declared UN Decade on Ecosystem Restoration (2012–2030)* which is a clear mark of the commitment of the global community to prevent, halt and reverse the declining ecosystem globally.

The *Agenda 2030* adopted by the United Nations in 2015 established 17 development goals as its core elements of development known as Sustainable Development Goals (SDGs). Sustainable forest management is being recognized as an avenue for development manifested in goal 15 called *Life on land* that has ample scope to contribute in achieving other goals provided an effective trade-off mechanism is available (Baumgartner 2019; Swamy et al. 2017). NWFPs are a central element of sustainable forest management and development. Tropical forest and their multiple resources can be used to address the social, cultural and economic dimensions where NWFPs are invaluable (Martinez 2021). Restoring fragile ecosystems, halting biodiversity loss and reversing the degradation process may get substantial impetus from the introduction, conservation and management of NWFPs engaging local communities as experienced in many studies (Martinez de et al. 2021; Jong et. al. 2018). NWFPs can also be used to address three major dimensions related to sustainable development whereby they can play a substantial role in addressing crosscutting goals in addition to SDG 15 Life on land (Table 1.1).

Ensuring access to genetic resources and their fair and equitable sharing of benefits from the utilization of these resources has been determined as one of the three major objectives of CBD. With the development of the Nagoya Protocol, CBD paved the route of conserving and utilizing NWFPs by scoping the rights of Indigenous and local people which is a fairly new development (Borrini-Feyerabend et al. 2004). Based on the subsequent progress with regards to human rights, the *ILO Convention 169* recognized the definition of the Indigenous people and their rights on social, cultural and spiritual values and practices. *UN Declaration on the Rights of Indigenous People* adopted in 2007 added further significance regarding community rights.

Table 1.1 Contribution of NWFPs in achieving various SDGs

Various dimensions of SDG	Potential contribution/roles of NWFPs	Cross cutting SDGs
Social and cultural dimension	1. NWFPs are part of cultural heritage 2. NWFPs contribute to health and well-being 3. NWFPs sustain household economies 4. NWFPs contribute to social integrating gender balance and equality	1, 2, 3, 5 and 10
Environmental dimension	1. NWFPs contribute to sustainable land management 2. NWFPs are instrumental in maintaining high biodiversity value agro-ecosystem and other priority habitats	12, 13 and 15
Economic dimension	1. NWFPs are the potential source of industrial raw material 2. NWFPs as an avenue of trade	8, 9 and 12

In attaining this, sustainable management and conservation of NWFPs may have commendable roles to play provided effective policy support is in place.

1.4 Features of Supportive Policy Related NWFPs

Community development and their sustainable livelihood based on NWFPs and related activities require policy and institutional support. One such provision is financial cooperation in the desired form. Financial incentives and exemption of taxes to promote NWFPs may also help achieve multiple goals and objectives of forestry at large and local communities specifically. Small and medium scale forest based industries may flourish at local level that will also have national impact on many dimensions. However, shifting the paradigm from open access regime to more secure and organized form of tenurial arrangements prescribed were effective in harnessing better outcomes as experienced in Nordic countries (Saastamoinen 1999).

The threats and challenges to NWFPs not only generated due to modification of the physical climate resulting in the loss of wild genetic resource base and yields but also due to the influence of social and economic situation and volatile market behavior. NWFPs and associated practices should be given extra priorities in national forestry policies and programs considering their crucial roles such as generating substantial income, food and medicines for the community along with recreational values to many users and pickers, as NWFPs and their related issues were often found obscure and ignored in the forestry and other polices.

1.5 Way Forward and Conclusion

The problems and prospects of NWFPs vary remarkably by country in general and more among regions hence policies and programs should be formulated and tailored considering the local context and needs. These variations can be experienced in terms of resource availability and the sustainability of their use, traditional user pattern, commercial status and potentials. NWFPs as a means of biological conservation and sustainable livelihood demands many interventions, congenial environment and policy support. In this regard, the following policy features need to be considered globally, regionally and nationally depending on the respective context of the individual stakeholder (Weiss et al. 2020; Robalino et al. 2015; Saastamoinen 1999):

a. Traditional knowledge, practices, usufruct and ownership rights management and utilization are long practiced traditions. These attributes need to be carefully examined while devising any policy or making any changes.
b. The structure, growth and dynamics of the NWFPs based markets demands extra contemplation. Despite having significant gaps, the market study is essential,

firstly to assume the extent of policy interventions needed, secondly for all extension and development purposes.

c. Revival of NWFPs as a consequence of various social trends are creating growing demands for the nature based products, traditional skill and harvesting methods, healthy and sustainable lifestyle, livelihood options. All of these could be a substantial departure from conventional forestry practices provided new and supportive policy interventions are made available.
d. Prevailing structure of economic incentives and disincentives also demands careful investigations with a view to harmonize the process as per global standards taking lessons and best practice of individual countries.
e. Research and development (R&D) are integral parts of any policy development and is also applicable for NWFPs sector. R&D helps to identify lesser known species and products whereby value addition and sustainable management aspects can be addressed.
f. Development of product and its marketing needs adequate support through a supportive policy. State or institutional support in this regard is imperative and will assist in promoting heterogeneous NWFPs.
g. However, specific policy for the NWFPs sector cohesive with forestry and other polices may have enhanced potential to contribute economically, socially and ecologically.

Creating enabling conditions for the conservation and sustainable management of NWFPs is the need of the times. In the milieu of vanishing trends of biological resources, particularly forest resources including NWFPs, effective stakeholder participation, co-creation mechanism in the formulation and execution of the relevant policies are imperative. A stable institutional framework with sufficient technical, financial capacity supported by coherent policy can help achieve desired goals in the NWFPs sector (Weiss 2020). In addition, cross sectoral interactions, indigenous knowledge, practices based on locally generated ideas may add significantly to ensure sustainable conservation, management while addressing community livelihoods.

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Chapter 2
Historical and Contemporary Views on Non-wood Forest Products in Sweden—Contrasting Reflections

Håkan Tunón

Abstract Far away from the Southeast Asian forests in Northern Europe lies Sweden, a contrasting industrial country. Approximately 75% of the country is covered with boreal forest. Due to intense industrial forestry for almost two centuries, only about 25% have qualities as primary forest. The rest is managed forests. Biodiversity is low compared to Southeast Asia, the dominant species are 40.3% Norway spruce (*Picea abies*), 39.3% Scots pine (*Pinus silvestris*), and 12.4% birches (*Betula* spp.). About 8.7% of the forests is protected, mostly areas with low capacity to produce timber. Sweden is a developed country with 10 million inhabitants (average 25.4 inhabitants /km^2). Historically, the forests supplied game, fir and pelts, to a lesser extent berries and mushrooms, and it was also used for grazing. Timber was extracted mainly for household purposes or to produce coal, tar, and potash, but during late nineteenth century, the sawmill industry became increasingly important. Today most forests are subjected to industrial forestry and harvest of non-wood forest products (NWFPs) is considered a conflicting interest. So, how can forestry and harvest of NWFPs coexist? In industrial countries ecotourism and recreational uses of forests may be more urgent NWFPs than many provisioning ecosystem services—and most likely also more profitable. However, in order to safe-guard the future of valuable biodiversity-rich forests suitable for recreation as well as harvest of more concrete NWFPs it is necessary that some of the profits from such ventures finds the way to the forest owners in order to motivate them not to clear-cut.

Keywords Forestry · Hunting · Trapping · Berries · Mushrooms · Recreation

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2.1 Historical and Contemporary Non-wood Forest Products in Sweden—Contrasting Reflections for Common Benefits

2.1.1 Introduction

Far, far away from lush rainforests of Southeast Asia lies Sweden, a contrasting boreal country (Fig. 2.1). This might seem like an odd bird in this nest of chapters, and it is. However, the aim of this contribution is to inspire, for good or for worse, and to ventilate some different perspectives from a different reality.

The Swedish forestry industry has previously attracted the interest from Southeast Asia, when the king Chulalongkorn of Siam (Thailand) visited Swedish forests and sawmills in 1897 in order to reflect upon possible improvements that could be made within Siam's national forestry. Maybe it is now time to reflect further upon the clash between industrial forestry and the harvesting of non-wood forest products and consider how to achieve a sustainable future for forests, their ecosystems and adjacent human societies. Could lessons learnt in Sweden contribute to long-term solutions in Asia?

Fig. 2.1 A boreal spruce forest. Fiby pristine forest reserve, Uppsala. Photo: Håkan Tunón (2020)

This essay is based on experiences from previous research projects, personal observations, and a large proportion of surveys of the literature (scientific, grey and more popular literature as well as information in mass media) over a wide area of diverse interests in order to give a broad reflection on the subject.

2.2 Background

Sweden is situated in Northern Europe (55°20′–69°03′N 11°57′–24°10′E) (Fig. 2.2). In total there are 28.0 million hectares of forests. The total land area is 447,435 km^2, and approximately 75% of the land area is covered with forest. Due to an intensive forestry during the past two centuries and an active reforestation for the past, only about 25% of the forests have qualities as primary forest or ancient woodland.

The remaining forested area is the result of intense forestry and the term *plantation* is often used by nature conservatists to describe these managed forests, since natural forest-ecosystems seldom remain. Compared with more tropical countries the biodiversity is fairly low. There are only around 45 different species of trees in Sweden (including some few introduced species), and the dominant species are 40.3% Norway spruce (*Picea abies*), 39.3% Scots pine (*Pinus silvestris*), 12, 4% birch (*Betula pendula* and *B. pubescens*), 1.7% aspen (*Populus tremula*), and 1.7% alder (*Alnus glutinosa* and *A. incana*). In the southern part of the country there are mostly broad-leaved trees (seasonally shedding all foliage, no foliage during winter), while in central and northern Sweden there are mostly conifers, a part of the western taiga forest. Parts of the western mountainous area (the Scandes or the Scandinavian mountains) are above treeline. About 8.7% of the forests is formally protected, mostly areas with low capacity to produce timber, and only 6% of the productive forest area (SCB n.d.; SEPA 2021). However, if other forms of voluntary protection and considerations are included additional 6–7% could be included (Hannerz and Simonsson 2021, p. 59; SCB 2020).

Sweden is a developed country with around 10 million inhabitants. Today over 80% of the inhabitants are living in urban areas, but due to the low population density only 41% is considered to live in urban areas according to the OECD-definition. The country has undergone a quick transition from a relatively poor rural country in early twentieth century to today's urban society. In the early 19th about 90% of the population was living in rural areas, but. At the same time a change has occurred from primarily rural production from agriculture, animal husbandry and peasant forestry, to industrial society and further on to a post-industrial present with a stronger focus on the service sector and information technology. In average there are 25.4 inhabitants per km^2 (the average within the European Union is 117.7 inhabitants per km^2), but it is higher in the southern parts of the country, especially the Stockholm county with 364.9 inhabitants per km^2. Still relatively scarcely populated compared to other parts of the world. The northern county of Norrbotten is the least populated one with 2.6 inhabitants per km^2, followed by Jämtland county with 2.7 inhabitants per km^2 (SCB 2021).

Fig. 2.2 Map over Sweden and Europe. (*Source* Nuclear Vacuum, Wikimedia Commons)

The rapid change from a rural to an urban country and the industrialization and rationalization of agricultural and forestry have led to a rapid decrease of biodiversity-rich, small-scale, mosaic landscapes which used to be manage through traditional land uses (Emanuelsson 2009, pp. 25–43). The year 1900, 78.5% of the population lived in rural areas. Traditionally farmers mixed farming and small-scale selection forestry. The changes in land use during the past century have led to the disappearance of a cultural landscape based on traditional agroforestry, and consequently also the biodiversity that had become adapted to specific biotopes in that landscape. According to the national red list, forests and agricultural lands are the biotopes with the most red-listed species; about half of all red listed species appears in these areas. Forestry and clear cutting have a strong negative impact on about 1400 species, and bush and tree encroachment on former agricultural and pasture lands due to structure rationalisation is threatening about the same number of species (SLU Artdatabanken 2020). When comparing the present situation with historical data for approximately 123,000 ha it was shown that prior to the more intensive forestry the dominating natural stands were more than 200 years old. The number of old trees has been reduced with around 90% and old stands constitute less than 1% (Linder and Östlund 1998). On the other hand, the reforestation efforts during the twentieth century have resulted in that the standing volume per hectare has almost double between 1925 and 1995 (National Board of Forestry 1998), but this doubling is from an all-time low. Consequently, the ongoing forestry is questioned based on both environmental and social arguments, and the public debate is strongly polarised. The World Economic Forum highlights the problem with the Swedish forestry and even if the growth is bigger than the amount harvested the levels of biodiversity keeps decreasing. They also highlight the potential problems when climate change is putting pressure on a forested landscape with basically two species of trees and predicts increased risks for pest outbreaks, drought and storms (World Economic Forum 2018). However, a recent report points at the fact that the situation for forest biodiversity has improved slightly, since 1990s when ecological considerations were introduced in forestry meaning that the development might be going in the right direction (Hannerz and Simonsson 2020). The "forestry lobby" is currently highlighting the potential commercial value and climatic importance of an even more intensified forestry. The forests are considered to contribute to mitigate climate change through substitution of greenhouse gas-intensive materials and through carbon-sequestration. The reasoning goes as follows "In regions where forest growth rates exceed harvest levels (e.g. in Europe), it is expected that sustainably managed forests can make a substantially larger contribution to energy and material supply than is currently the case, thereby reducing carbon emissions." In order to increase the forest growth rates through various measures such as species selection, planting, fertilization, and other management options (Royal Swedish Academy of Agriculture and Forestry 2018). It is also stressed that products from forestry will result in materials that will trap carbon for a long time. However, according to statistics from 2011 concerning the Swedish forestry around 25% is used as timber, 16% is used for bioenergy and 59% was used for pulp and paper (Träguiden 2017). More recent calculations from the Swedish Environment Protection Agency 22% timber, 50% bioenergy and 25%

Fig. 2.3 Different versions of boreal forests. A pristine forest reserve (Fiby pristine forest reserve, Uppsala), a protected area for recreational activities (Andersöns natural reserve, Jämtland), a spruce plantation for production on former fields (Uppsala), and a clear-cut with'general consideration' in Dalarna. Photo: Håkan Tunón, 2020, 2017, 2019, 2012, respectively

pulp and paper (Röstlund 2021). Hence, the long-term trapping of carbon might be questioned (Fig. 2.3).

The most common forestry since the beginning of the twentieth century is industrial clear-cutting followed by replanting with spruce and pine trees. The rotation time is less than 80 years for spruce and 120 years for pine. Furthermore, during the 1960s and 1970s the clear-cut areas where initially sprayed with an herbicide and defoliant mixture of phenoxy acetic acids (2,3-D and 2,4,5-T, i.e. "Agent Orange") in order to kill off the competition from broad leaf shrubs and weeds. However, due to environmental consideration it was banned in 1977. During the last decades of the twentieth century an increasing environmental awareness has resulted in a rephrasing of the first paragraph of the Swedish forestry act: "The forest is a national asset and a renewable resource that should be managed sustainably in order to provide a good return while still preserve the biological diversity." It is also stressed that forestry should take other general interests into consideration (SFS 1998; Hannerz and Simonsson 2020). This resulted also in the evolvement of what is generally called 'the Swedish forestry model' that gives the forest owners a large amount of freedom regarding how to conduct forestry if it is within the legislation. This expects that the forest owners and companies will take a 'general consideration', i.e. when

managing the forest safeguard old valuable trees and elements in the forest and leave patches of less productive forests and tree curtains towards waterways and arable fields (Hannerz and Simonsson 2020). "The Swedish forestry model" is generally presented as a way to achieve a sustainable forestry, but on the other hand it is pointed out that the system has "led to even-aged forest stands with a single dominating tree species replacing previously diverse forests, to accommodate the forestry industry" (Royal Swedish Academy of Agriculture and Forestry 2009; Beland Lindahl et al. 2017). However, the issue of sustainability has been contested by various actors (e.g. Protect the Forest and Greenpeace Nordic 2021). In the recent taxonomy for sustainable financing within the EU's new green deal it is stated that: "the term 'sustainable forest management' should be construed by taking into account practices and uses of forests and forest land that contribute to enhancing biodiversity or to halting or preventing the degradation of ecosystems, deforestation and habitat loss, by taking into account the stewardship and use of forests and forest land in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems" (EU 2020/852).

This have been interpreted that the forestry in Sweden and Finland is considered to be unsustainable and is consequently risking losing future investments, and this in now heavily debated by the Swedish Forest Industries (2020). However, I will not dwell further into this in this essay. An interesting and relevant aspect to consider when it comes to Non-Wood Forest Products (NWFP) is that Sweden for the past century has a customary law called the right of public access (SE: *Allemansrätten*, 'everyone's right'). It is not a law per se, but it is mentioned in the Swedish constitution and is considered to be an historical custom, maybe even from Medieval time. However, the present regulations are from 1940 and give the public rights to a considerate access to most outlying lands, even if they aren't the landowners. The motto is "Don't disturb—don't destroy". You are free to pick flowers, berries, mushrooms, twigs and branches from the ground, but not damage living trees or bushes or leave garbage. You are allowed to walk in forests and pasture lands, but not on peoples' fields or in direct vicinity of gardens. For hunting you will need special permits and it is only the landowner that is allowed to pick nuts (hazel, *Corylus avellana*). This last remark goes back to days when nuts in southern Sweden had a commercial value. However, during the past decades arguments have been made that the right of public access and private harvesting limits the landowners' possibilities to develop business from their resources and that it consequently ought to be restricted. Thus the issue has divided the society in landowner organizations and right-wing parties on the "restriction" side and left-wing parties, NGOs and tourism organizations on the other (Naturvårdsverket n.d.; Sandell and Svenning 2011; Sténs and Sandström 2013, 2014).

When reflecting upon the delicate balance between urbanisation, forestry and a continued harvest of NWFPs Sweden could serve as an inspirational example vis-à-vis the situation of Southeast Asia and the future development. Sweden has a long tradition of forestry, but during the past 100–150 years it has been perceived as the sole

value of the forested landscape (Hannerz and Simonsson 2020, pp. 16–18). Most of the NWFPs have been seen as competing interests and limiting factors. However, the management and use of forests might need a change in order to improve or maintain biodiversity and the sustainable use of some of the NWFPs. The aim of this chapter is to visualise the complexity of historical and contemporary dependency of NWFPs and its change over time. Today most of this harvest is done for household purposes and on common resources, while the forestry is commercial and on owned land, this conflict of interest creates a tension between several different groups in society. The issue is complex and there are many different interests and perspectives to be considered. In these days forestry is not always profitable for the smaller landowners and it often compete with the use of other NFWPs. Perhaps there is time reconsider what the values of the forest really are?

2.3 NWFPs in History and Current Situation

In this essay I have chosen a broad definition of NWFPs (or non-timber forest products, NTFPs). Jenne H. De Beer and Melanie J. McDermott define NTFPs as "all biological materials other than timber which are extracted from forests for human use" (De Beer and McDermott 1989), while others have been more or less inclusive (Shackleton et al. 2011). I have mostly excluded wooden materials, for instance as material for handicraft and craft, which might have a strong potential for sustainable use. Furthermore, I have not fully differentiated between 'products' and 'services', as the recreational value of the forest is becoming increasingly important, especially in industrial countries, and nature experiences, eco- and cultural tourism constitute an increasing market. The policy discussions in industrial countries are beginning to highlight a decoupling of economic growth from material consumption meaning that experiences could be at least equally important as physical products.

Still over a century ago most forests belonged to farms with agriculture and animal husbandry, and forestry was based on selected logging for the household or sold in small-scale. The forest constituted a mixed source of all sorts of wood and NWFPs. In some parts of Sweden, close to the ironworks, most of the forest was repeatedly clear-cut and burnt into coal already in the seventeenth and eighteenth centuries. Some areas exported tar and pitch from pine and spruce and potash from wood of birch and aspen (SCB 1972, pp. 124–129). It could be questioned whether tar, pitch and potash really should be considered to be NWFPs, as they are produced from wood. However, they played an important economic role over a long period, especially during the seventeenth and eighteenth century. During the seventeenth century there was a huge demand for potash in Europe and potash became a valuable export product for Sweden as well as tar and pitch that was one of Sweden's most important export products due to the maritime expansion around Europe (Larsson 1996; Villstrand 1996). The statistics shows that in 1770 tar, pitch and potash constituted 4.2, 1.0, and 1.5% of the total Swedish export value, respectively. But around the year 1800 they had almost reached zero (SCB 1972).

Table 2.1 Statistics over the contribution from forest products to the total Swedish export (SCB 1972, pp. 155, 286–288; SPIN2015)

Year	Timber and pulp (%)	Paper (%)	Total (%)
1770	5.5	–	5.5
1871	45.3	1.2	46.5
1901	48.7	4.8	53.5
1911	41.3	5.1	46.4
1920	27.1	32.5	59.6
1930	17.8	25.9	43.7
1940	40.5	14.1	54.6
1950	23.3	11.7	35.0
1960	0.7	10.2	10.9
1970	0.7	8.8	9.5
2019	3.8	5.7	9.5

When Carl Linnaeus made his Lapland journey in 1732, he concluded from Lycksele (in northern Sweden) that:

> 2 June. The forest was filled with large pine trees, totally in vain, because no one uses him to build houses and he is eaten by no one. According to me he would be of better service if pitch and tar was burnt from him. (Carl Linnæus 1973).

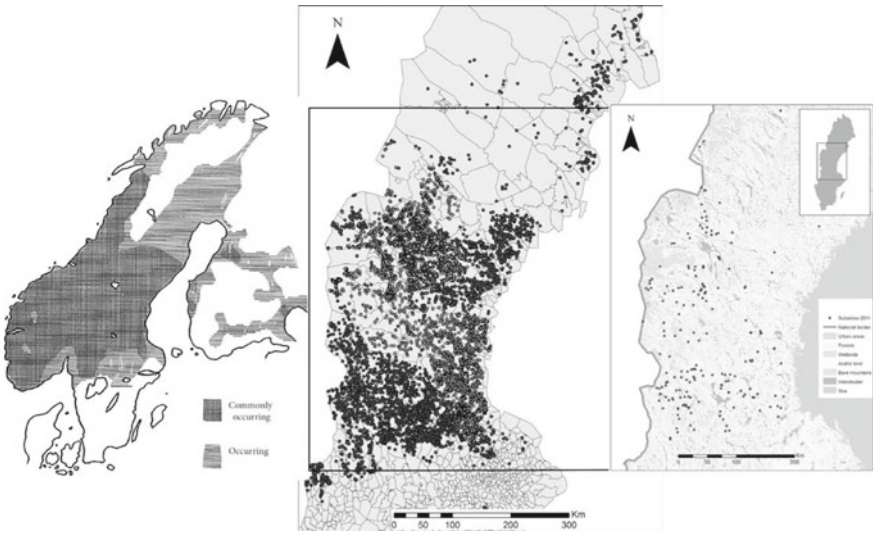
During the nineteenth century selected logging was intensified to an industrial scale and rivers were cleared and used for log-driving. Down the coasts, sawmills produced beams and boards for export, particularly to Great Britain. Around 1900, the standard procedure selected logging of big trees had led to vast areas of deforestation and consequently the clear-cutting and replanting became the way forward. This has since 1903 basically been the only kind of forestry in Sweden (Hannerz and Simonsson 2020, pp. 16–18). When it comes to NWFPs this kind of forestry has their pro and cons, but more about that later. Replanting changes the diversity of trees in the forests and creates more of a monoculture, which also often results in changed different vegetation on the forest floor and consequently can affect the possibility to harvest some NWFPs. During eighteenth and nineteenth century timber was among the most important export products nationally, but during the twentieth century pulp and paper gradually became of more and more important (see Table 2.1), but all in all the importance of forestry to the national export has dropped during the last 50–60 years (Fig. 2.4).

2.3.1 Grazing and Fodder Production

The outlying lands and the forest were for many centuries used for grazing by cattle, goats, sheep and horses, often guarded by a shepherd, and the traditional Swedish meadows are also often fairly rich in trees and bushes. In the southern and central

Fig. 2.4 Cows on forest grazing in Jämtland. Scandinavian mountain cows in an alpine birch forest, a crossbreed of Charolais and Hereford on a few years old clear-cut with saplings of pine, Different versions of boreal forests, red polled cows ploughing through bilberry and willow bushes. Scandinavian mountain cows and Jersey cows searching grazing in a spruce forest. For forest grazing the cow breeds need to be fairly light and with small udders. Photo: Håkan Tunón, 2012, 2016, 2018, 2012, respectively

parts of the country where the population was fairly dense the farms were close and the areas in the direct vicinity were used for agriculture, while in the northern half of Sweden the climate and geography was less favourable for cultivation meaning that the small proportions of available arable land were used for more robust crops like barley and potatoes. Consequently, fodder was to a large extent produced on the outlying, often forested, land. However, during the nineteenth century the competition with forestry led to conflicts and in early twentieth century there were political campaigns against forest grazing due to its potential negative effect on trees and saplings. Today forest grazing is of a limited importance to agriculture, but it still exists, and it plays an important role in nature conservation since this kind of biotopes and the plants, mushrooms and insects adapted to them have practically disappeared. It is also highly appreciated in the production of artisanal food. In the central part of Sweden there is still approximately 200 summer farms with seasonal grazing of forests (see Maps 2.1, 2.2 and 2.3). These are scattered remains of a customary transhumance system with probably 50,000–100,000 summer farms in the central region of Sweden 100–150 years ago. The daily practice was that the animals together with



Map 2.1 A presumed distribution of summer farms in Fennoscandia (Bergils et al. 1998). **Map 2.2** A GIS-map over documented summer farms present and historical (by Sebastian Liahaugen from Tunón and Bele 2019). **Map 2.3** A GIS-map with active summer farms in 2012 (by Parbakhar Poudel)

a cowherd left the summer farm in the morning after milking and went grazing in the outlying lands, e.g. forests, mires and alpine meadows, all day before returning to the summer farm in the evening. These daily excursions went to different directions each day, creating a grazing pattern with a radius of about 5–10 km from the summer farm. In some areas the grazing of the forests were quite intense. The cowherd accompanied the herd and made sure that they were safe from predators, and that they didn't graze the meadows for hay harvests for winter fodder or entered the grazing lands of a neighbouring village. When the number of large carnivores, mainly wolves, bears and lynx, as well as the number of active summer farms went down the need to herd the animals disappeared (Tunón et al. 2013; Tunón and Bele 2019). Also in other parts of Sweden the forests were used for grazing and are still to a very small amount used (Fig. 2.4).

However, it wasn't only the animals themselves that harvested the vegetation growth during the summer. Farmers harvested leaves, twigs and bark from trees and bushes, dried the harvest and gave to the cattle, goats, sheep and horses as winter fodder. There are several different ways to harvest leaves, either to cut down the trees and pick the leaves or make tight sheaves of the twigs with leaves, or you could pollard the tree, i.e. cut the branches and twigs from the standing tree, or coppice it and collect the ground shoots. All broad leaf trees could be used. However, in southern parts willow (*Salix* spp.), ash (*Fraxinus excelsior*) and elm (*Ulmus glabra*) and in the northern mainly sallow (*Salix caprea*), birch, and rowan (*Sorbus aucuparia*). All harvested parts were used in some way, first and foremost as fodder and then for

handicraft or firewood (Aronsson 1996; Borgegård 1996; Carlsson 1996; Kardell 1996a; Ljung 2015a).

Furthermore, in the most northern parts of the country the Saami reindeer husbandry is dependent on ground lichens (*Cladonia* spp.) and beard lichens (*Usnea* spp.) in the old forests with pine and spruce. In younger forest the abundance of lichens is almost absent (Berg et al. 2011). For the past century the annual number of herded reindeer after autumn slaughter have been around 250,000. Ground lichens have also been harvested as winter fodder for cattle, goats and sheep (Tunón and Bele 2019). A more modern conflict is due to commercial harvest of *Cladonia stellaris*, not for fodder but for Christmas and flower ornamentals, where some mean it is a part of the right of public access. However, some recent rulings in court have gone against that interpretation, so that resource is for landowners or private use (Fig. 2.5).

Fig. 2.5 Reindeer grazing leaves and ground lichens, mostly *Cladonia* spp. Both male and female reindeer have antlers. In the summer most reindeer graze leaves and herbs in the mountains, but in the autumn the migrate to the forested to graze lichens. There are no wild reindeer in Sweden anymore, they got extinct from hunting in the nineteenth century. However, they roam around freely in groups or larger herds and are gathered up several times a year. Photo: Håkan Tunón, 2017

2.3.2 Game

Forests have also always been used for hunting and trapping, especially in the northern parts where these activities still play a very important role for the individual households as well as the local economy. From rural areas game, fir and pelts were for centuries sold to the larger cities in Sweden or exported to other parts of Europe, and even taxes were paid in fir and pelts. Still hunting is a rural practice and today the number of active hunters is approximately 300,000 (i.e. 3% of the inhabitants), but the local importance in the rural communities is much more prominent. Hunting is regulated and you need special licences. The traditional game for food has been elk (*Alces alces*), roedeer (*Capreolus capreolus*), hare (*Lepus timidus*, *Lepus europaeus*), brown bear (*Ursus arctos*) and in recent decades wild boar (*Sus scrofa*) and red deer (*Cervus elaphus*). For fir and pelts the most important species are red fox (*Vulpes vulpes*), badger (*Meles meles*), wolf (*Canis lupus*), lynx (*Lynx lynx*), stoat (*Mustela erminea*), Eurasian red squirrel (*Sciurus vulgaris*) and brown bear. Among birds western capercaillie (*Tetrao urogallus*), black grouse (*Lyrurus tetrix*), hazel grouse (*Tetrastes bonasia*), and willow ptarmigan (*Lagopus lagopus*) are of importance (Arvidsson 1983; Kjellström 1995, 2013; Brännström 2006; Danell et al. 2016). Today hunting is regulated, and special permits need to be obtained, but still these species are of great significance, at least locally, and for instance over the past decade somewhere 80–100,000 elks have been shot annually (Viltdata n.d.), which equals about 10,000 tonnes of meat, but it also plays an extremely important cultural role in the rural communities. In many rural areas the first week of the elk hunting season is the most appreciated vacation of the year, and people that have moved away from the area will return for the hunt. In general it could be said that the populations of important game have increased during the past fifty years so the governance for most of the species seems to be sustainable (Danell et al. 2016; Hannerz and Simonsson 2020, pp. 25–26). The urban people's opinion on hunting is today partly related to their opportunities to access game meat. Not very surprisingly a study has shown that people with connections to rural hunters and access are more positive to hunting (Ljung et al. 2015). The interaction between forestry and the harvest of game varies depending on what kind of species we're referring to. Elks thrive on clear-cuts and feed on birch bushes and young pines and thus are a potential threat against future timber values. On the other hand forestry is less favourable for capercaillie, that relies on a varied forest with old-growth pines, and hazel grouse that is dependent on dense old-growth spruce forests (Fig. 2.6).

2.3.3 Wild Berries

In the northern forests there are about 35 species of berries, but there are only a few that have had any economic significance. The most important species are bilberry or blue berry (*Vaccinium myrtillus*), cowberry or lingonberry (*V. vitis-idaea*), and

Fig. 2.6 An elk (or moose) cow grazing on a clear-cut in Jämtland. The hunting of elks is one of the major events in the rural parts of Sweden, especially in the north. Elks benefits from the growths on clear-cuts and appreciate grazing saplings of pine, thus creating damage to the forestry. Photo: Håkan Tunón, 2016

raspberry (*Rubus idaeus*). According to the right of public access berries are considered as every one's property. The interest in harvesting berries has varied through history; increased during wars and depression but diminishes when times get better. The availability of berries is influenced by the local forestry. The annual production of berries in the forests in the 1970s were estimated to 219–307 million kg bilberries, 142–168 million kg cowberries and 15–20 million kg raspberries fresh weight, which equals about 20 kg berries produced per hectare of the total forested area and year. For the year 1977 it was estimated that only about 30 million kg of these three berry species were harvested, i.e. about 5% of the total production. After a clear-cut about 80% of the bilberries and 10% of the cowberries disappear for a decade or so. The herbicide treatment that was still ongoing at the time of this study killed many bushes and made the berries unsuitable for human consumption (Kardell 1980). During the past decade the average annual berry production in the forests has been estimated to 323 million kg of bilberries and 265 million kg of cowberries.

Historically harvesting of berries was considered too time consuming and it coincided with more important labour intense activities in agriculture. Conservation of the berries has also been a limiting factor, but drying or jam/preserves have been the methods of choice. In early twentieth century, people from urban areas went to

forested areas as seasonal labour to assist with the harvest of berries. From 1911 a more formal infrastructure was organised with the building of regional berry dryers around the country. The purpose was to use them both as food and medicines. The decades to follow the concept of "bilberry girls" was coined for young females from Stockholm and other cities that went to the rural areas for the berry seasons. For instance, one municipality in northern Sweden was "invaded" by around 300 "bilberry girls" for approximately two months in 1917. There was a small dip in the interest after World War I, but it rose again around World War II. In some cases there were conflicts between the guest harvesters and the locals, but the "bilberry girls" were generally seen as a positive experience (Tunón 2021; Sténs and Sandström 2013) (Fig. 2.7).

After the Perestroika and Glasnost in the Soviet Union and eastern Europe in the mid 1980s and then the aftermaths of the fall of the Soviet Union in 1991, eastern Europeans from Poland, Bulgaria, Estonia, Latvia, Lithuania, Ukraine, and Romania started coming to Sweden as seasonal berry pickers. About the same time Thai women that had migrated to Sweden for marriages started picking bilberries, cowberries and cloudberries (*Rubus chamaemorus*). In the early 2000s, the wild berry industry was restructured and staffing agencies in Thailand started to arrange transports and work permits for Thai people to come to Sweden. The berry pickers were promised good

Fig. 2.7 Bilberry (*Vaccinium myrtillus*) and cowberry (*Vaccinium vitis-idaea*) are the most important species of forest berries. Photo: Håkan Tunón

profit for harvesting berries and many pickers took loans to come. They were often forced to pay all sorts of fees for the opportunity to pick berries, so the profit margins weren't as good as promised. Consequently, they had to pick large quantities of berries as they were paid per kilo and they often had to work 12–19 h, six days a week. The kilo price depends on the world-market price that is determined by for instance the availability of wild berries. Some seasons the pickers could just not earn enough to cover the costs, so they ended up in debt. Some local companies withheld their earnings for various reasons. This has been described as human trafficking. The is bad press resulted in 2011 that the rules were changed, and the Swedish wild berry actors had to prove that they in the beginning of the season had sufficient financial assets to pay the workers in order to get work permits from the Swedish Migration Board. For the following seasons they companies had to show that the workers from previous years had been paid. Annually about 5000 people received work permits to pick berries, and they mainly came from Bangladesh, China, Thailand and Vietnam. The berry pickers do not pay tax in Sweden, but on the other hand they haven't any kind of social security either. The general situation has improved during the last decade but is still not considered to be satisfactory (Wingborg 2011, 2013, 2018; Thörnqvist and Woolfson 2012; Eriksson and Tollefsen 2013; Axelsson and Hedberg 2018; Hedberg et al. 2019) (Fig. 2.8).

Fig. 2.8 Porcini (*Boletus edulis*), chantarelles (*Craterellus lutescens*, *Cantharellus cibarius*). Photo: Håkan Tunón

2.3.4 Mushrooms

Among the peasants in the eighteenth and nineteenth century mushrooms were rarely seen as edible. They were perceived as related to the devil and was a sign of rotting. However, among the higher classes it began to be increasingly popular due to influences from the French court. In the mid-nineteenth century campaigns to increase the interest in mushrooms as a resource and a delicacy and from the mid-twentieth century a wide interest among the public has continued to grow. Today picking mushrooms is widely appreciate, mostly as a recreational activity that still makes a culinary contribution. However, there is a limited number of species that are being picked by the public. The most popular are chantarelles (*Cantharellus cibarius*, *Craterellus tubaeformis*, *C. lutescens*, *C. cornucopioides*) and porcini (*Boletus edulis*).

Interestingly enough, oyster mushroom (*Pleurotus ostreatus*) and shiitake (*Lentinula edodes*) are abundantly growing on decaying wood, but hardly ever picked by the public, even though they are among the most popular mushrooms in the supermarkets. Sweden has approximately 4000 mushroom species of which about a dozen are very poisonous, while around 120–130 species are considered culinary (Dahlberg and Tunón 2007). An interesting finding was made in 1998 when the species Matsutake (*Tricholoma matsutake*) was found in Sweden. Studies showed that it was abundantly occurring in some old pine forests. It is a mushroom of great economic interest and there is some export to Japan. Due to this export the value of the mushrooms in an old pine forest might be much higher than the value of the timber.

A recent study has shown that the industrial forestry with clear cutting is detrimental to the mushroom diversity in an area since the trees and the mushrooms are dependent on mycorrhiza. When the trees are harvested this dependence is broken and the mycelium dies. As an element of environmental consideration 5–10% of the trees are left at a clear-cutting. The study showed that this still resulted in a loss of 75% of the mycorrhiza mushrooms in the area. However, if 60% of the trees are left there are still losses of 30% of the species. It is estimated that the mushroom diversity is restored around 90 years after a clear-cut. However, some species will not recover within that interval. A cutting cycle of pine in Sweden is generally between 90 and 120 years and for spruce 70–100 years. If no trees were left the abundance of mycorrhiza mushrooms decreases with 95% and the number of species with 75% (Sterkenburg et al. 2019). Furthermore, when it comes to carbon sequestration of boreal forests the contribution from fungal mycelium is significant and the long-term below-ground input has been shown to contribute to around 50–70% of the total carbon stored in humus. When a forest is clear-cut much of the mycelia dies and the soil start leaking from the stored carbon. Initially the growing trees capture carbon, but when the forest gets older the importance of the humus and fungal system increases (Clemmensen et al. 2015) (Figs. 2.8 and 2.9).

Fig. 2.9 Mezereum (*Daphne mezereum*) and witch's brooms (*Taphrina betulina*) are two of many traditional medicinal plants that can be harvest in the Swedish forests. Mezereum is strongly poisonous and had a diverse use. Witch's broom has been used against skin diseases, but also as a protected measure against evil spirits. Photo: Håkan Tunón

2.3.5 Harvest of Medicinal Plants and Other Remedies

From time immemorial local people have depended on the forest for harvesting medical cures for various ailments. Some of these are pharmacologically active while others probably benefit mostly as placebo. In the folk medicine some of the most renowned domestic plants were mezereum (*Daphne mezereum*), heather (*Calluna vulgaris*), bilberry, cowberry, bearberry (*Arctostaphylos uva-ursi*), European goldenrod (*Solidago virgaurea*), common club moss (*Lycopodium clavatum*). Furthermore, resin from both pine and spruces were collected as wound healing agents or for dental health. Witch's brooms, a deformity on birches caused by a fungi (*Taphrina betulina*), was considered both as having medical properties and magical powers to protect from evil spirits. Animal parts were also used in the traditional medicine (Tunón 2021) (Fig. 2.9).

Around year 1900 there was an increased awareness among apothecaries and physicians in Sweden that the national supplies of medicinal plants relied too heavily on import and that in an international crisis the healthcare would be compromised. Hence, a national network for cultivation and wild harvesting of medicinal plants where initiated. This relied on the general public as harvesters of plant material and to deliver it to the local pharmacies or special facilities. During the first decades of the twentieth century several manuals were published instructing people in what to harvest and how to do it. Most of them described only 20 or 30 different medicinal plants that were easily identified by people to ensure a safe identification. Some of the most common plants for harvest was alder buckthorn (*Frangula alnus*), bearberry, bilberry, cowberry, common club moss, Iceland moss (*Cetraria islandica*), male fern (*Dryopteris filix-mas*) and yarrow (*Achillea millefolium*) (cp. the "bilberry girls").

After World War II the public interest in harvesting medicinal plants went down to close to zero and was supplied through import (Samuelsson 2001; Tunón 2021).

Even if there have been some minor endeavours in trying to develop businesses based on medicinal plant harvest it is today almost exclusively small scale and for personal use. You can still find ointments with resin from spruce on the market. However, the big part of the bilberries that are being picked in the Swedish forests are exported to European and Asian companies to produce herbal medicines or food supplies (Wingborg 2011). For medical and chemical purposes resin from pine and spruce was harvested, both for personal use and commercially. The bark was scarred in order to stimulate the resin production in the tree. This has been ongoing for centuries, but during World War I resins were harvested in substantial amounts. In 1917 alone it is estimated that more than 1450 tones of resin were distributed from the railway station in the village of Ljusdal. Most of which was harvested in the Ljusdal parish and neighbouring parishes. The national collection during World War I is estimated to have been worth over 20 million USD in today's value. A couple of years later the harvest of resins became banned due to its potential negative impact on the industrial forestry (Anonymous 1917, 1919; Magnusson 1996; Ljung 2015b). The resin was mainly used to manufacture turpentine and other products. Today turpentine is a biproduct in pulp production (Fig. 2.10).

Fig. 2.10 NWFPs have become high fashion on the market, for instance. The spring shoots on spruce are sold pickled or as marmalade, syrup or flavoured oil. Small bottles or jars with artisan products at fairly high prices. This development is driven by innovative entrepreneurs in the rural areas, and many products are short-lived, while other turns into success stories. Photo: Håkan Tunón

2.4 NWFPs as Food from the Forests

Vegetable food stuff not emerging from agriculture has often been referred to as emergency food. However, during the past decades there has been an increasing interest in more exclusive gastronomic products based on "forest food". Historically, apart from berries, mushrooms and game other NWFPs have been harvested in a relatively small-scale. The most renowned example is different kinds of bark to eke out flour in bread or porridge. In the southern parts of Sweden barks from elm (*Ulmus glabra*), birch and linden (*Tilia cordata*) were mostly used, but in the more northern parts pine bark was preferred (Niklasson et al. 1994; Niklasson 1996). However, there is a significant difference between them, as the southern bark flour was made from the entire bark, while in the north only the inner bark (cambium) was used. The Sami people traditionally harvested inner bark from pine that was eaten fresh, dried or roasted. The bark was often mixed with reindeer milk, fat, blood or other kinds of food, like fish or meat soup. When the bark was roasted it was done in pits in the ground. The bark was harvested from standing trees and in a way that ensures that the tree would survive the process in order to be able to harvest again. The oldest remains of Sami bark harvest are from 1450 A.D., but there are findings in Finland of tools for harvesting dated as far back as 1200 A.D. This tradition ended in the late 1800s (Niklasson et al. 1994; Zachrisson et al. 2000; Östlund et al. 2009).

In the spring when the birch sap rises after the freezing winter it was time to harvest in order sap to make a sugary and refreshing beverage—or after fermentation a kind of wine or cider. This has been further developed and from 2006 a Swedish sparkling wine is made commercially from birch sap in a méthode champenoise. Another traditional beverage *enbärsdricka* or *jenlag* is made from berries, twigs, branches and roots of juniper (*Juniperus communis*) together with yeast, water and sugar. The fresh shoots of pine and spruce have also been used to make herbal tea rich in vitamin C, which was valuable in a boreal country with long winters with a very limited supply of vegetables and fruits.

Attempts have also been made during the centuries with Swedish syrup production from broad leaf trees, like maple (*Acer plantanoides*). However, the sugar content is much lower than in its North American relative sugar maple (*Acer saccharum*), which explains why it never really succeeded, and in the early nineteenth century the sugar beets (*Beta vulgaris*) made other sources irrelevant. In rural development, a diversity of other products is being developed based on fresh spring shoots of spruce like for instance pickled shoots, jam, preserve, syrup and vodka. Often in small jars and at high prices. Consequently, you can today also buy exclusive, artisan bread with ground pine bark as an additive to the flour (Fig. 2.10).

2.5 Cultural and Recreational Values as NWFPs

Forests are also important for cultural and recreational reasons. It is sometimes said that poor people don't—or at least seldom—have the opportunity, possibility or ability to enjoy nature and its aesthetic values. However, in industrial and urban societies the concepts of spare time and outdoor recreational activities have become increasingly important. Thus the forest is a space for recreation while at the same time productive activities, like berry and mushroom picking or hunting, have gone from subsistence activities to leisure. This has turned outdoor and ecotourism into financially important business opportunities, which has changed the way we look at rural areas and the values they have to offer. In the late nineteenth century an increasing number of urban people started going on recreational vacations in scenic landscape.

Around 1930 the issue concerning equal opportunities also for poorer people to enjoy nature related recreation was on the political agenda. This resulted in the legal right to a 12 days' vacation in order to give all people a possibility for a meaningful spare time. Consequently, more areas close to the cities were set aside as protected areas for recreational values. In the 1990s and early 2000s the right of public access was questioned, especially in relation to the commercialisation of values, either in the form of commercial berry picking or ecotourism businesses. There is a political pressure from certain groups to restrict the right to public access which might affect the future possibilities for the public's outdoor activities (Sandell and Svenning 2011). Outdoor recreation in the forests is considered to have a strong tradition in Sweden. It has been shown that when it comes to housing, a large group (45%) wish to have a forest within 1 km from the household and that they plan their living accordingly. The closer a forest is the more often people will visit it. They take walks; pick berries and mushrooms, search peace and calm, etc. An increased distance to forests is considered to be negative to the quality of life. The forest ought ideally to be within walking distance and therefore forests within 1–3 km from the household are appreciated for recreation (Hörnsten and Fredman 2000).

The view on forests as recreational areas has been evaluated in 1977 and 1997 to establish possible changes in peoples' behaviour and perspectives. In this study it is shown that the average respondent visited a forest once a fortnight in the winter and once a week in the summer and this was comparable between the two questionnaires. However, the group of respondents of 45+ years had increased their number of visits, while the numbers had decreased slightly for younger people. The general interest in picking berries and mushrooms decreased significantly in all age groups. The conclusion was that the public use is changing from harvesting towards recreational and that there was an increased appreciation of pristine forests vis-à-vis production forests (Lindhagen and Hörnsten 2000; Hörnsten 2000). According to another survey, visits in forests make Swedes "feel relaxed and harmonious" (Hörnsten 2000).

In another study, social science students were compared with forestry students, and the result showed that both groups preferred recreational forests on photographs compared to natural forests and forests with signs of forestry management, including

clear-cuts, that was rated the lowest. Accessible forests with paths and trails were most appreciated. However, the preference was part affected based on the intended purpose of the visit (walking, outings (e.g. picnic), picking berries or mushrooms, exercising, or studying plants and animals). The students preferred "to walk, go on outings, and exercise in recreational settings whilst natural-looking settings were favoured for picking berries or mushrooms". Forestry students preferred "to study plants and animals in natural-looking settings than in settings with traces of forest management" (Eriksson et al. 2012).

Even if tourism is getting increasingly important and rural ecotourism businesses are growing all over the country one problem remains: The landowners are seldom the ones running ecotourism. Consequently, due to the right of public access other people can make a profit from being on someone else's land. But on the other hand, an ecotourism business might invest, plan and advertise activities, but in the end the landowner might clear-cut the site that is planned to be visited. Clear-cut areas are seldomly considered to appeal to tourists. In the same one there might be a clash between forestry and the customary use of an area by the local community. During the past decades all sorts of initiatives regarding ecotourism have appeared, like horseback riding, dogsledding or safaris to see elks or bears, or listen to wolves or owls. All of which to a certain amount relies on at least a convincing air of wilderness. When it comes to the perception of the urban population most forested areas are to be considered as wilderness even if it is a managed forest, but among biologists there is also an increasing interest for rewilding, i.e. "letting nature take care of itself, enabling natural processes to shape land and sea, repair damaged ecosystems and restore degraded landscapes" (Rewilding Europe 2021). This constitutes a major challenge vis-à-vis forestry, but only a minor threat to the harvest of NWFPs, except possibly for hunting. Among the urban population there is also a beginning anti-hunting lobby.

2.6 Reflections

Over the past centuries there has been continuous changes concerning what NWFPs that have been considered to be most important—or in some cases even legal. As forestry became more and more important in Sweden, everything that interfered has been actively hindered due to financial reasons, but still there are many different interests clashing in the forest. Today the forestry sector is an extremely powerful societal actor and fiercely defends its positions, but the sawmill and paper industry and the forest owners are not necessarily on the same side. The interest of the industry is not necessarily the interest of the landowners or the common good. The industry is interested in low prices of timber, while the landowners are interested in high return on their lands. When the importance of forestry in society is gradually going down other interests may come to play a more important role. Furthermore, since all stakeholders feel very strongly about their particular domain of interest the debate is fairly harsh. From a societal point of view it is important to consider all perspectives from a variety of users in order to include all potential values from forests, including various

NWFPs, but it is equally important to take the landowners' interests into consideration. It has been suggested that there is a need for a landscape forestry planning in order to make forestry and nature conservation work in practice (Michanek et al. 2018). I would say there from a NWFP point of view is a need for a much wider landscape plan in order to identify areas valuable for forestry, conservation, and harvest of NWFPs, recreation or as culturally significant places. The forest is providing many different ecosystem services, but only a few, like timber, is easy to put a price on. Hence, the "softer" uses of the forests often is neglected when estimating the values the forests provide—even if they might be more valuable to society, and potentially to the landowners. However, the right of public access is of course both a blessing and a curse since it makes the forests open to anyone, while it narrows down the possibility for the landowner to make a financial profit from other activities than forestry. This custom also makes it difficult to charge a small fee for access to the landowners' land. People are so accustomed to get access for free that they do not readily want to pay. Urbanisation has also resulted in that an increased proportion of the population lacks prior experiences from harvesting NWFPs, while at the same time various immigrant groups contribute with new possibilities for forest products based on their harvest traditions.

It could perhaps appear strange to include an essay on NWFPs in Sweden in a book focusing on the forests of Asia? However, I hope there might be some lessons to be learnt from experiences made during the Swedish transition from a rural country with high dependency of local biological resources in the nineteenth century to an industrial and urbanised country where NWFPs are of limited urgency for the national or the household economy, except perhaps the recreational part, in the twentieth century. Sweden has also at the same time gone from forests with multiple uses, where forestry was one of many activities, to a situation where industrial forestry became the dominant land use, and now it appears as we might be on the brink of returning to multiple use again. Today logging companies are active all over the world and the values of the forests are easily visualised in monetary terms by timber values. However, when trying to calculate the value of products from a forest one has to take both tangible and intangible products into consideration. I have for this essay interpreted the term NWFPs fairly wide, and even included 'products' that in fact are services, like ecotourism and recreation. NWFPs are basically only one part of what is often referred to as ecosystem services. The use of NWFPs can be for household purposes only or for commercial ones, either on a smaller or a larger scale. The international (and national) discussion concerning the value of a multitude of ecosystem services has been difficult to adapt to the Swedish forest situation, since the forestry industry is such a dominant player. For the past hundred years forestry has more or less been the sole answer to rural development, together with extraction industries, e.g. mining and hydroelectricity, now this hegemony is being challenged. When rating the value of ecosystem services the forestry is easy to put figures on, while softer values like recreational, emotional or cultural activities are almost impossible to put a true price on. However, increased consideration for environmental and biodiversity issues, as well as the evolvement of alternative livelihoods in the countryside, e.g. ecotourism businesses, but also the option of working remotely through

telecommuting, has put the rotation forestry with clear-cuts in a new light. There is in Sweden a dawning discussion regarding the possibilities to substitute the conventional rotation forestry with clear-cuts to a selection forestry, which probably would increase the potentials for a multiple land use at least for some NWFPs. We have to ask ourselves, what are the most valuable ecosystem services in the forests, to whom and in what 'currency'? I would like to see an increased discussion on that matter also in Asia and all over the world.

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Chapter 3
Traditional Ecological Knowledge on Non-wood Forest Products Management and Biodiversity Conservation: A Focus on Chittagong Hill Tracts (CHTs), Bangladesh

M. Khairul Alam

Abstract Non-wood forest products (NWFPs) occupy an important position in the lives and livelihoods of the people of Chittagong Hill Tracts (CHT), Bangladesh. It is linked with food and nutrition security, health care and other livelihood support components. In addition to sustenance, it also generates cash through sale of some species and commodities. The use patterns of NWFPs from CHTs can be broadly categorized under food plants, medicinal plants, bamboo, rattan, broom sticks, sun grass, *Litsea glutinosa* bark and plants for other uses. Most of the NWFPs are collected from wastelands near households and natural forests, which are mostly degraded and poorly managed. The current NWFP stocks in CHT are in a depleting state. The main causes include overexploitation, land use change, habitat degradation, market forces for traded items, impacts of climate change, unscientific management and a lack of institutional support. Over exploitation and market demands can be adjusted through domestication. It discusses the domestication and cultivation potential of commercially prospective species and the scope of enterprise development. The role and links of traditional ecological knowledge (TEKs) and their practices for NWFP conservation are also discussed. Although NWFPs play vital roles in the economy and livelihoods of the people in CHTs, they are a much neglected sector in terms of development interventions. Even research studies are not adequate. Lack of land, market information, financial support, training, and awareness are identified as the major constraints for development interventions. Considering the importance and potential of NWFPs in CHTs, this paper suggests some strategies for their sustainable management.

Keywords Bangladesh · Chittagong hill tracts · NWFPs · Conservation strategy

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3.1 Introduction

Traditional forests are natural ecosystems in which trees are a significant component. The term "Non Wood Forest Product (NWFPs)" includes all biological materials other than woods and timbers that are extracted from natural forests for human use. These include foods, medicines, spices, essential oils, resins, gum, latexes, dyes, ornamental plants, wildlife (product and live animals), fuel wood and raw materials, notable rattan, bamboo, small and fibers. These products play an important role in the economy of forest dwelling people. In addition, NWFPs provide environmental services such as watershed conservation, soil stabilization and climate regulation. In addition, these NWFPs are linked with many cultural, spiritual, religious and object values of indigenous inhabitants.

Chittagong Hill Tracts (CHTs) cover approximately nine percent of the area of Bangladesh, mostly under primary, degraded and denuded forest situations. It is home to 13 ethnic communities with distinct cultures, livelihoods and identities (Roy 2002) whose lives and livelihoods are centered on the plant resources occurring around them. In a fragile hill ecosystem, to date shifting cultivation, locally known as *jhum* is the main stay of livelihood. Other than *jhum* harvest NWFPs support most of the dietary rations and primary health care of these people. In addition, plant resources supply their construction materials, fuel wood, weaving implements and elements for various life support systems.

The hill people know the plants, their use patterns, ecological distribution and their functions in the ecosystem. Plant use over time made them able to develop the cropping pattern, crop calendar, harvest pattern and overall pant management systems of their own. Hill ecosystems are always fragile and vulnerable to climate change. Plants occurring in different habitats showing different climate change scenarios are instrumental in adjusting to vulnerable changing situations due to climate change.

Interactions with plants over time made hill people develop their own knowledge system. Adjustment and innovations in these management patterns are also ongoing. All this knowledge and innovations have become a knowledge system that we call traditional ecological knowledge (TEK), which refers to the knowledge, innovations and practices of indigenous and local communities around the world (Warren 1991; Cotton 1996; Ramakrishnan 2009). It is transmitted orally from generation to generation (Fernandez 1994; Khan and Fever 1996; Rehman and Kane 1996; Ahmed 2001; Khan et al. 2007). The tribal people of the different parts of the world conserve different plants in the name of taboos, totems and myths, holy hills and sacred forest, which act as an indirect method of sustainable management of wild plants (Hongnao et al. 1990; Vartak and Gadgil 1991; Shengji 1984; Jain 1987; Abraham 1991; Jain 1991 and Cunningham 1993). Currently, scientists and development workers emphasize TEKs for their easy acceptability to people, which reduces time and research costs (Posey 1996). Traditional forest-related knowledge (TFRK) has long been known to have important implications for forest management and the conservation of forest biodiversity (Fox et al. 2007; Parrotta et al. 2008; Mukul etal. 2010).

The hill people of the CHTs have their own TEK system on natural resources. Lewin (1869) seems to be first in recording some TEK on plant uses from CHTs. Its integration in different farming practices and management and coping with their own agroecological and socioeconomic environments has been addressed by many authors (Alam 1996, 1997, 1998, 2002; Alam and Khisa 2000; Alam and Mohiuddin 2001; Mohiuddin 2009; Mohiuddin and Alam 2011). Their roles in natural resource management in CHTs have been well focused (Khisa 1997, 1998; Millat-e-Mustafa 1998; Hoque 2000; ADB 2001). TEKs are eroded and need to be documented before they disappear.

NWFPs contribute directly and indirectly to the livelihood of hilly people in CHTs (Miah and Chowdhury 2004; Alam and Mohiuddin 2010; Kar 2010; Miah et al. 2011). Forest resourced income occupies the second largest share of the total household family income of the hill people, of which 68% was generated from shifting cultivation, 11% from marketing forest products, and 21% from the consumption of forest products (Mia et al. 2011). People who are dependent on NWFPs are mostly harvesters from the wild state (Kar 2010; Miah et al. 2011).

Despite the importance of NWFPs, there has been little systematic analysis on their scopes of integration in the development of livelihoods of hill people. There are no or few initiatives on the domestication process of species that have market potential. Little information is available on their market chain and marketing information system. One of the important issues is lack of or poor entrepreneurship of NWFPs and related products. There exists no management or strategy planning on this aspect, and the TEK system is not given prior weighting in the local-level resource management process. This chapter thus aims to determine the scoping of some TEK and some of their practices in CHTs and their linkages to NWFPs in developing a framework strategy for NWFPs in the region.

3.2 Methodology

This chapter is mainly based on secondary information by review of pertinent literature and compilation of published and unpublished documents. The approach also includes the use of participants' observations of what the author gathered during his botanical explorations, documentation of ethnobotanical information, documentation of farmers' practices in hill cultivation and innovations in the CHTs over the last four decades.

3.3 Non-wood Forest Products Use Pattern in the CHTs

NWFPs can be classified in many different ways according to their perceived end uses (Alam 1998; Chowdhury et al. 2009; Mia et al. 2011; Jannat et al. 2018; Alam and Khisa 2000; Wong et al. 2001; Vantomme et al. 2002; Kar 2010; Chikamai et al.

2009; Shackleton and Gumbo 2010; Uprety et al. 2016; Thinyane and Maroyi 2019). Kar (2010) states that bamboo (45%), wild vegetables (30%), and broom grass (13%) are the three most important wild NWFPs collected by households from CHTs. In this chapter, the NWFPs from CHTs are discussed based on the perceived ideas of end uses and the present trend of trade. Considering the frequency of use attributes from published literature and cash generation, the use patterns of NWFPs from CHTs are discussed broadly under food plants, medicinal plants, bamboo, rattan, broom sticks, sun grass, *menda (Lisea glutinosa)* bark and plants for other uses.

3.3.1 Food Plants

In addition to foods from *jhums* hill, people of the CHTs also use approximately 50–60 wild plant species as food plants that they collect from fallow *jhums* or other fallows. Lewin (1869), probably for the first time, documented a good number of food plants occurring both in shifting farms and wild states from CHTs. Major foods harvested from wild states are tubers, rhizomes, bulbs, spices, vegetables, oil seeds and culinary herbs (Alam 1998, 2002; Miah and Chowdhury 2004; Chowdhury et al. 2009; Mia et al. 2011; Alam and Mohiuddin 2009, 2010; Motaleb et al. 2013; Khisa 1998; Khisa and Mohiuddin 2015; Paul et al. 2016). Most of the wild harvests of food plants are culinary herbs. Fruits of approximately 60 plant species are edible (Lewin 1869; Alam and Mohiuddin 2010). Generally, during the rainy season, there are shortages of *jhum* food stock. Although different wild food plants are available throughout the year, the rainy season (April–June) is the peak period for collecting and selling wild vegetables, including bamboo shoots. Wild yams are generally collected during dry months (November–February). Thus, the wild harvest of food plants, especially bamboo shoots, supplements the main dietary needs and ensures food security among hilly people for centuries (Fig. 3.1).

In addition to family consumption as a dietary ration hill, people also earn cash by selling wild harvests of food stuff in local markets, and hence wild food plants also work as a safety net. The dietary habits of hilly people indicate that underutilized crops have a distinct position and a well-defined role in providing food and nutritional security. Many indigenous vegetables are rich in vitamins and antioxidants such as phenolics, which contribute to better health and fit (Chanda 2009).

3.3.2 Medicinal Plants

Most tribal people still depend on local medicinal plants for the treatment of different diseases. Most communities of the CHTs have their own folk formularies in different names. In the Chakma language, their traditional *materia medica* is known as *Talik*

Fig. 3.1 Food plants in the market harvested from wild state

(Khisa, 1996). Records and documentation on indigenous knowledge on ethno-medico-botany and medicinal plants from hill regions seem to be more comprehensive than other aspects of NWFPs. A good number of ethno-medico-botanical studies were conducted from different regions of the CHTs and on different tribes. Worthy to be mentioned are (Alam 1992; Khisa 1996, 1998; Rahman et al. 2007; Yusof et al. 2007; Biswas et al. 2010; Mohiuddin et al. 2012; Motaeb et al. 2013, 2015; Uddin et al. 2015; Paul et al. 2019). Many other references are available across these studies. Uddin (2006) comprehensively documented 700 vascular plants used for 302 diseases and 2295 prescriptions from CHTs. Most of the medicinal plants are herbs, followed by shrubs and trees and climbers. People also collect different parts of medicinal from wild state for sale to local markets or agents for cash income, thus used for subsistence. Medicinal plants provide more cash income than wild fruits.

Traditional healers in CHTs, locally called *Baidyas;* often need a diversity of plant species for their practice. As medicinal plants are becoming increasingly scarce, they often try to maintain a stock of living specimens in their homesteads as much as possible (Rashid 2009).

3.3.3 Bamboo

Bamboo is the major house construction material in the hill region of Bangladesh. How bamboo is linked with the life and livelihood of a hill person could rightly be

assessed from Lewin (1869) as follows: "The bamboo is literally his staff of life. He builds his house of the bamboo; he fertilizes his fields with its ashes; of its stem he makes vessels in which to carry water; with two bits of bamboo he can produce fire; its young and succulent shoots provide a dainty dinner dish; and he weaves his sleeping mat of fine slips thereof. The instruments with which his women weave their cotton are bamboo. He makes drinking cups of it, and his head at night rests on a bamboo pillow; his forts are built of it; he catches fish, makes baskets and stools, and thatches his house with the help of the bamboo. He smokes from a pipe of bamboo, and from bamboo ashes, he obtains potash. Finally, his funeral pile is lighted with bamboo. The hill man would die without the bamboo, and the thing he finds hardest of credence is, that in other countries the bamboo does not grow, and that men live in ignorance of it" (Fig. 3.2).

Bamboo is present throughout the CHTs as undergrowth of the high forests and in some areas as pure vegetation. There are approximately six to seven species of naturally occurring bamboos in the CHTs. The species are *Melocanna baccifera*, *Bambusa burmanica, B. tulda, Dendrocalamus longispathus, Schizostachyum dullooa, Gigantochloa andamanica,* and *Melocalamus compactiflorus* (Banik 1998; Khisa 1998; Alam 2001). Among them, *M. baccifera* is most common and constitutes 80–90% of the total bamboo vegetation. Other than these *B. balcooa, B. polymorpha, B. vulgaris* and *D. giganteus* have been introduced for unknown past and are being cultivated by hill people.

Fig. 3.2 Harvesting of bamboo growing along the stream banks

Kar (2010) reported that in terms of subsistence or income, people from CHTs rank solid bamboo as the top of the list (45%) and bamboo shoots as the fourth position (10%). The gradual conversion of bamboo forests into plantations and burning for shifting cultivation have decreased the bamboo cover areas of CHTs (Banik 1998; Jannat et al. 2018). Gregarious flowering and monocarpic death also cause depletion of bamboo resources. The last gregarious flowering of *Melocanna baccifera* occurred in the CHTs during 2007–2009. It appears that out of naturally growing species, *Melocalamus compactiflorus* and *Schizostachum dullooa* have become threatened.

3.3.4 Rattan

It is one of the important nonwood forest resources of CHTs. Lewin (1869) says, "The cane is the hill man's rope; with it he weaves baskets, binds his house together, and throws bridges over the otherwise impassable hill torrents" and documented eight different types of rattans by Chakma names from the CHTs. Common species of rattans now available in the CHTs are *Calamus tenuis, C. guruba, C. erectus, C. latifolius, C. viminalis* var, *fasciculatus* and *Daemonorops jenkinsiana* (Alam 1990). Rattans are generally used as binding materials in basketry and wicker works. In addition, rattan fruits are much cherished by local people and have good demand in urban markets. Very tender rattan twigs are also cooked in curries (Fig. 3.3).

Rattan canes are generally collected from wild states but are not readily available. It grows sporadically. Some people also grow rattans around homesteads. Rattan canes are collected by male members during dry months. People generally make

Fig. 3.3 Raw rattan canes in the market for sale

2 m long pieces of canes for sale (Alam and Mohiuddin 2010). Now, it is mostly a commodity for subsistence cash earnings.

3.3.5 Broom Stick

One of the important NWFPs of the CHTs is the broom stick. The major use of the plant is inflorescences, which are tied into bundles to make dusting brooms. It is the product from *Thysanolaena latifolia*, called *phuljharu* in Bangla. It is both a sustenance and cash earning commodity. In preferential ranking, it occupies 3rd in position in terms of usage and harvesting (Kar 2010). It has a wide domestic and overseas market. Broom stick supply to the whole of Bangladesh mostly goes from CHTs. It is mostly collected from wild state. There are good numbers of steps from its collection to broom-bundle making and in trading. Therefore, it is a crop that adds value and creates income generation opportunities (Fig. 3.4).

It is also being exported, and exports are increasing daily (Alam 2016). It has a strong marketing channel, but most stakeholders are middle men, and ultimately, poor harvesters obtain little portion of the revenue (Mohiuddin and Alam 2010; Alam 2016). Recently, Alam (2016) provided an overview of the cultivation techniques, trading and marketing of this commodity. It is harvested generally from November to February.

Fig. 3.4 Drying broom sticks for making brooms

3.3.6 *Sun Grass*

(*Imperata cylindrica*) is an important NWFP of CHTs, as it is almost the only thatching material. In addition to household use, it also generates cash through sale. In terms of preference, it occupies the 5th position, but it is the third largest income provider to households (Kar 2010). It is a strong light demander and grows profusely in open naked hills. With the change in land use by planting timber and other fruit trees, its habitats are decreasing. Similar to broom sticks, sungrass is seasonally harvested from November to February.

3.3.7 *Menda (*Litsea Glutinosa*) Bark*

Menda bark is an important cash-generating NWFP in CHTs and has seemed to enter trade during recent decades of the past century (Alam and Mohiuddin 2010; Kar 2010). It is a tree bark, extracted from *menda* tree. Its powder is used as binding material in mosquito coil factories. The bark was collected from living trees 5–6 years old. In most cases, the collectors collect the whole bark of the trunk, and thus, the tree dies. Barks are sold both in green and dry conditions. Collected bark is dried or sold fresh on the market. Primary traders buy and make stock. In regard to a desired transportable size, they sell it to secondary traders who sell them to crushing mills. Ultimately, ground powder goes to the mosquito coil industry (Fig. 3.5).

Although it is a cash-generating commodity, it ranks 7th in position in terms of preferential ranking by villagers (Kar 2010). In terms of stocks, Kar (2010) reported

Fig. 3.5 Dried Menda bark ready for processing

that *menda* bark is becoming much depleted compared to other NWFPs. Generally, male family members are more involved in *menda* bark harvesting. Villagers walk approximately 1.5 km to collect *menda* bark (Kar, 2010). An increase in trade and unscientific bark extraction without any management strategy might be the causes of this depletion.

3.3.8 Plants for Other Uses

Different plants and plant parts are used for many aspects of life and livelihoods, such as fuel wood, agricultural implements, furniture, house construction, dugout making, resins, dyes, hair wash, skin care, containers, etc. (Lewin 1869; Hutchinson 1909; Alam 1998; Khisa 1998; Alam and Khisa 2000; Akhter et al. 2008). Few worthy uses to be mentioned are *Derris* spp., *Albizia procera* bark and some other plant roots and bark for stupefying fish; inner bark of *Sterculia* sp. for making basket straps; *Albizia procera* and *Bischiofia javanica* barks for dying fabrics; dried shell of locally cultivated bottle gourd as water container, etc.

3.4 Ecology and Distribution Pattern

A large amount of NWFPs is collected from areas around and wastelands near households and villages. Harvests from home surroundings include wild vegetables, bamboo shoots and wild fruits. In addition, villagers usually collect small fish, crabs and snails from the wetlands near their households. Most of the NWFPs are collected from natural forests that are mostly degraded and not managed (Kar 2010). Plantation forests also provide habitats for approximately 15% of NWFPs (Kar 2010). It is evident from the literature, as mentioned under food and medicinal plant titles, that most food and medicinal plants are herbs, undershrubs and climbers. Generally, the NWFPs grow in a wide range of habitats from evergreen forests with dense canopies to degraded forestland. Approximately 65% of plants grow in secondary forests (Kar 2010), mostly on hill slopes, along streams, and fallow *jhums*. In the Chakma language, the abandoned *jhum* is called *raniya,* meaning the market. This indicates that someone will get most of his food plants from and abandon *jhum*. Generally, people collect food plants from areas around their home compounds, which are mostly covered with herbs and shrubs. Many of the root crops and leafy vegetables grow in moist partial shades along the stream banks. Most zingibers and edible ferns prefer to grow in partial shades and along stream banks. Yams and shrubby vegetables usually grow in scrub forests. Most of the edible wild fruits are borne either in woody climbers or trees. Some herbaceous climbers also bear edible fruits. These mostly occur in high forests. Muli bamboo (*Melocanna baccifera*) grows both in pure brakes and admixtures with other vegetation in secondary forests. Generally, other bamboos grow as tree undergrowths in secondary forests. One of the common

rattans, *Daemonorops jenkinsiana,* prefers moist sandy-loam slopes along stream banks. *Calamus viminalis* grows in comparatively dry soils, and other rattans prefer to grow under growth in secondary forests. Menda (*Litsea glutinosa*) trees grow in a wide range of habitats from homesteads, fallow lands to mixed forests. Broom stick grass (*Thysanolaena latifolia)* and sungrass (*Imperata cylindrica*) are light-demanding species and prefer to grow on denuded slopes and ridges of the hills. These two sometimes also grow together (Alam 2016). Secondary scrub forests and disturbed habitats are important niches for the majority of medicinal and other life support plants for tribal people.

Bamboo, rattan, broom grass, sun grass and some other aroids and zingibers grow from rhizomes. In most cases, their aboveground parts are harvested. Generally, in the case of herbs, whole plants and roots are used as medicines and food. These two parts cover almost half of the total plant parts under use. Harvest pattern with respect to parts used as an important factor in the regeneration of important NWFPs in CHTs. If a species is represented by a small population, then indiscriminate harvest of these two plant parts will cause damage to that population, ultimately causing a serious threat of extinction. Therefore, harvest from nature should be regulated based on regeneration of the capacity of a species. Alam (2000) stated that the hill people generally harvest and gather different plants and plant parts from different habitats and in different seasons. This harvest adjustment mechanism maintains biodiversity.

3.5 Commercialization, Trade and Market Chains

Currently, most of the NWEPs are being collected from the wild states. Commercialization creates opportunities for the selected products to expand the trade that can provide farmers with greater economic opportunities (Leakey and Izac 1996). Furthermore, in addition to alternative income opportunities, the commercialization of the selected NWFPs ensures the supply of niche products to hill people outside the forest area. Trading of many NWFPs has a place in the sustenance economies of forest dwelling people (Kar 2010; Alam 2016). Many commodities, such as broom sticks, are traded in both domestic and international markets (Alam 2016). *Menda* bark and some medicinal plant parts are also traded and have become commercial commodities. Bamboo shoots are traded in limited form in both local markets and urban markets. Kar (2010) reported that 63% of NWFPs are collected in CHTs mainly for household consumption and 37% of NWFPs are collected for cash sales. However, the exception is *menda* bark, which is mainly collected to sell.

NWFP markets in CHTs comprise formal and informal structures, activities, and processes. Most formal markets, which usually comprise physical structures such as shops and/or arrangement of buyers and sellers at a particular place, are located road- or river-side near villages or at local and district markets. NWFPs are collected from forests, semiprocessed (sorted, bundled, seasoned, etc.) and carried to the nearby markets. The marketing of nontimber forest products is entirely conducted by private traders in Bangladesh. The middlemen/traders collect information about

market conditions and offer prices for the products or collectors. Depending on the type of NWFPs and the scale of the household collections, these products are sold in markets on either a retail or wholesale basis. In informal markets, traders or middlemen come to villages and purchase NWFPs with cash or order a future supply through an informal advance money lending system known as *dadon*. Through this system, influential local traders advance money to poor villagers, thereby compelling villagers to collect a particular NWFPS and sell it exclusively to them (Kar 2010). The price of broom sticks doubles from harvesters to wholesale markets (Alam et al. 2013).

NWFP markets generally share a set of distinct market chain characteristics, stakeholders, and processes. The collectors are mostly local forest villagers who usually become connected to local traders through middlemen, but sometimes they contact the local traders and sell directly to them. There is a considerable disparity in stakeholder income. The collectors obtain the lowest although they put in more labor and time than the other stakeholders, although middlemen or local traders enhance the NWFP market links and offer some income opportunities to the villagers. There are many similarities in the vertical linkages of the producer to consumer systems of NWFPs. There are few reports on analyses of production to consumption systems on bamboo and bamboo shoots, rattans, broom sticks, *menda* bark, medicinal plants, and nontraditional food plants from CHTs (Kar 2010; Alam and Mohiuddin 2010; Alam et al. 2013 and Alam 2016). The market chains differ for different NWFPs. Some are long for bamboo and broom sticks, and some are shorter for *menda* bark and medicinal plants (Kar 2010). The average number of collectors is much higher than the number of traders and producers and higher than the number of retailers (Kar 2010; Alam 2016). NWFP market systems in CHTs suffer from poor transportation facilities, communication systems, financial capital or credit access, and market information and linkages. NWFP market knowledge and information among households is deficient and limited (Kar and Jacobson 2012). Lintu (1997) provided a review of the basic prerequisites for efficient marketing, process development, and proposed development actions for the marketing of NWFPs.

3.6 Entrepreneurship Development Initiatives Based on NWFPs

NWFP-based entrepreneurship development initiatives can play a vital role in generating alternative incomes for villagers, and they would also encourage sustainable NWFP-extraction practices. Gurung (2017) identified the gaps and potentials of community-based NWFP enterprise development in the South Asian region. Although the government had established a few bamboo- and cane-based cottage

Fig. 3.6 NWFPs based handicrafts on display in tourists' market

industry development initiatives in CHT, most had failed because of a lack of coordination between government departments (Bangladesh Cottage Industries Corporation, Forest Department, District Council, CHT Development Board, etc.), insufficient financial credit support, lack of product market information and linkages, and weak product development support and training. There are also no government organizational activities to organize villagers and encourage them to pursue entrepreneurship development activities through cooperative groups, technology transfer, and capacity building, with the exception of the rubber plantation (Alam and Mohiuddin 2010; Kar 2010) (Fig. 3.6).

Few NGOs are working with natural resources and alternative livelihoods. However, these are mostly project driven by external funds and are not sustainable in the long run. A study states that villagers in CHTs are willing to participate in entrepreneurship development initiatives and that almost all are interested in being NWFP-based cooperative members (Kar 2010).

3.7 Domestication and Cultivation Potentials

Commercialization increases the demand for NWFPs, which may lead to resource depletion. With the ravages of deforestation, indigenous plant resources have come

under severe pressure, made worse by the growing numbers of people who have led to the concept of domesticating many of these indigenous plants (Leakey et al. 1996). Kusters and Belcher (2004) reported the cultivation potential and domestication process of many NWFP commodities from Asia. In Bangladesh, little information is available on the domestication of NWFPs. Only a comprehensive account is available on broom grass (Alam 2016). *Acorus calamus* (a medicinal herb), rattans such as *Calamus gracilis, C. latifolius, Daemonorops jenkinsisana,* yams (*Dioscorea* spp.), some bamboos and many food plants are found to be cultivated in homesteads by hill people on a limited scale (Alam and Khisa 2000). It is also observed that some surplus from this cultivation is sold in local markets. This is a sign of people's perception of the domestication process (Fig. 3.7).

At present, there are formal trades of broom sticks, *menda* bark and some medicinal herbs and plant parts. Bamboo culms are being traded for long. These factors need immediate attention for domestication and cultivation. Kar (2010) reported that 76% of villagers believe that domestication of NTFPs could put less pressure on natural forests. However, 93% of respondents from the study did not domesticate any NTFPs. Large cardamom, yams and some taros have domestication potential. A priority list of potential species for domestication can be made through market surveys. It should be made with caution, and the ultimate market size must be strictly taken into consideration. Although specific reports on cultivation on NWFPs from CHTs are not sufficient, nursery and cultivation techniques and other protocols on

Fig. 3.7 Rattan cultivation in the homesteads

bamboos, rattans and good numbers of medicinal plants have been developed by the Bangladesh Forest Research Institute (BFRI), Chattogram.

The Lepcha tribe in Sikkim (India) domesticated the large cardamom (*Amomum subulatum* Roxb.) (Sharma and Sundriyal 1998) and has long been popular in Darjeeling (India), Bhutan, and eastern Nepal as a cash crop (Kvitvik 2001; Koirala 2008). Leakey and Izac (1996) discussed the steps of the domestication process of NWFPs and their linkages with commercialization.

3.8 Threats to NWFPs

There is no quantitative assessment of the stocking of nonwood forest resources from CHTs. However, now it is clearly visible that the NWFPs are sharply declining. People's perception is that now the food and medicinal plants are not readily available near home compounds and they are to go far away from home for harvest. Indiscriminate harvest and exploitation cause the depletion of nontimber forest resources in the tropics (Peters 1994). Causes for the depletion of NWFPs are discussed in almost every paper dealing with documentation on medicinal plants, food plants and plants of other uses (Khan and Rashid 2006; Rashid 2009; Kar 2010; Alam 2016; Paul et al. 2016). The causes of degradation are many-fold, and causes may vary from commodity to commodity. The following paragraphs briefly describe the threats to NWFPs in CHTs:

Overpopulation, overexploitation and destructive exploitation: Due to population increases, food plants, including bamboo shoots and medicinal plants, are being overexploited. In a recent study, Paul et al. (2019) found that approximately 31% of herbs used for medicinal purposes are roots, rhizomes and whole plants that cause destruction of plant resources. Similar situations are prevalent in other parts of the world (Uprety et al. 2016; Jimoh et al. 2012).

Land use change and habitat degradation: New lands are being cleared for *jhum* and/or planting of forest or horticultural crops. Degraded lands that are niches for major food and medicinal plants are now coming under plantations. Thus, the habitats are being decreased, causing stock depletion of many food plants and medicinal herbs.

Financial crisis: Temporal food insecurity during lean periods (November to February) and rainy seasons make people more dependent on collecting bamboo shoots and other food plants for consumption and sale. This accelerated rate of harvest eventually impacts natural regeneration.

Increased NWFP trade market force: Increased trade in bamboo, medicinal plants, broom sticks and *menda* bark is encouraging indiscriminate harvests, maintaining no biological harvest limit and causing significant depletion of these commodities. Commercialization without any management plan causes overharvest and thus causes depletion of the resource.

Lack of awareness: Total collection of *menda* and broom sticks and partial harvesting of bamboo shoots and some medicinal plants are demand driven. Marketing opportunities have encouraged people to overexploit these resources for cash income. In some areas, people are totally debarking *menda* trees, causing their death. This is because of a lack of knowledge about the scientific management of resources and a lack of awareness about resource depletion.

Lack of domestication initiative: Increased NWFP trade and market demand are causing overexploitation of resources. However, in general, people's perception is that these naturally occur and regenerate from themselves. It needs no cultivation. Except for little domestication of broom sticks (Alam 2016), there is generally no domestication initiative by the inhabitants of the CHTs.

Attitude of urban dwellers and young generation: It is evident from many studies that urban dwellers and a section of young generation from hill communities are quiet ignorant about beneficial hill flora and fauna. There is a lack of respect for traditional knowledge among young generations, particularly those living in urban areas.

Impact of climate change: People's perception about climate change is that it is causing degradation of habitats, which impacts the productivity of NWFP resources.

Lack of NWFP management plan and institutional support: Information on the current status, growth statistics, use pattern, market information system and scientific know-how about NWFPs is not adequate to provide management guidelines. Additionally, there is no formal institution to provide financial support or product development from NWFPs to support local NWFP-dependent people.

3.9 Traditional Ecological Knowledge and NWFP Management in the CHT

Most TEKs in practice centered on natural resources in CHTs are mostly based on their uses, cultivation, and management and conservation practices (Alam 2000, 2002; Hoque 2000; Alam and Mohiuddin 2001; Khisa et al. 2006; Mohiuddin and Alam 2011). The role and links of TEKs in the context of NWFPs and their conservation are discussed under the following major heads: *land use; plants and their use pattern; practices and management* and *ecosystem services.*

3.9.1 Land Use

Land use zoning: The hill people of CHTs generally differentiate land forms into seven categories: hill tops or peaks; depressed flat basins between two hills; slopes; eroded slopes with broken landslides; very narrow ravines between two hills; foot

trails along hill crests; and narrow marshy strips between two hills. Each land form has its use specialty and indigenous nomenclature (Alam and Mohiuddin 2001; Mohiuddin and Alam 2011). Along with land forms, hill people also consider the landscape of the hills in land use planning. Landscapes are broadly classified into three categories: villages or *para;* farming sites or *jhums* and fallow *jhums* or *ranyas*. Alam and Mohiuddin (2001) stated that those zones are equivalent to intensive use zones, sustenance use zones and eco-restoration zones from a biodiversity conservation perspective. In addition, they also use streams and water courses (*jhuris* and *charas*) for multiple purposes. Alam and Mohiuddin (2001) termed this zone a habitat management zone. Knowledge of these indigenous land use classifications is important, as plants of different uses are distributed through these land forms. This will help in developing NWFP management plans for sustainable production and conservation.

***Jhum* land selection based on soil indicators**: The gentle hill slopes (generally the middle portion); lands covered with dense bamboo jungle; land with luxuriant growth of vegetation (*Mucuna* spp., wild banana) are considered suitable criteria for *jhum* preparation. Loose and black soils (admixture of gravel) are avoided, and the presence of earthworm burrows is preferred (Khisa 1998; Alam and Mohiuddin 2001; Millat-e-Mustafa et al. 2002). Little admixture of gravel in soil is considered better for fruit orchard establishment, as reported by farmers.

Hill slope differentiation for different crop cultivations: The moisture content and nutrients of the hills vary with slope differentiation and are generally higher in foothills than hilltops. Using traditional ecological knowledge, hill farmers differentiate slopes for different crop cultivation practices. They plant crops of different habits, such as annual crops (such as aroids and gingers), towards the lower slopes and foothills. In the mid-slopes they plant fruit trees. Toward the hilltop, they prefer to plant timber trees (Alam and Mohiuddin 2001).

3.9.2 Plants and Their Use Pattern

Knowledge about food plants and medicinal herbs: Organisms of high cultural utility are apt to be named (Raven et al.1971). Hill people use different nomenclatural terms to indicate different categories of plants in terms of habit, habitat, utility, etc. Alam (2000) reported a brief note on folk taxonomy of plants from CHTs. Although there are no systematic anthropological studies on this aspect of plants from CHTs, limited studies on ethnobotany indicate that almost every plant used by them has a vernacular name by each tribe (Lewin 1869; Khisa 1996; Banik 1998; Alam 1992, 2002; Mohiuddin and Alam 2011; Mohiuddin et al. 2012; Motaleb et al. 2013; Uddin et al. 2015; Paul et al. 2016). As discussed in the resource use pattern and ecology and distribution section, we see that people are conversant with plants and their use, occurrence, distribution and harvest patterns. Generally, hills eat fruits that are eaten by monkeys, squirrels, and birds. The choice of leafy and shoot vegetables is very

wide. Generally, people do not concentrate much on the harvest of particular species and do not emphasize a particular area. This is a mode of plant and people interaction towards biodiversity conservation and management (Alam 2000). Regarding the choice of species, people think that those eaten by cattle and buffaloes are edible (Alam 2000). Banik (1998) stated peoples' perception of bamboo shoot harvest. It has been observed that people harvest different plant parts in such a way that the stock is not exhausted. Most (approximately 90%) people do not destroy the whole plant when they are collecting parts of it (Kar 2010). This knowledge system is very important for NFWP management and conservation.

Mushroom identification: The mushrooms that grow on dead wood or bamboo and form clumps on the soil are considered edible. On the other hand, non-clump forming mushrooms are considered poisonous. Sometimes the hill people use lime for determining poisonous and edible mushrooms. Lime is applied on the fruit body of the mushroom. If the lime-applied area of the mushroom becomes black, then it is considered poisonous. The mushroom covered with ants is considered edible by the *Tanchangya* tribe. The mushrooms that grow on wooden logs of *dharmara* (*Sterospermum personatum*) and *gamar* (*Gmelina arborea*) are considered edible (Mohiuddin, 2009).

Fuel wood selection: The tribal people collect fuel wood from the surrounding forests. Generally, they prefer white colored, straight grained wood as fuel wood. Attributes perceived by hill people in selection fuel wood were discussed by (Alam 2000; Mohiuddin and Alam 2011), and they also provided a tentative list of selected fuel wood species. Wood with fast drying, easy splitting and cutting, efficient burning, and easy burning produces less smoke, good storage characteristics and high heat intensity and is reported to be suitable for fuel wood. Wood with a higher concentration of resin in wood produces toxic fumes upon burning.

Indigenous food preservation through sun drying: The hill people have the practice of food preservation through sun drying. During the growing period, they use slices of radish, bamboo shoots, ripe banana pulp and dry in the sun to preserve them for the rainy season (Alam 2000). They also dry many fruits, such as jujube, and many medicinal herbs to preserve and store them. This ensures food security and cash generation during lean periods.

3.9.3 Practices and Management

Three-stage seed sowing technique in *jhums*: Generally, the hill people practice a three-stage sowing system in *jhum* cultivation. After field preparation, farmers first broadcast the small seeds (*Ocimum*, *Capsicum*, *Coriander*, etc.) all over the field. Then, after approximately a week, they sow the seeds of rice, cotton, maize and other vegetable crops by dibbling methods. When the rice seedlings become approximately 10 cm in height, farmers broadcast *til* (*Sesamum indicum*) seeds spreading over the

field. *Farmers reported that if til seeds are sown with rice, it hinders the growth of rice tillers.* This indigenous practice reduces crop competition at the germination stage and ensures higher production (Mohiuddin 2009).

Local climate condition as an indicator for crop selection: Farmers select crops considering climatic conditions such as *thanda* (coldness) and *gorom* (warmness) of a locality depending on altitudinal variation. Farmers of Empu Para at a higher altitude in the Chimbuk hill range (approximately 875 m) grow citrus fruits such as orange (*Citrus reticulata*), *malta* (*Citrus sinensis*), *jambura* (*Citrus grandis*), and *satkora* (*Citrus hystrix*). in addition to *jhum* farming (Mohiuddin 2009). They consider it *thanda* and suitable for citrus crops.

Crop selection based on altitude and wind velocity: The altitude and wind velocity of an area are also considered important criteria for crop selection. Farmers at higher altitudes do not cultivate *til* (*Sesamum indicum*) in *jhum* because when the *til* fruit ripens, the pods split up and disperse for high wind velocity (Mohiuddin 2009).

Cultivation of ornamental plants in *jhum* fields as insect repellants: It is the custom of hilly people to cultivate red- or yellow-colored ornamental plants along the borderlines of *jhum* fields for beautification. Khisa et al. (2006) stated it as an innovation by the Murong tribes in Banaderban district. *Farmers reported that pungent smell of ginger, onion, mint and pepper and bright flower colour reduce insect attack.* It could be a good biological pest control approach.

Seed collection and storage using traditional ecological knowledge: Hill people have sound knowledge on seed management. They select healthy and disease-free plants as seed plants and collect seeds from mature and larger fruits. In the case of upland paddies, desired seed crops are harvested on sunny days and threshed immediately after harvest. For fleshy cucurbits, farmers put rice straw or dried grass beneath the fruit in the field, so they do not touch the soil. Generally, farmers dry seeds in the sun for 7–10 days and store them in bamboo tubes or hallow gourd pots. To protect against insect attack and to keep moisture at optimum levels, seed jars are stored near fire places or hung under roofs over stoves.

Seed distribution: A community-based seed sharing system still exists among the hill farmers in the CHTs. There are more than ten varieties of rice cultivated in the hilly areas of CHT, as reported by *Marma* farmers. One family generally maintains seeds for 3–4 varieties. They share among themselves the different varieties of rice according to their choice of cultivation. This community-based sharing of seeds maintained agro-biodiversity over time and localities. This also helps in maintaining seed diversity and reduces the storage risk.

Mulching ginger fields: Generally, farmers plant gingers along slopes in lines. Hill farmers use mulch ginger fields with brush wood harvested from fallows. It has been reported that mulching increases the soil temperature, which helps ginger in emerging shoots. It also keeps the field free from weeds. Mulching material in the long run decomposes and adds humus to the soil.

Maintenance of agro-biodiversity: A set of varieties and land races are conserved through shifting cultivation; thus, it is traditional community-based in situ germplasm conservation (Alam and Khisa 2002; Alam and Mohiuddin 2009).

Fallow *jhum* management: Many farmers maintain fallow *jhums* for fuel wood, bamboo and timber production (Alam and Mohiuddin 2001; Khisa et al. 2006). Regeneration of secondary forests in fallow *jhums* also helps in forest regrowth with diversities and thus enhances some sort of diversity.

3.9.4 Ecosystem Services

Maintenance of vegetation in the catchment areas: The hilly people maintain vegetation cover in the upper catchments without any disturbance of the vegetation. The vegetation in the catchment areas ensures continuous flow of stream water. While slashing vegetation for shifting cultivation the hill people do not clear vegetation along the foot hills what they keep for protecting the soil from erosion (Alam 2000).

The preservation, protection and promotion of the traditional knowledge, innovations and practices of local and indigenous communities (TK) are of key importance for developing countries (Kapoor and Twarong 2004).

3.10 NWFPs and Cross Cutting Issues in the CHTs

NWFPs are now in a cross road of development interventions. A focus on traditional ecological knowledge in non-wood forest product management in CHTs concerns cross-cutting issues beyond the livelihood approach. Some cross-cutting issues concerning NWFPs and their conservation are discussed below:

3.10.1 Links with International and National Obligations

The NWFPs and livelihood of the people of the CHTs and practicing TEKs also have linkages with SDGs and some other important international and national obligations. These are briefly focused below:

Sustainable Development Goals (SDGs): The following goals for Agenda 2030 are directly linked with NWFPs and TEKs from CHTs. Linked SDGs with targets are:

SDG 2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

SDG 15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss.

The Convention on Biological Diversity (CBD) recognizes the following:

Article 8(i) Endeavour to provide the conditions needed for compatibility between present uses and the conservation of biological diversity and the sustainable use of its components;

Article 8(j) Subject to its national legislation, a contracting party is required to:

- respect, preserve and maintain the knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant to the conservation and sustainable use of biological diversity;
- promote the wider application of traditional knowledge, innovations and practices with the approval and involvement of their holders; and
- encourage the equitable sharing of benefits arising from the use of traditional knowledge, innovations and practices.

The Nagoya Protocol on Access and Benefit-sharing: Article 7 demands that, in accordance with domestic law, each Party shall take measures, as appropriate, with the aim of ensuring that traditional knowledge associated with genetic resources that is held by indigenous and local communities is accessed with the prior and informed consent or approval and involvement of these indigenous and local communities and that mutually agreed terms have been established.

3.10.2 NWFPs and Ethnobotany

Ethnobotany is an interdisciplinary science for documentation of indigenous knowledge and interactions between people and plants. It is mostly a qualitative catalogue of species and compilation of information. On the other hand, NWFPs are the lists of plants used and their linkages with livelihood and income generation. Knowledge from ethnobotanical studies is being utilized to derive benefits from NWFPs. There is now growing recognition for the relevance of ethnobotanical knowledge and its potential role in the design of agroforestry, upland farming systems and other alternative economic options (Martin 1995; Alam 1996, 1997, 1998, 2002; Khisa 1998). Ethnobotanical information is mostly qualitative and needs to be transformed into quantifiable relative use values. It is now in an evolutionary state—moving from being a classical, purely descriptive method to a more quantifiable science (Wong et al. 2001).

3.10.3 Climate Change

The impacts of climate change on forest resources and biodiversity are now notably perceived by forest dwellers in situations such as CHTs (Sahoo et al. 2018). These vulnerabilities may cause habitat drying, structural changes in vegetation and niches of species in particular habitats. Again, plants have a wide range of adaptations to climate change. Their adaptability, phenotypic plasticity and resilience to stresses provide farmers with needed coping strategies to confront climate change (Stapit and Padulosi 2012). Many NWFPs, such as bamboo and rattans, can adapt to a wide range of habitats. Their high growth rates can sequester more carbon. Most of the species growing in degraded habitats are adapted to harsh habitats. Thus, many NWFPs are supposed to be climate change resilient. This diversity invariably increases the adaptive capacity and response options of people to climate change shocks since they are not dependent on a single species or crop (Zaman et al. 2015).

3.10.4 Genetic Resource Base

Most of the traditional crops have originated from wild states. Thus, wild food and plants for other uses have wide genetic bases (Alam 1998, 2002). Non-wood forest plants comprising different commodity classes are distributed through a wide range of ecosystems with species diversity. Genetic diversity also occurs among crops and other use-potential species that have not yet been recorded. Alam (2016) reported at least four local variants of broom grass as recorded by farmers (*Thysanolaena latifolia*) from Bangladesh. Farmers of Sikkim can recognize different species and varieties of *Amomum* spp. as occur in nature and being cultivated (Sharma and Sundriyal 1998). With indiscriminate harvesting, these resources are being eroded. Their domestication and cultivation can ensure sustained production of commodities and conservation of genetic resources (Alam 1998, 2002; Thinyane and Maroyi 2019).

3.10.5 Gender Role

Knowledge about the food plants are gender oriented. Women have much knowledge about food plants, fuel wood choice, plants for health care, skin care, hair wash, seed storage and maintenance of genetic diversity (Alam 1998; Mohiuddin 2009; Talukdar 2012; Khadka and Verma, 2012). Adult females appear to collect approximately 66% of the NWFPs, whereas adult male members tend to collect approximately 30% (Kar 2010). Approximately 90% of broom sticks are collected by tribal women (Alam, 2016). Mohiuddin (2009) analysed knowledge on agro-biodiversity, seed storage, fuel wood and wild food plants by the Marma and Murung tribes from Banderban hill

district. In both tribes, the females were found to be more conversant with ecological knowledge on these aspects.

3.11 Key Observations and Analysis

The role of NTFPs is well recognized in the livelihood support of forest dwellers in the CHT and occupies the second position (Mia et al. 2011). It grows in a wide range of habitats from evergreen forests with dense canopies to degraded forestland mostly on hill slopes, along streams, and fallow *jhums.* The perceived use pattern of this resource can broadly be categorized under food plants, medicinal plants, bamboo, rattan, broom sticks, thatching grass, *menda (Lisea glutinosa)* bark and plants for other uses. Food harvesting from the wild state is linked with temporal food security and supports the sustenance economy of people. In addition to production functions, NWFPs also render service functions such as watershed conservation and erosion control.

The current NWFP stocks in CHT have not yet been assessed, but apparently evident, this resource is much depleted. The main causes include population pressure, overexploitation, indiscriminate harvest, land use change, habitat degradation and lack of management. Commercial exploitation for trading broom sticks, *menda* barks, and medicinal herbs without any production and management are also causing depletion of resource bases.

Most of the studies on NWFPs merely document plant uses, particularly herbal medicines and health care. The first documentation of plant uses from the CHTs might be that by Lewin (1869) and is still continuing. CHTs have treasures of traditional ecological knowledge (TEK) on natural resources. The ethnobotanical research reports are just information but not codified and digitally stored. The same is the case with traditional ecological knowledge. Hardly any report is available on stock assessment, growth and production rate of the desired parts of the used plants, no harvest assessment, harvest limit, and other biological aspects needed for management planning.

Currently, NWFP domestication initiatives are extremely limited. Few initiatives have been recorded for broom stick grass by some plain land setters (Alam 2016). Kar (2010) reported that 76% of villagers believe that domestication of NTFPs could put less pressure on natural forests. However, 93% of respondents from the study did not domesticate any NTFPs.

Little or no information is available on wild genetic resources of the NWFPs. Fragile hill ecosystems of the CHTs are under stresses of climate change vulnerabilities. This area is still unexplored. A good number of NWFPs, including bamboo and rattans, occur in watersheds and catchment areas. Hardly any assessment of the role of NWFPs in watershed conservation management was done in the CHT context.

In CHTs, there are no effective NWFP-based market interventions. A lack of market information and administrative initiatives are considered some of the major constraints of NWFPs in CHTs (Kar 2010). It is also evident from the present review

that there are inadequate market facilities and no effective enterprise development. Lack of land, institutional and financial support, training, and awareness are also identified as major constraints for not domestication, product and enterprise development of NWFPs in the CHTs. Above all, there is no management or strategic plan for NWFP production in the region.

3.12 Recommendations

NWFPs have a large stake in the livelihoods of vulnerable hill people of CHTs but are still in a neglected state. Considering the ecological, economic, cultural and socioeconomic conditions and potentials of NWFPs, the following strategies are proposed for their development and sustainable management in CHTs:

a. Developing an institutional system that leads and coordinates among a broad range of NWFP stakeholders in CHTs.
b. Continuous qualitative and quantitative assessment and monitoring of NWFPs, their use pattern and change of use pattern for their sustainable management.
c. In situ and ex situ conservation interventions for NWFPs involving communities. Designate and manage special habitat conservation zones for threatened NWFPs, particularly along streams and mini water sheds.
d. Domestication and commercialization initiatives for market potential and product oriented crops and species involving communities.
e. Value added product development from NWFPs from the CHTs and use of a CHT logo for the products.
f. Develop a market information system (MIS) to inform all stakeholders with necessary market information and improve producers' access to market information.
g. Enhancing technical skills through facilitating trainings and establishing production cum training centers for NWFP-based product development.
h. Facilitating the establishment of producers' associations, federations, community-based enterprises and other means to empower producers and collectors and to increase income along value chains.
i. Develop a detailed NWFP management plan translating strategies into actions along with sustainable and innovative financial plans, social equity and gender empowerment in the NWFP production, consumption and dissemination process in CHTs.

3.13 Conclusion

The state of knowledge about NWFP production, harvest, commercialization and management has not kept pace with this emerging and evolving perception of their increased importance. This chapter tried to shed light on the present-day context of

present situations of NWFPs towards the sustenance and livelihood support of people from CHTs. It also took into account the prospects and potential of domestication and product and enterprise development. Institutionalization through sound strategy implementation can bring benefits.

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Chapter 4
Ethnomedicinal Knowledge of *Tangsa* Community from Patkai Hills Region of Changlang District in Arunachal Pradesh, India

Pyonim Lungphi, A. P. Das, and Victor Singh Ayam

Abstract This chapter depicts considerable information on traditional uses of medicinal plants by *Tangsa* tribe in Changlang district of Arunachal Pradesh, India. This is the first quantitative ethnobotanical study from the area. Data were collected by interviewing 64 local informants and 07 traditional health practitioners from 11 villages of Changlang district. Medicinal uses of 56 species representing 47 genera and 36 families were documented. Demography of informants; plant habit-groups, parts used, preparation and application methods and ethnomedicinal uses were documented. Collected data were analysed using quantitative tools like Fidelity Level (FL), Use Value (UV), Informant Consensus Factor (ICF) and Relative Frequency Citation (RFC). *Clerodendrum glandulosum, Curcuma longa, Mikania micrantha, Psidium guajava* and *Zingiber officinale* were recognised as most popular medicinal plants. Recorded ailments were classified into 11 disease categories based on ICF values. The study reveals the preservation of knowledge on folk medicine by *Tangsas* in their folk songs and through oral transfer to their descendants. Quantitative evaluation shows the high impact of traditional knowledge of Tangsa tribe. However, medium to low values of some of the data like FL (<50%), UV (<0.5), and RFC (<0.5) in certain species having claims of curing more than two or three diseases requires further scrutiny through phytochemical characterization before promoting their wider uses.

Keywords Quantitative ethnobotany · Traditional knowledge · Phytochemical characterization · Arunachal Pradesh

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4.1 Introduction

Tangsa (*Tangshang* in Myanmar) is a very primitive tribe, now living in a few districts in Myanmar, bordering India and in the Changlang and Tinsukia districts of Arunachal Pradesh and Assam, respectively (Barkataki-Ruscheweyh 2013, 2017). From the folklore studies it is revealed that Tangsas probably left their Mongolian (China) settlement area long back, crossed the Tanai river, settled on Patkai Hills in Myanmar and migrated to India sometime towards the beginning of thirteenth century (Simai 2008; https://www.indianetzone.com/46/tangsa_tribe.htm). In India, they are now living mostly on the western slopes of Paktkai range extensions in the Changlang district of Arunachal Pradesh. Few of them are also living in some villages of Tinsukia district of Assam, bordering Arunachal Pradesh (Barkataki-Ruscheweyh 2017; Lungphi et al. 2018, 2019). According to Wihufolklore-songs, the Tangsas are believed to have originated from a mythological place called 'Yuixkhux' wherefrom, under the leadership of Wihu, they crossed the Tanai river at '*wakrap*' (pig's way through the river; *wak* = pig; *rap* = crossing the river). Later, while crossing Patkai range they defeated *Shamsha* (Shan = Tai/Thai) people and established their first settlement in Myanmar (Morey 2011, 2017, 2020).

Tangsas has a long history of survival in nature in different phyto-geographical regions during migration from Mongolia through Yunnan (China) and Myanmar to India. So, it is expected that they should have an extremely rich heritage, rich in useful traditional knowledge as described in the Wihufolklore-songs. However, probably due to difficulty in accessibility, very little work has been done so far on this aspect of Tangsa tribe (Barkataki-Ruscheweyu 2017). Recently, Jugli et al. (2019) recorded their zoo-therapeutic knowledge. Lungphi et al. (2018, 2019) worked on the wild edible plants and on *Phalap*, a special traditional tea of Tangsa people. Sen et al. (2019) while recording some medicinal plants used by different tribes in North-east India, also recorded 27 species of plants used by the Tangsa tribe. Sarmah and Arunachalam (2011) tried to assess the NTFP potential of Changlang district as a whole.

Ethnobotany is one important branch of botany that deals basically the traditional knowledge base of the indigenous people and is now studied almost in all areas where there are people with traditional life-style. The subject is receiving increasing attention even in European countries like UK, France, Denmark, Portugal and others (Pal 2000).

Kirtikar and Basu (1935) stated, "*Ethnobotany is virtually a new field of research in India*" though Indian ancient literature, including Vedas recorded enormous traditional knowledge on the uses of plants and that is over 5000 years old.

The communities of autochthonous people, popularly known as the Tribals are particularly numerous in different states of India. They are officially recognized by the Government of Indian as 'Scheduled Tribes' in the Fifth Schedule of the country's Constitution, and often been categorized as being indigenous (United Nations 2004; World Bank 2005). The Indian Government recognised different communities as scheduled tribes on the basis of a community's 'primitive traits, distinctive culture,

shyness with the public at large, geographical isolation and social and economic backwardness' (Anonymous 2004), with substantial variations in each of these dimensions among such different scheduled tribal communities (Basu 2000). The Indian subcontinent is inhabited by over 84 million people belonging to 698 communities are identified as scheduled tribes (Anonymous 2004), constituting 8.2% of the total Indian population (Anonymous 2001).

India with its diverse flora coupled with large number of aboriginal tribes, inhabiting different pockets in the country, offer immense scope of studies to the Ethnobotanists. This wealthy inheritance of knowledge and age-old wisdom of India might well be among the earliest in the world. From the period of '*Vedas'*, *Rigveda* (2500 B.C.–1600 B.C.), *Atharva veda* (1500 B.C.–500 B.C.), Kautilya's *Arthashastra* (321 B.C.–186 B.C.), *Vishnu Puran* (500 A.D.), *Agni Puran* (500 A.D.–700 A.D.), *Vishnudharmottara Mahapuran* (500 A.D.–700 A.D.), *Apstanga Smriti* (200 B.C.–200 A.D.), *Brihat Samhita* (500 A.D.), *Upavananavinoda* (1120 A.D.–1330 A.D.), etc., and with medieval literature in Sanskrit, Pali, Tamil, Persian and other regional languages, possess huge wealth of ethnobotanical information. Ascertaining of the scientific identity of large number of plants in ancient literature is one of the difficult branches of investigation in ethnobotany. Starting from "*Vishalyakarani*" in the epic Ramayana and "*Soma*" in Vedas, more than one and a half dozen of plants have been attributed with important medicinal properties (Pal 2000). Bodding (1925–1940) perhaps sowed the seed of field investigation in ethnobotany through his pioneering contribution on '*Studies in Santal Medicine and Folklore*'. This was followed by an equally important contribution by late Prof. G. P. Majumdar (1938) through his '*Some Aspects of Indian culture (in plant perspective)*'. Kirtikar and Basu (1935) and De (1968) considered that ethnobotany is a new field of scientific studies in India and has almost unlimited scope of studies. Dr. E. K. Janaki Ammal initiated researches on ethnobotany in Botanical Survey of India and studied food plants of some south Indian tribes. Since 1963, Botanical Survey of India started intensive field study in Central India,—one region rich with tribal communities (Jain 1963). Later years, he instituted (i) one 'Ethnobotanical Institute', (ii) one 'Society of Ethnobotanists' and (iii) one *Ethnobotany* journal, and these have, certainly, promoted the subject at least in this sub-continent (Pal 2002, 2007). Different institutes in India including National Botanical Research Institute (NBRI), National Bureau of Plant Genetic Resources (NBPGR), Central Council for Research in Ayurveda and Siddha (CCRAS); Central Council for Research in Unani Medicine, (CCRUM); Central Council for Research in Homeopathy (CCRH) and Tropical Botanic Garden and Research Institute (TBGRI), apart from numerous Universities are now actively pursuing ethnobotanical researches (Das et al. 2007; Mao et al. 2009; Mao 2013; Mao and Roy 2016).

In North-eastern states of India (Sikkim, Assam, Meghalaya, Arunachal Pradesh, Nagaland, Mizoram, Manipur and Tripura), tribals constitute 65% or more of the total population. In majority of the areas they still pursue their traditional knowledge in their every-day life. Even to get rid of their sickness they mostly depend on local wild plants (Kala 2005). Mao and Roy (2016) tried to compile ethnobotanical works

done in North-east India, which is regarded as the store-house of Traditional knowledge and also as ethnobotanical capital of the world. Apart from Assam, sufficient ethnobotanical studies are yet to be done in other states of this region mainly due to the lack of trained local man-power, fund and inaccessibility. In Arunachal Pradesh, with 100% ST population, studies on tribal communities started very recently. Most of the 26 recognised tribes are yet to be studied. Few tribes living in comparatively accessible areas like Nyishi, Apatani, Adi, Tagin and Galo studies have been initiated by some workers including (Gangwar and Ramakrishnan 1990; Bora 2001; Tag and Das 2004; Tag et al. 2005; Goswami et al. 2009; Murtem and Chaudhry 2016; Rinyo et al. 2018; Srivastava and Nyishi tribe 2010). Though, all these works are considered as preliminary and more intrinsic surveys are required. The same is true for the Tangsa tribe living in the Changlang district along the Myanmar border.

The present survey on the medicinal plants has been conducted among the Tangsa people in eleven villages of the Changlang district of Arunachal Pradesh as a part of developing a database on Tangsa Heritage.

4.2 Materials and Methods

4.2.1 Study Area

In India, people of Tangsa tribe live mainly in the Changlang district [26° 40′ N–27° 40′ N Latitude and 95° 11′ E–97° 11′ E Longitudes; altitude 200–4571 m AMSL] of Arunachal Pradesh (Fig. 4.1). Administratively the district has been divided into 04 sub-Divisions and 17 circles (Anonymous 2014a, b; https://changlang.nic.in/about-district/circle/#). The area receives an annual rainfall of 3800–4866 mm of which nearly 85% is received during monsoon (FSI 2011). At Miao, 1757–3970 mm/per annum rainfall has been recorded during different years and up to 9 rainy months per year. Due to extreme altitudinal variations, the overall climate varies from tropical to sub-alpine at its different locations. The maximum and minimum temperature varies between 32 and 38 °C in May and 10–15 °C in January (Chauhan et al. 1996) at Miao. The area falls under the Eastern Himalaya (2D) biogeographic province of Indian biogeographic region that covers the Paleartic and the Indo-Malayan (Oriental) realms (Rodgers and Panwar 1988). As much as 90.97% ground-area of the district is forest-covered (FSI 2011).

Apart from the Chakmas and Nepalese, among the tribes, Tangsa population (10,074 persons) is highest in the district. A good number of people from other tribes are also living in the region, of them the population of Nocte is quite high (1364 persons) (Anonymous 2014a, b).

Fig. 4.1 Location map for the study area—Changlang district of Arunachal Pradesh

4.2.2 Present Work

The present survey for the uses of medicinal plants by the people of Tangsa community has been conducted in eleven villages [*Injan, Longtom- I. Longtom-II, Jorong, Kharsang bazaar, Kuttom, Namphai–I, Neirong, Namgoi, Namphuknala, Samkhidong,* and *Tengmo*] from four Circles [*Jairampur, Kharsang, Nampong,* and *Namphai*-1] of Changlang district during July 2018–July 2020. The first author herself being a Tangsa, it was easier to reach the knowledgeable people in different villages and to develop a workable ambience.

4.2.3 Respondents

Apart from the seven traditional medicine practitioners, 64 more elderly-people, both men and women, aged between 47 and 70 years were interviewed using a pre-structured questionnaire explaining the objectives of our scientific exploration in their local dialect (Tangsa language) and after taking their consent by signing the PIC (personal information consent). The respondents from Tangsa tribe were covering a number of subtribes like *Lungphi, Hacheng, Tikhak, Mungrey, Tonglim, Sangwal, Ngaimong, Jugli, Longri, Rera (Ronrang), Mosang* and *Langching*.

4.2.4 Field Records

The knowledge shared by the respondents has been recorded in the Field Note Book (FNB) and sometimes, in addition, by videography. Plants were recorded with their Tangsa name and spotted in the field by the respondents themselves. While recorded in FNB, along with the Tangsa-name of plants and field-characters, useful plant-parts, method of preparation and administration were also included. Collected specimens were tagged with the *Field-numbers*.

4.2.5 Botanical Documentation

Voucher specimens were collected, as recognized by the respondents, recorded in the FNB and processed into mounted herbarium-sheets following Bridson and Forman (1998), and will be deposited to the AUH (Herbarium of the Department of Botany, Rajiv Gandhi University) after the present project is over. Plants were identified using available floras including Hooker (1872–1897), Grierson and Long (1983, 1984, 1987, 1991, 1999, 2001), Noltie (1994, 2000), Hajra et al. (1996), Giri et al. (2008), and Chowdhery et al. (2009).

Identification of some of the doubtful specimen were done through consulting experts of the plant groups. All plant names along with author-citations and family delimitation were updated mainly from www.plantsoftheworldonline.org and www.theplantlist.org (during August 2020) and presented here alphabetically in Table 4.1.

4.2.6 Quantitative Evaluation

For better understanding of the collected information, (i) Informants' Consensus Factor (ICF), (ii) Use Value (UV), (iii) Relative Frequency of Citations (RFC),

and (iv) Fidelity Level (FL) were calculated following Umair et al. (2017, 2019). Formulations used are given below:

- *Fidelity Level* (FL): The FL is calculated using the equation:

  $\text{FL} = \frac{SF}{TF} \times 100$

  Where, SF = Single frequency of citation of a species over a single disease.

  TF = Total frequency of citation of a species over a number of diseases.

- *Use Value* (UV): The (UV) is calculated using the equation:
  $\text{UV} = \frac{\sum Ui}{N}$

Where, U = The number of uses recorded for the species.
N = Number of informants who reported the species

- *Informants' Consensus Factor* (ICF) is calculated by the formula:
  $ICF = \frac{nur - nt}{nur - 1}$

Where, *nur* = total number of use reports for each disease cluster
nt = total number of species used for that cluster

- *Relative Frequency of Citations* (RFC): *RFC* is calculated by the formula,

  $RFC = \frac{FC}{N}\ (0.0 < RFC < 1)$

where, *FC* = Number of informants who mention the species
N = Total number of informants.

4.3 Results and Discussion

Present survey of ethnomedicinal plants was conducted among the people of *Tangsa* community in the Changlang district of Arunachal Pradesh, India. In this article only the single-plant medicines has been presented. For the preparation of medicines only four additives has been recorded, water, salt ($NaCl_2$), honey and mustard-oil. Entire collected traditional knowledge, including quantitatively generated data has been presented in Table 4.1.

Table 4.1 Plants and their uses collected during the ethnomedicinal studies on Tangsa community in the Changlang district of Arunachal Pradesh

Sl. No	Plants [Family]; Tangsa name; Voucher no	Habit	Parts used	Disease	Preparation	Administration	Perfor-mance	No. of informants responded on the species	No. of Citation for a diseases	FL (%)	UV	RFC
1	***Acmella paniculata*** (Wall. ex DC.) R. K. Jansen [Asteraceae]; *Pajong-naam; PLAPDAVS-011*	HP	Inf, Ls, Lf	Toothache	Crush 3–4 inflorescence	Stuffing on the affected tooth 3–4 times daily, till cure	Sf	71	71	53.38	0.04	1
				Cleanse stomach	Boil shoots and leaves in water with little amount of salt	Eating boiled shoots and leaves regularly till complete relief	P		23	17.29		
				Gastric	Boil the twigs and leaves in water with little amount of salt	Eat the boiled shoots and leaves regularly till complete relief	Sf		39	29.32		
2	***Ageratum conyzoides*** L. [Asteraceae];*Thiingriing; PLAPDAVS-085*	HA	Lf	Cuts& bruises	Crush leaves to get an extract	Apply extract on the injury till cure	Sf	32	32	100.00	0.03	0.45
3	***Alstonia scholaris*** (L.) R. Br [Apocynaceae]; *Waknok pungtai; PLAPDAVS-101*	T	Bk	Loss of appetite in pigs	Chopped the bark into small pieces and cooked with the feeds	Feed them morning & evening till improvement	Ex	28	25	51.02	0.07	0.39
				Pneumonia	Chopped bark into small pieces and boil	One cup of decoction is taken orally twice daily till cure	Sf		24	48.99		

(continued)

Table 4.1 (continued)

Sl. No	Plants [Family]; Tangsa name; Voucher no	Habit	Parts used	Disease	Preparation	Administration	Perfor-mance	No. of informants responded on the species	No. of Citation for a diseases	FL (%)	UV	RFC
4	***Angiopteris evecta*** (G. Forst.) Hoffm. [Marattiaceae]; *Chahmah; PLAPDAVS-044*	HP	Rz	Stings of spider or snake bites	Chop and grind the rhizome	Apply directly on the affected area as soon as possible; continue till cure	VG	19	19	100.00	0.05	0.27
5	***Baccaurea ramiflora*** Lour. [Phyllanthaceae]; *Haichao; PLAPDAVS-017*	T	Fr	Dysentery	Ripe whole fruits	Eat fruits in good amount including seed cover; taking 4–5 may be enough	Sf	63	63	100.00	0.02	0.89
6	***Begonia aborensis*** Dunn [Begoniaceae]; *Choilan; PLAPDAVS -025*	HP	Ls	Rashes	Crush two leafy twigs and get the extract	Apply the extract on the rashes	Sf	63	55	41.35	0.05	0.89
				Stings of bees and spiders	Crush the leafy twigs and make a paste	Apply the pastes on the stings, bandage the area, till cures	VG		49	36.84		
				Asthma	Cook leafy shoots, also prepare as salad	Consume salad and/or cooked shoot regularly	Sf		29	21.80		
7	***Begonia roxburghii*** (Miq.) A. DC. [Begoniaceae]; Choiwang; *PLAPDAVS*-020	HP	Ls	Rashes	Crush the leafy shoots	Apply on the infected part once or many times till cures	VG	40	34	60.71	0.05	0.56
				Stings of spider			Sf		22	39.29		

(continued)

Table 4.1 (continued)

Sl. No	Plants [Family]; Tangsa name; Voucher no	Habit	Parts used	Disease	Preparation	Administration	Perfor-mance	No. of informants responded on the species	No. of Citation for a diseases	FL (%)	UV	RFC
8	***Begonia silletensis*** (A. DC.) C. B. Clarke [Begoniaceae]; Choilung; *PLAPDAVS*-037	HP	Ls	Vomiting	Clean and washed leafy-shoots	i. Eat about 1–2 fleshy petiole it will stop vomiting	Sf	45	31	62.00	0.04	0.63
				Worms in the intestine		ii. Eat it raw, regularly till the removal of worms	VG		19	38.00		
9	***Begonia sikkimensis*** A. DC. Begoniaceae]; Choiphak; *PLAPDAVS*-048	HP	Ls	Leech attack	Make a paste of leafy shoots	Smear the paste on the legs and hands when in jungle	VG	33	33	100.00	0.03	0.46
10	***Canarium strictum*** Roxb. [Burseraceae]; *Saan-ri; PLAPDAVS-095*	T	Bk, Rs	Eczema in pigs	Chop bark into small pieces;	Chopped barks mixed with food, 2–3 times	Ex	59	52	47.70	0.03	0.83
				Cough and cold	Put dry resins on flameless fire to emit smoke	Smoke is inhaled for some time	VG		57	52.29		
11	***Centella asiatica*** (L.) Urb. [Apiaceae]; *Ningkhoi; PLAPDAVS-062*	HP	Lf	Gastric ulcer	Grind leaves and collect the extract, mix with one spoonful of gooseberry juice	i. Taken in empty stomach in the morning	Sf	65	43	27.56	0.06	0.91

(continued)

Table 4.1 (continued)

Sl. No	Plants [Family]; Tangsa name; Voucher no	Habit	Parts used	Disease	Preparation	Administration	Perfor-mance	No. of informants responded on the species	No. of Citation for a diseases	FL (%)	UV	RFC
				Weak eyesight	Collect and wash the whole plant	Taken raw as salad, regularly	VG		36	35.90		
				Liver problems	Collect and wash the whole plant	Taken raw as salad, regularly	VG		24	15.38		
				Purification of blood	Collect about 8–9 leaves and washed it	Eat the leaves and drink a glass of water in the early morning everyday	VG		53	33.97		
12	***Chromolaena odorata*** (L.) R. M. King & H. Rob. [Asteraceae]; Thangba; *PLAPDAVS*-055	S	Lf	Cuts	Crush the leaves	Apply it on the cuts	Sf	48	48	100.00	0.02	0.68
13	***Clerodendrum glandulosum Lindl.*** [Lamiaceae]; Khahmao; *PLAPDAVS*- 007	S	Ts, Lf	High blood pressure	Boil twigs and leaves in water	Consume as cooked vegetableregularlywith meals	Sf	71	71	100.00	0.01	1
14	***Clerodendrum infortunatum*** L. [Lamiaceae]; Rang khahmao; *PLAPDAVS*-088	S	Ts, Lf	i. Ringworm	Leafy twigs and leaves are slightly roasted in fire	Roasted twigs and leaves are tapped or brushed on the affected areas at night before sleep	Ex	61	58	51.33	0.03	0.86

(continued)

Table 4.1 (continued)

Sl. No	Plants [Family]; Tangsa name; Voucher no	Habit	Parts used	Disease	Preparation	Administration	Perfor-mance	No. of informants responded on the species	No. of Citation for a diseases	FL (%)	UV	RFC
				ii. rashes	Boiled with water and get the decoction	Decoction is applied on the affected areas or infected person can take bath in it	Ex		55	48.67		
15	***Chloranthus elatior*** Link [Chloranthaceae]; Soksai; *PLAPDAVS*-074	S	Ts, Lf, Rt	Tuberculosis	Chop a few twigs, leaves and roots together, boil them in about 500 ml of water for 30 min and get the decoction	Decoction is taken orally in morning and evening after meals, till cures	Ex	45	33	38.37	0.07	0.63
				Gastric			Sf		42	48.84		
				Snake bite			Sf		11	12.79		
16	***Citrus limon*** (L.) Osbeck [Rutaceae]; Chengi-hai; *PLAPDAVS*-092	S	Fr	Dysentery	Fruits kept in air-tight container for some days; take out when required and extract the juice	Juice is taken in empty stomach in the morning for 5 days	Ex	37	37	100.00	0.03	0.52
17	***Cocculus laurifolius*** DC [Menispermaceae]; Rulang; *PLAPDAVS*-099	C	Lf	Cuts	Crush the leaves	Crushed leaves are applied on the cuts till cure	Ex	26	26	100.00	0.04	0.37
18	***Curculigo capitulata*** (Lour.) Kuntze [Hypoxidaceae]; Hokpa-jaak; *PLAPDAVS*-102	HP	Rz	Cuts	Soft apical part of rhizome is crushed	Apply on the cuts till cure	Ex	53	53	100.00	0.02	0.75

(continued)

Table 4.1 (continued)

Sl. No	Plants [Family]; Tangsa name; Voucher no	Habit	Parts used	Disease	Preparation	Administration	Perfor-mance	No. of informants responded on the species	No. of Citation for a diseases	FL (%)	UV	RFC
19	***Curcuma caesia*** Roxb. [Zingiberaceae]; *Khohnyak; PLAPDAVS-018*	HP	Rz	Stomach-ache	Pieces of rhizomes are boiled in water and get the decoction	Decoction is taken orally on SOS	Ex	48	48	100.00	0.02	0.68
20	***Curcuma longa*** L. [Zingiberaceae]; *Khohmin; PLAPDAVS-029*	HP	Rz	Cuts and wounds	Rhizomes are crush into a paste	Apply paste on cuts and wounds regularly till cures	Ex	71	71	100.00	0.01	1
21	***Cynodon dactylon*** (L.) Pers. [Poaceae]; *Thiingphang; PLAPDAVS-089*	HP	WP	Jaundice	Leafy twigs taken in small bundles and little mustard oil with little water in a bowl	The bowl is kept on the head of the patient; stir the oil–water mixture with a bundle of grass twigs till the mixture transform to a sticky jelly like substance; continue for 4–5 days	VG	33	33	100.00	0.03	0.46
22	***Dillenia indica*** L. [Dilleniaceae]; *Masangsi; PLAPDAVS-056*	T	Fr	Diabetes	Accrescent sepals, green or ripe, cut into small pieces	Eaten as salad/ chutneywith major meals regularly	Sf	27	27	100.00	0.04	0.38
23	***Drymaria cordata*** (L.) Willd. ex Schult. [Caryophyllaceae]; *Pipep-jaak; PLAPDAVS-072*	HA	Lf	Abscess	leaves are crushed to make a paste	Apply the paste on abscess, 1–2times a day till cures	VG	40	40	100.00	0.03	0.56

(continued)

Table 4.1 (continued)

Sl. No	Plants [Family]; Tangsa name; Voucher no	Habit	Parts used	Disease	Preparation	Administration	Perfor-mance	No. of informants responded on the species	No. of Citation for a diseases	FL (%)	UV	RFC
24	***Entada rheedei*** Spreng. [Fabaceae]; *Wijang; PLAPDAVS-078*	L	Sd	Gastric	Seed-coat removed; cotyledons sliced to small pieces, boiled in water and get the decoction	50 ml of decoction is taken orally, in morning and evening before food till cures	Ex	57	38	18.90	0.09	0.8
				Cough			VG		53	26.37		
				Tuberculosis			VG		53	26.37		
				Fever	Cotyledons are ground and soaked in water	A table spoon of extract is mixed in half glass water and is drink	Sf		36	17.91		
				Body-ache			Ex		21	10.45		
25	***Garcinia pedunculata*** Roxb. ex Buch.-Ham. [Clusiaceae]; *Haipum;PLAPDAVS-110*	T	Fr	Dysentery	Fruits are cut into small pieces; eaten raw or boiled with little salt in water to get the decoction or stores sun-dried	Fruit slices eaten raw or the decoction consumed in empty stomach, 2–3 times a day till cure	Ex	68	66	53.66	0.03	0.96
				Stomach-ache		Dried fruit-slices are eaten in stomach ache on SOS	VG		57	46.34		
26	***Garcinia xanthochymus*** Hook. f. ex T. Anderson [Clusiaceae]; *Sophong; PLAPDAVS-106*	T	Fr	Dysentery	Fruits are sliced and kept above the fireplace where it will dried and store it	The dried fruits are boiled in water for about 10 min and the decoction is drink	Ex	54	54	100.00	0.02	0.76
27	***Hellenia speciosa*** (J. Koenig) S. R. Dutta [Costaceae]; *Khohrim; PLAPDAVS-096*	HP	Rz, St	Urinary problems;	Boil the rhizome, get the decoction	i. Drink decoctionin morning and evening till cure	Ex	70	69	50.00	0.03	0.99

(continued)

Table 4.1 (continued)

Sl. No	Plants [Family]; Tangsa name; Voucher no	Habit	Parts used	Disease	Preparation	Administration	Perfor-mance	No. of informants responded on the species	No. of Citation for a diseases	FL (%)	UV	RFC
				Oral ulcer	Crush the stem and extract juice	ii. Eat stem raw; for babies put few drops of juice on tongue	Ex		69	50.00		
28	***Hodgsonia macrocarpa*** (Blume) Cogn. [Cucurbitaceae]; *Pie; PLAPDAVS-009, 064*	L	Fr	Rashes	Soft mesocarp is taken after removal of outer hard cover	Mesocarp is rubbed on the rashes till cure	Sf	7	7	100.00	0.14	0.1
29	***Houttuynia cordata*** Thunb. [Saururaceae]; Thalai-naam; *PLAPDAVS*-040	HP	Lf	Blood impurity	Leaves are cooked or processed as salad	Eaten cooked or as salad regularly with meals	VG	45	35	60.34	0.02	0.63
				High blood pressure			Sf		23	39.65		
30	***Hydrocotyle sibthorpioides*** Lam. [Araliaceae]; Hah-naam; *PLAPDAVS*-103	HA	Lf	Rashes due to caterpillar sting	Leaves crushed to make apaste	Apply paste on infected part, 2–4 times till cure	Ex	42	42	100.00	0.02	0.59
31	***Kalanchoe pinnata*** (Lam.) Pers. [Crassulaceae]; *Wiima kham-jaak; PLAPDAVS-077*	HP	Lf	Burns (fire/hot water)	Grind 2–3 leaves into a paste	Apply paste on the burns, 2–3 times a day, till cures	Ex	71	71	41.28	0.06	1
				Stomach inflammation	Take 2–4 leaves and make cold water extract	About 200 ml of extract is taken on SOS or till cure	Ex		21	12.21		

(continued)

Table 4.1 (continued)

Sl. No	Plants [Family]; Tangsa name; Voucher no	Habit	Parts used	Disease	Preparation	Administration	Perfor-mance	No. of informants responded on the species	No. of Citation for a diseases	FL (%)	UV	RFC
				Dysentery	2–3 leaves are grind and add about 150 ml of water	About 100 ml of extract is taken till cure	VG		42	24.42		
				Urinary problems	Make cold-water extract of 2–3 leaves, add a pinch of salt	About 100 ml is taken on SOS or till cure	VG		38	22.09		
32	***Lasia spinosa*** (L.) Thwaites [Araceae]; *Hamwey; PLAPDAVS-058*	HP	St	Jaundice	Garland is made with stem pieces	Garland is wearing at the neck and keep it till cure	Ex	56	54	50.00	0.04	0.79
				Intestinal worms in pigs	Leaves and stem chopped into a rough paste	Added to pig feeds regularly	Sf		54	50.00		
33	***Lophatherum gracile*** Brongn. [Poaceae]; Thiingphangchu; *PLAPDAVS*-100	HP	Rt-Tb	Spider sting	Tubers are made to a paste	Apply paste on infected part and wrap it Keeps it till cure	VG	6	6	100.00	0.17	0.08
34	***Mallotus tetracoccus*** (Roxb.) Kurz [Euphorbiaceae]; Nyaplung; *PLAPDAVS*-055	T	Ls	Cuts and wound	Chop leafy twigs into a paste	Apply the paste on the injured area 2–3 times a day, till cure	Ex	34	34	100.00	0.03	0.48

(continued)

Table 4.1 (continued)

Sl. No	Plants [Family]; Tangsa name; Voucher no	Habit	Parts used	Disease	Preparation	Administration	Perfor-mance	No. of informants responded on the species	No. of Citation for a diseases	FL (%)	UV	RFC
35	***Mangifera sylvatica*** Roxb. [Anacardiaceae]; Haisotri; *PLAPDAVS*-065	T	Bk	Nail infection	Bark is grind to make a paste	Paste is applied on nailsat night regularly till cure	Sf	67	65	50.00	0.02	0.94
				Diseases of pigs	Crush it to a semi-paste	Pigs: feed the chopped bark till cure	Sf		65	50.00		
36	***Mikania micrantha*** Kunth [Asteraceae]; Chaahpan-jaak; *PLAPDAVS*-004	C	Lf	Burns	Leaves grind into a paste, heated slightly on fire	Warm paste applied to burnt area 2–3 times a day, till cure	Ex	71	34	32.38	0.01	1
				Cuts	Fresh leaves crushed	Crushed leaves applied on cuts	Ex		71	67.62		
37	***Mimosa pudica*** L. [Fabaceae]; *Junithiing; PLAPDAVS-086*	HP	Rt, Lf	Kidney problem	Roots grind to a paste	Root-paste with little water is consumed at night, till cure	Ex	37	33	50.00	0.05	0.52
				Vaginal white discharge and bleeding	Leaves boiled in water for about 30 min to get the decoction	Leaf decoction is consumed, twice a day, till cures	Sf		33	50.00		
38	***Paederia foetida*** L. [Rubiaceae]; *Raunam; PLAPDAVS-012*	C	Ls	.Joint pains	Leafy shoots are boil in water, strained to get the decoction	Drink the decoction, 2–3 times a day till cure	Sf	26	8	16.00	0.15	0.37
				Dysentery			VG		22	44.00		
				Gastric			P		14	28.00		

(continued)

Table 4.1 (continued)

Sl. No	Plants [Family]; Tangsa name; Voucher no	Habit	Parts used	Disease	Preparation	Administration	Perfor-mance	No. of informants responded on the species	No. of Citation for a diseases	FL (%)	UV	RFC
				Pneumonia			Sf		6	12.00		
39	***Persicaria chinensis*** (L.) H. Gross [Polygonaceae]; Choihai-jaak; *PLAPDAVS*-014	HP	Ls	Weakness	Leafy shoots boiled with a pinch of salt	Eaten regularly with meals	Sf	45	45	100.00	0.02	0.63
40	***Phlogacanthus thyrsiformis*** (Roxb. ex Hardw.) Mabb. [Acanthaceae]; *Phikhip; PLAPDAVS-067*	S	Lf, Ts	Malaria	Decoction of leafy twigs is prepared after boiling in water	i. Drink the decoction in morning and evening after food, till cure	Ex	67	66	40.49	0.04	0.94
				Dysentery	Leafy twigs are boiled with a pinch of salt	ii. About 250 ml of the decoction is drink till relief	VG		43	26.38		
				Rashes	Leaves heated slightly on fire	iii. apply on the rashes	Ex		54	33.13		
41	***Physalis angulata*** L. [Solanaceae]; *Khangtok–ri; PLAPDAVS-036*	HA	Lf	Headache;	i. Fresh leaves crushed into fine paste	i. Gently apply on forehead and keep it till cure	VG	17	15	38.46	0.18	0.24
				Pneumonia	ii & iii. Leaves are boiled with a pinch of salt	Decoction is consumed 2–4 times a day, till cure	Sf		12	30.77		
				Typhoid			P		12	30.77		
42	***Portulaca oleracea*** L. [Portulacaceae]; Ahaijaak; *PLAPDAVS*-082	HA	Lf	Abscess	Leaves crushed into a paste	Apply the paste on abscess many times till cure	VG	21	21	100.00	0.05	0.3

(continued)

Table 4.1 (continued)

Sl. No	Plants [Family]; Tangsa name; Voucher no	Habit	Parts used	Disease	Preparation	Administration	Perfor-mance	No. of informants responded on the species	No. of Citation for a diseases	FL (%)	UV	RFC
43	***Pothos scandens*** L. [Araceae]; *Wiise-pyari; PLAPDAVS-105*	C	Lf	Joint & waist pain	Leaves are chopped and boiled to get the decoction	Decoction is consumed in empty stomach regularly till cure	Ex	58	58	100.00	0.02	0.82
44	***Psidium guajava*** L. [Myrtaceae]*; Mantaka; PLAPDAVS-049*	T	Lf	Stomach-ache with loose motion	Handful of tender leaves crushed to extract juice, diluted with 100 ml of water	Mixture is consumed 2–4 times, till cure	Ex	71	71	100.00	0.01	1
45	***Pseuderanthemum latifolium*** (Vahl) B. Hansen [Acanthaceae]; Meyrap-jaak; *PLAPDAVS*-019	HP	Lf	Cuts	Crush the leaves	Apply on the cuts, repeat it regularly till cure	Ex	34	34	100.00	0.03	0.48
46	***Rhus chinensis*** Mill. [Anacardiaceae]; *Basang; PLAPDAVS-068*	T	Fr	High Blood Pressure	About 500 gm of fruits is soaked in water for few hours and strained	About 50–100 ml is taken orally in the morning or on SOS	Sf	55	53	50.00	0.05	0.77
				Dysentery			Sf		37	34.91		
				Indigestion			VG		16	15.09		
47	***Ricinus communis*** L. [Euphorbiaceae]; Wuma-phum; *PLAPDAVS*-015	S	Lf	Chickens' diseases	Leaves are crushed to get an extract	Few drops of extract is fed to each chicken till cure	Sf	31	31	100.00	0.03	0.44

(continued)

Table 4.1 (continued)

Sl. No	Plants [Family]; Tangsa name; Voucher no	Habit	Parts used	Disease	Preparation	Administration	Perfor-mance	No. of informants responded on the species	No. of Citation for a diseases	FL (%)	UV	RFC
48	***Scoparia dulcis*** L. [Plantaginaceae]; Kungwoi-naam; *PLAPDAVS*-091	HP	Ts, Lf, Rt	Skin lesions;	Leafy-twigs crushed to a paste	Applied topically on the lesions till cure	Ex	12	11	57.89	0.17	0.17
49				Pneumonia	Crushed roots boiled in water for about 10 min and get the decoction	Drinkdecoction2–4 times a day till cures	Ex		8	42.10		
50	***Stemona tuberosa*** Lour. [Stemonaceae]; *Waakkao-thah; PLAPDAVS-072*	C	Rt-Tb	i. Appendix;	i. tubers boiled in water to get a decoction	i. Decoction is taken orally till cure	Ex	60	59	50.00	0.03	0.84
				ii. cuts & wounds	ii. tubers grind to make a paste	ii. apply the paste on cuts/wounds many times till cure	Sf		59	50.00		
51	***Solanum spirale*** Roxb. [Solanaceae]; *Kaithuh; PLAPDAVS-081*	S	Lf	High blood pressure	Young leafy shoots cooked with salt	Consume after the meals regularly	Sf	52	47	54.65	0.06	0.73
				Gastric					28	32.55		
				Diabetes					11	12.79		
52	***Solanum torvum*** Sw. [Solanaceae]; Sukkang; *PLAPDAVS*-033	S	Fr	High blood pressure	Green fruits cooked with a pinch of salt	Cooked fruits are eaten with meals regularly	Sf	44	44	100.00	0.02	0.62

(continued)

Table 4.1 (continued)

Sl. No	Plants [Family]; Tangsa name; Voucher no	Habit	Parts used	Disease	Preparation	Administration	Perfor-mance	No. of informants responded on the species	No. of Citation for a diseases	FL (%)	UV	RFC
53	***Tabernaemontana divaricata*** (L.) R Br. ex Roem. & Schult. [Apocynaceae]; *Phanpung-nati; PLAPDAVS-106*	S	Rt	Toothache	Roots are crushed	Crushed roots are stuffed on affected teeth	VG	19	19	100.00	0.05	0.27
54	***Terminalia chebula*** Retz. [Combretaceae]; Laakchaa-ri; *PLAPDAVS*-024	T	Fr	Gastric	Matured fruits are boiled with salt and dried under the sun	Eat fruits in empty stomach every day till cure	Ex	71	65	35.71	0.04	1
				Cough		ii. Eat about 2–3 fruits when cough	VG		71	39.01		
				Indigestion		iii. Eat fruit and drink water if indigestion	Ex		46	25.27		
55	***Zingiber siangensis*** Tatum & A. K. Das [Zingiberaceae]; *Chhiiinchha; PLAPDAVS-112*	HP	Rz	Cough and cold;	Rhizome is grind to make a paste and mix with one teaspoonful of honey	Consume the mixture 2–4 times a day till cure	Ex	71	71	55.90	0.03	1
				Itching from caterpillar hair-stings		Apply paste (without honey) on the infected area	Sf		56	44.09		

(continued)

Table 4.1 (continued)

Sl. No	Plants [Family]; Tangsa name; Voucher no	Habit	Parts used	Disease	Preparation	Administration	Perfor-mance	No. of informants responded on the species	No. of Citation for a diseases	FL (%)	UV	RFC
56	***Zingiber officinale*** Roscoe [Zingiberaceae]; *Chiingsa, Chhiing, Sinka; PLAPDAVS-076*	HP	Rz	Cough and cold	Juice extracted by crushing the rhizome; one spoon-full honey added to it	Taken orally, 2–4 times a daytill cure	Ex	71	71	100.00	0.01	1

Abbreviations: **Habit groups**: C = Climber; HA = Annual Herb; HP = Perennial Herb; L = Liana; S = Shrub; T = Tree. **Plant parts**: Bk = Bark; Fr = Fruit; Inf = Inflorescence; Lf = Leaf; Ls = Leafy shoot; Lx = Latex; Rt = Root; Rz = Rhizome; Sd = Seed; St = Stem; Tb = Tuber; WP = Whole Plant. **Performance (recovery status)**: P = Poor (0–50%); Sf = Satisfactory (50–70%); VG = Very Good (70–90%); Ex = Excellent (90–100%)

4.3.1 Taxonomy

Botanically, the reported plants represent 56 species from 47 genera of 36 families. Considering the major plant groups, only Marattiaceae (1 sp.) is from Pteridophyta. Dicotyledonous angiosperms are represented by 29 families (44 spp.) and Monocotyledons by 06 families (11 spp.). No gymnosperm has been recorded during this survey. Out of the dicotyledonous families Asteraceae, Bignoniaceae, Solanaceae and monocotyledonous Zingiberaceae are the best contributors with 4 spp. each. However, the remaining families are represented by 1 or 2 species only.

4.3.2 Habit Groups

Out of the four major habit-groups (herbs, shrubs, climbers and trees), recorded plants are dominated by 28 species (50%) herbs of which 22 species are perennials. Shrubs are represented by 10 species (17.86%), 07 species (12.5%) of climbers (including 2 liana) and trees are represented by 11 species (19.64%). So, the medicinal plants used by Tangsas' are mostly dominated by herbs.

4.3.3 Plant Parts in Use

Based on efficacy, use only one organ of some plants in the preparation of a medicine while two or more parts are used in the preparation of other medicines. Out of the total collections, leaves are used for 23 species (35%), leafy-shoots 13 spp. (20%), fruits 10 spp. (15%), rhizome 7 spp. (11%), roots 4 spp. (6%), bark 3 spp. (5%), stem and tuber 2 spp. (3%) each and other plant parts like inflorescence, latex, resin, seed and whole plant 1 sp. (2%) (Fig. 4.2). This shows the dominance of leaves and leafy-shoots used for the preparation of Tangsa medicines. Practically, in most cases, while collecting leaves; leafy young shoots are also collected, so those are mostly synonymous in this case. However, while collecting leaves, they prefer to collect matured leaves. Now, taking together leaves and leafy-shoots, it comes to 64.29% and that express the overall preference for the raw-drugs in Tangsa medicines. However, in majority of tribal medicines leaves are regarded as the most important plant parts (Debbarma et al. 2017).

Fruits are known to be the sources of many important phytochemicals (Patricia et al. 2013) and are also widely used as raw drugs, which is also expressed in the present survey. Medicinal qualities of rhizomes are well-known (Rakotonirina et al. 2001), especially from Zingiberaceae and its related families. In this case, rhizome of one primitive fern (*Angiopteris evecta*) is also in use. The uses of plant secondary metabolites and other plant-products like latex, oil, honey, etc. are significantly less in Tangsa medicines as it has been recorded so far.

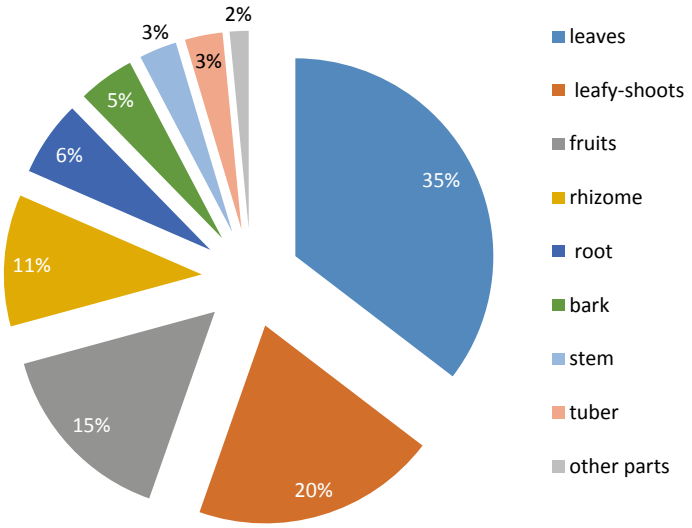

Fig. 4.2 Uses (%) of different plant parts for the collected 56 spp

4.3.4 Diseases Treated

Tangsas successfully treat a very wide range of diseases, starting from simple cuts and bruises or cough and cold to pneumonia, diabetes, asthma and other allergic diseases, tuberculosis, dysentery, jaundice, ulcers, malaria, high blood pressure, eczema, joint-pains, infection in appendix, etc. For the treatment of all these ailments they trust on their traditional medicines as modern medical treatments are still not available properly in these villages. The recorded performance of such medicines, as expressed by the informants also speaks for the high efficiency. Informants expressed their satisfaction as 'Excellent' for 44.29% of cases, 18.57% for 'Very Good', 34.29% for 'Satisfactory' and only 2.86% for 'Poor', constituting a total of 97.14% of informants' satisfactory level on the usefulness of these medicines.

Tribal people are mostly forest-dependent. They need to collect innumerable materials from the forests for their sustenance. So, while working in the forest, cuts and related wounds of different types, bites or stings of snakes and different type of insects, attack of leeches, allergy from different pollens, trichomes, insect body-fragments, etc. are the problems they face quite often. An analysis of Table 4.2 shows that at least ten species they use for the treatment of cuts, wounds and burns (ICF 0.983). Similarly, for allergy related problems (rashes, insect stings, snake bites etc.) similar number of species are generally used (ICF 0.979). Largest number of (14) plant species has been recorded for treating stomach or abdominal problems (stomach-ache, gastric, vomiting, tender appendix, etc. securing ICF value: 0.983). The incidence of cases of stomach-ache, gastritis, vomiting, and tender appendix among the Tangsas could be due to excessive consumption of smoke-dried and

fermented foods and limited availability of safe water for drinking and cooking. Infection through water is very common in rural areas of Changlang and correspondingly eight plant species were recorded for the treatment of dysentery during the study. They also recognised plants for the treatment of skin diseases, teeth-problems, typhoid, malaria, diabetes etc.

Tangsas are good agriculturists and they practice both *jhum* and fixed wet-land cultivation. Also, they rear different animals, including pigs, hens, goats, dogs and cows. So, they have selected medicines for the treatment of their domesticated animals as well.

4.3.5 Drug Preparation and Administration

Tangsas prepare medicines mostly with the freshly collected plants and follow a number of techniques which can be recognised as:

- Boiled and extracted (decoction)
- Eating raw (as salad)
- Chewing plant-part for some time
- Cooked and eaten
- External reaction [e.g. shoot of *Cynodon dactylon* + mustard oil]
- Paste for external use
- Paste and extract for oral consumption
- Soaked for long time and supernatant is used (cold maceration)
- Tablets prepared from paste
- Touch therapy
- Wrapping with heated leaves; etc.

Though touch therapy is rare among the Tangsa people but is prevalent in many other communities. Sarkar and Das (2011) discussed such treatments by the Mech healers in Dooars (or Duars) region of West Bengal in India.—Two interesting preparations need to discuss here. For the treatment of jaundice stirring mustard-oil with a bunch of leafy-shoots of *Cynodon dactylon* for long time, till it transformed into a sticky-thick gel, probably needs investigation. They keep some lemon-fruits (*Citrus limon*) in an air-tight container with little water for 1–2 months and feed the extract of one such fruit to a person suffering from dysentery and the result is 'excellent'. However, none of the respondents agreed to the use of any *mantra* (religious hymns) either during the preparation of medicine or during its administration. So, there is no influence of any super-natural power for the efficiency of Tangsa medicines.

4.3.6 Quantitative Evaluation

For better understanding of the collected ethnomedicinal information the data were assessed through some statistical parameters like Informants' Consensus Factor (ICF), Fidelity Level (FL), Use Value (UV) and Relative Frequency of Citations (RFC).

4.3.6.1 Fidelity Level (FL)

Assessment shows that the FL value of 28 species is 100%. This indicates that these plants are well-known to the people of Tangsa community and they use them regularly whenever required.

In 20 cases the FL values are in between 50 and 70% and the rests are below 50%. However, those having FL value lower that 50% are used in more than two different diseases. These indicate their multiple applications and lesser in one particular disease treatment and the efficiency of such drugs need to be verified properly.

Again, the lowest determined value of 10.45% has been recorded for *Entada rheedei* when it is used against Body-ache. The value is slightly higher (17.91% and 18.9%) for this species when it is used for Fever and Gastritis respectively and 26.37% each when it is used for Cough and Tuberculosis. A similar situation is also for *Paederia foetida* with 12% FL value for use against Pneumonia which indicates lesser use or may be such a use is not known to many people. However, the FL value is above 50% in most of the cases that express the popularity of these medicines in Tangsa society.

4.3.6.2 Use Value (UV)

The determined UV index to medicinal plants cited by Tangsa informants varies from 0.01 to 0.18. It's a complex value as it includes the diversity in the use of a species in one hand and its popularity (number of informants) on the other. The analysis of use values also indicates the importance of these medicinal plants for the society. UV index varies between 0.01 and 1.0 (Umair et al. 2019). In the present study five species with lowest index value (0.01) has been recorded, viz. *Clerodendrum colebrookeanum, Curcuma longa, Mikania micrantha, Psidium guajava* and *Zingiber officinale.* All the 71 respondents cited these plants for their use in the preparation of medicines. These plants can the treated as most important for the Tangsa people and most of the people in the community know such uses.

Just the next set of 11 species are recorded with 0.02 UV index (*Baccaurea ramiflora, Chromolaena odorata, Curculigo capitulata, Curcuma ceasea, Garcinia xanthochymus, Houttuynia cordata, Hydrocotyle sibthorpioides, Mangifera indica, Persicaria chinensis, Pothos scandens* and *Solanum torvum*) and another set of four

species are with 0.03 index value (*Mallotus tetracoccus, Pseuderanthemum latifolium, Ricinus communis* and *Stemona tuberosa*) are the plants which are also cited by majority of the informants and are used against one or more diseases.

On the other hand, five species with recorded higher UV index values are *Hodgsonia macrocarpa* (0.14), *Paederia foetida* (0.15), *Lophatherum gracile* (0.17), *Scoparia dulcis* (0.17) and *Physalis angulata* (0.18). These are cited by quite lesser number of informants but are used against one of more diseases. Of these *Scoparia dulcis* is one well-known medicinal plant but the medicinal properties of other four species need investigation.

4.3.6.3 Informants' Consensus Factor (ICF)

For its calculation all the diseases or discomforts they treat with plant-drugs were grouped under 11 categories based on their one or more common relations (Table 4.2). Apart from these categories, there are four diseases or discomforts [Leech attack, Gynaecological problem, Eye-sight, Health tonic] for each of which the use of only one species was recorded. The ICF value for these four plants/ailments will be just 1 for each. Table 4.2 displays the 11 categories and their determined ICF values.

It is interesting to note that the ICF value for all the 11 categories are too close to the maximum value 1, with ten of them above 0.97 and one of them above 0.96. This is one indirect acceptance of these medicines/ medicinal plants by the informants (or, the users).

Table 4.2 Determined ICF value for different category of diseases as per the selection of species and preferences by the informants

	Disease/discomfort category [number of species recorded]	No. of citations	ICF value
1	Teeth problems [3 spp.]	118	0.982
2	Cuts, bruises, wounds & burns [10 spp.]	533	0.983
3	Cough cold, pneumonia [8 spp.]	340	0.979
4	Skin and nail infections, abscess [4 spp.]	137	0.977
5	Allergy: rashes, ringworm, insect-stings, snake-bite [10 spp.]	444	0.979
6	Problems of lungs, kidney, spleen, urinary bladder [8 spp.]	188	0.963
7	Stomach-ache, gastric, gastric-ulcer, vomiting, appendix infection [14 spp.]	679	0.980
8	Dysentery, typhoid, malaria, jaundice [12 spp.]	637	0.982
9	High Blood Pressure, impurity of blood [6 spp.]	345	0.985
10	Joint pain [2 spp.]	84	0.987
11	Pet's diseases [5 spp.]	227	0.982

4.3.6.4 Relative Frequency of Citations (RFC)

The RFC shows the relative importance of a plant in a locality. It represents the preference by the number of respondents out of all participated in the study. Here, the maximum possible value is 1. In the present study RFC score is 1 for 11 species. In 22 cases it is between 0.6 and 0.99 and the rest are below 0.6. If we consider plants or treatments with citation frequency 0.6 and above are significant, then 33 plants, out of the total 56, are to be accepted as important.

4.4 Conclusion

The list of recorded plants during the survey included many renowned medicinal plants including *Acmella paniculata, Alstonia scholaris, Centella asiatica, Clerodendrum infortunatum, Citrus limon, Curcuma caesia, Curcuma longa, Cynodon dactylon, Hellenia speciosa, Kalanchoe pinnata, Mimosa pudica, Paederia foetida, Rhus chinensis, Ricinus communis, Scoparia dulcis, Stemona tuberosa, Solanum viarum, Terminalia chebula* and *Zingiber officinale*. In addition, many other species (Table 4.1) were also found using for treating many new ailments.

Present article is the first of its kinds reported the various uses of medicinal plants by the culturally rich *Tangsa* tribe who survived in very difficult situation during their long journey from Mongolia to Patkai Hills in Arunachal Pradesh of India and in Myanmar. Even today, many of their villages are located far away from modern medical facilities. Naturally, they are getting cured using their own traditional medicines and, of course, with their naturally induced immunity against local causal agents in the environment creating discomforts and diseases.

The 56 species of plants identified and recorded during the survey are mostly known to the common people of the community and majority of those were mentioned by good number of respondents. All four types of quantitative evaluation of collected data showed high impact of the traditional knowledge of *Tangsas* and it is essential to scrutinize the data further through phytochemical characterization and using such scientific knowledge for the improvement of health care system for the mass community particularly the Indigenous community and the community living in remote areas.

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Chapter 5
Non-wood Forest Products of the Sundarbans, Bangladesh: The Context of Management, Conservation and Livelihood

Mahmood Hossain and A. Z. M. Manzoor Rashid

Abstract The Sundarbans is the single largest continuous tract of mangrove forest of the World. This forest is rich in biodiversity with a wide array of conventional and nonconventional Non-wood Forest Products (NWFPs). So far, 25 types of NWFPs have been identified from the Sundarbans. Among them, thatching materials, honey, beeswax, bony fish, cartilaginous fish, dry fish, crabs, shrimps, and mollusks are the major types. These NWFPs are generally extracted by the local, poor community living around the Sundarbans for sustaining their livelihood. The annual amount of the extracted NWFPs vary significantly. The increasing and decreasing trends of the respective NWFPs depend on the resource base and their market demand. The extracted NWFPs have to pass through at least two and a maximum of five stages in between collectors to retailers. The percentages of value addition are varied with the extracted resources and steps involved. Assessment of the resource base and identifying the potential threats of the respective NWFPs; strict monitoring of the harvesting rule; proper record-keeping for the extracted amount of NWFPs; proper implementation of field level management interventions for the NWFPs are of prime importance for the sustainable management of the valuable NWFPs of the Sundarbans.

Keywords Beeswax · Fisheries · Honey · Livelihood · Mangroves · Thatching materials

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5.1 Introduction

The Sundarbans is a mangrove or tidal forest or tidal wetland. This forest is an assemblage of different angiosperm plant species of various families having the adaptive capacity to a fluctuating aerobic to anaerobic semi-fluid like substrate and tidally influenced saline environment (Duke 1992; Siddiqi 2001; Mahmood 2015). The Sundarbans is the world's largest single tract of mangrove forest covering about 1,000,000 ha of land and water bodies that covers India and Bangladesh. In Bangladesh, it covers a total of 6, 01, 700 ha which is 4.13% of the total land area and 38.12% of the total forest land of Bangladesh (BFD 2017). This forest is located in the Southwestern coastal region of Bangladesh starting from the Harinbhanga River in the west to the Baleswar River in the east. This forest is about 80 km in the North to South direction and about 100 km in the East to West direction. This landscape of the Sundarbans can be categorized as active to the abundant delta that is crisscrossing by numerous rivers and canals, with a range of elevation from 0.9 to 2.11 m from the sea level (Saenger and Siddiqi 1993; Siddiqi 2001).

The Sundarbans, characterized as an open ecosystem comprising of terrestrial and aquatic ecosystems. This ecosystem is dynamic and highly productive among the other coastal ecosystems. This forest ecosystem is home to diverse species of flora and fauna. 334 plant species are recorded in the Sundarbans and its' adjacent areas (Prain 1903), while Rahman et al. (2015) recorded the highest of 528 plant species. Mangroves and mangrove associates are the floristic elements of the Sundarbans. However, this ecosystem contains about 50% of the world mangrove plant species (Hoque and Datta 2005; Aziz and Paul 2015) and 505 species of wildlife (Khan 2013), 261–320 species of birds, 177–400 species of fishes (Khan 2013), 5530 species of insects (Mitra et al. 2016), and numerous species of fungi, bacteria, algae, lichen, phytoplankton, etc. (Siddiqi 2001). It is believed that a wide range of soil salinity (<2 to >4 dS m^{-1}), lower elevation and frequent tidal inundation, plenty of supply of freshwater from upstream and rainfall control the composition and distribution of non-salt tolerant to salt-tolerant plant species in this forested ecosystem (Iftekhar and seanger 2008; Mahmood 2015).

The floral and faunal composition of the Sundarbans forest ecosystem yields a wide array of resources. The human being had started to utilize these resources before 321 BC as record available on the state supervision and formulation of laws for the utilization of the forest areas during the Muryan period (321-226 BC) (Iftekhar and Islam 2004). This forest has an important role in the economy and climate of the national, regional, and global scale. It provides many direct benefits to the vicinity community starting from the fuelwood collection to the fisheries and maintaining the ecological balance for the southwestern region of Bangladesh. About one million peoples are directly or indirectly dependent on the resources of the Sundarbans for their livelihood. Besides these, Sundarbans protect the lives and properties of the adjacent population from tidal surges, tropical cyclones, and tsunamis (Saenger 2011; Hale et al. 2019). The Sundarbans has a significant role for shelter, nursery, feeding, resting, and breeding ground of many aquatic organisms and supports the coastal

fisheries resources through the supplies of particulate and sub-particulate form of organic matter (Mahmood 2015). This forest also helps to enhance the carbon stock and carbon sequestration, and cycling of other nutrients in forest soil, vegetation (Rahman et al. 2015; Gob 2019).

5.2 Non-wood Forest Products (NWFPs) of the Sundarban

Non-wood forest product generally refers to the tangible biological products other than wood that is originated from forests. Large portions of floral and faunal species of a forest ecosystem provide both wood and non-wood products. Interestingly, most of the non-wood forest products (NWFPs) are usually remain invisible and unaccounted (Muir et al. 2020). The major extractable NWFPs of the Sundarbans are thatching materials, honey, beeswax, and aquatic fauna (Hossain and Acharya 1994). The NWFPs of the Sundarbans can be grouped into plant resources, honey and beeswax, and aquatic resources. Different species of trees, shrubs, palm, climbers, and grasses are the major sources of NWFPs originated from the plant resources of the Sundarbans (Mahmood 2015). *Apis dorsata* and *A. mellifera* are the two honey bee species of the Sundarbans. These bee species use the nectar of flowering plants of the Sundarbans for the production of honey (Baksha 2004). While the fishery resources consist of bony and cartilaginous fish, crustaceans, and mollusk. Different studies noticed that about 120 species of aquatic fauna have commercial uses or values (IUCN 1994; Shah et al. 2010; Ahsan 2014; Habib et al. 2020).

NWFPs are the major sources of livelihood to the people living surrounding the Sundarbans of Bangladesh. Broadly, the NWFPs of the Sundarbans can be categorized into conventional and non-conventional based on resources used by the people. The conventional NWFPs of the Sundarbans are plant resources (Edible fruits, Vegetable, Floating fruits as fuel, Thatching and bedding mats, Cord or Rope, Fodder, Tannin and dye, Fish poison, Perfumes, Chemical and Oil, Folk medicine); honey and beeswax; aquatic resources (Bony fish, Cartilaginous fish, Dry fish, Adult Crabs, Shrimps, Post larva and Fry collection, Baby crabs for crab fattening, Mollusks) (Table 5.1). The non-conventional NWFPs include edible fruits, vegetable, tannin, and dye, perfume and chemicals, folk medicine, cords, or rope from different plant species of the Sundarbans (Table 5.2).

Majority of the NWFPs are collected from the Sundarbans forest areas, but a portion of these NWFPs are collected from the peripheral water bodies and land areas immediately at the outside of the Sundarbans. It includes some edible fruits like *Sonneratia apetala, S. caseolaris*; and floating fruits are trapped from the surrounded rivers, canals, and creeks for fuel; thatching materials; fodder; and a good portion of aquatic resources. However, these products are not included in the resource collection records of the Forest Department. The local community people close to the Sundarbans are rearing domesticated bees (*A. cerana indica*) for honey production as their alternate livelihood. These bees use the nectar of different flowers of the Sundarbans for honey production (Baksha 2004). Bangladesh forest department

Table 5.1 Conventional non-wood forest products of the Sundarbans. NWFPs with '*' mark indicates commercial collection from the Sundarbans

Product	Sources
Plant products	
Edible fruits	*Nypa fruticans*, *Phoenix paludosa, Sarcolobus globosus*, *Sonneratia apetala,* and *S. caseolaris* (Mahmood 2015; Siddiqui 2016)
Vegetable	Young shoots of *Acrostichum aureum*, *N. fruticans* and fruits of *S. globosus* are cooked and also consumed as raw. Stem pith of *P. paludosa* can be eaten raw. Pickle is made from the fruits of *S. apetala* (Giesen et al. 2006; Mahmood 2015; Siddiqui 2016)
Floating fruits as fuel	The floating fruits and seeds of *Aglaia cucullata, Avicennia officinalis, Bruguiera sexangula*, *Ceriops decandra*, *Heritiera fomes, N. fruticans, Pongamia pinnata, S. apetala, Xylocarpus granatum* and *X. moluccensis* are trapped by the local people from the peripheral rivers and canals of the Sundarbans. The local people use the dried fruits/ seeds as fuel for daily consumption
Fodder	Fronds of *Acrostichum aureum;* leaves of *Acanthus ilicifolius, Aegiceras corniculatum*, *A. alba*, *A. marina*, *A. officinalis*, *Clerodendrum inerme*, *Cyperus difformis, C. javanicus, Derris trifoliate, Eriochloa procera, Hibiscus tiliaceus, Kandelia candel, Pongamia pinnata, S. apetala, S. caseolaris* (Giesen et al. 2006; Mahmood 2015; Siddiqui 2016)
Tannin and dye	Barks of *B. gymnorrhiza, B. sexangula, Ceriops decandra, Cynometra ramiflora*, *Heritiera fomes, Kandelia candel, Lumnitzera racemose*, *X. granatum* and *X. moluccensis*; leaves and bark of *Rhizophora apiculate* and *R. mucronata* are the good sources of tannin and dye (Giesen et al. 2006; Mahmood 2015)
Fish poison	The oil from seeds of *Cerbera manghas;* stem and root extracts of *Derris scandens* and *D. trifoliate*; latex of *Excoecaria agallocha*; young fruits of *E. indica*; and roots and seeds of *P. pinnata* used as fish poison (Giesen et al. 2006; Mahmood 2015)
Perfumes	The flower extract of *C. inerme* is used to perfume the coconut oil (Giesen et al. 2006; Mahmood 2015)
Oil	Red-brown thick oil is extracted from the seed of *P. pinnata* that are used for lamp, manufacturing soap and lubricants (Giesen et al. 2006; Mahmood 2015)
Medicinal uses	Wide array of medicinal values of different plant species of the Sundarbans have been recorded (Appendix 1)

(continued)

Table 5.1 (continued)

Product	Sources
*Thatching and bedding mates preparation materials	Leaves of *N. fruticans* are principle and widely used as thatching and partition materials at the southwestern village areas of Bangladesh. Beside this, *Imperata cylindrical*, leaves of *P. paludosa* are also used as thatching materials. Older fronds of *A. aureum* are used for light construction like roofing of country boat, weaving and wall of cottage. While, stem of *Phragmites karka* are used for partition, ceiling, and often as outside wall of house with mud. However, *Typha elephantis, C. javanicus, I. cylindrical,* leaves of *P. paludosa* and *P. karka* are frequently used for preparing the bedding mates (Giesen et al. 2006; Mahmood 2015; Siddiqui 2016)
Cord	The common climbers (*Derris scandens*, *D. trifoliate*, *Flagellaria indica* and *Sarcolobus globosus*) are frequently used as rough cord or rope by the resource collectors. Beside this, cord or rope also be prepared from the mature fronds/ leaves of *A. aureum*, *Pandanus foetidus*; and fibers from barks of *H. tiliaceus* (Giesen et al. 2006; Mahmood, 2015)
Others use	Baskets are made from the bark and stem of *F. indica* and leaves of *N. fruticans.* Hats are also made from the stems of *Phragmites karka.* Young branches of *Brownlowia tersa* are traditionally used as *Miswak* (teeth cleaning twig). Dry petioles of *N. fruticans* are used as floater of fishing net. Hard round seed of *E. indica* used as marbles by children (Mahmood 2015)
***Honey and beeswax**	The honey bees (*A. dorsata* and *A. mellifera*) produce the bulk of the honey from the nectar of *A. ilicifolius, A. corniculatum, A. officinalis, Aegialitis rotundifolia, B. gymnorrhiza, B. sexangula, C. decandra, C. ramifolia, E. agallocha*, *R. apiculate, R. mucronata S. apetala, S. caseolaris, X. moluccensis.* But the best quality honey is produced from the nectar of *A. corniculatum* (Baksha 2004; Mahmood 2015; Siddiqui 2016). The proportion of beeswax is approximately 25–30% of the produced honey (BFD 2020b)
Aquatic resources	
*Bony fish	Hilsa shad (*Tenualosa ilisha*) is the most common and commercially important fish species of the Sundarbans. The other common bony species of the Sundarbans are King Soldier Bream (*Argyrops spinifer*), Paradise Thread Fin (*Polynemus paradiseus*), Asian sea bass (*Lates calcarifer*), Fatty cat fish (*Pangasius pangasius*), Pama Croaker (*Otolithoides pama*), Small head Ribbon Fish (*Eupleurogrammus muticus*), Gray eel-catfish (*Plotosus canius*), Long-whiskered Catfish (*Mystus gulio*), Bombay duck (*Harpadon nehereus*), and Gold Spot Mullet (*Liza parsia*) (Shah et al. 2010; Ahsan 2014; Habib et al. 2020)

(continued)

Table 5.1 (continued)

Product	Sources
*Cartilaginous fish	The cartilaginous fishes are mainly marine, but they are also available in the aquatic ecosystem of the Sundarbans. Some of them have economic value and sold in the local market. The important species area Blacktip reef shark (*Carcharhinus melanopterus*), Spadenose shark (*Scoliodon laticaudus*), Dog fysh (*Scoliodon sorrakowah)*, Milk shark (*Scoliodon walbeehmii*), Hammerhead shark (*Eusphyrna blochii*), Gulter fish (*Rhynchobatus djeddensis*), Skate (*Rhinobatos granulatus*), Pale-edged ray (*Dasyatis zugei*), Gangetic stingray (*Himantura fluviatilis*), Scaly stingray (*Himantura imbricate*) and Stingray (*Himantura uarnak*) (Shah et al. 2010; Habib et al. 2020)
*Dry fish	Dubla island of the Sundarbans is the place for fish drying (both the marine and brackish species). Bombay duck (*Harpadon nehereus*), Small head Ribbon Fish (*Eupleurogrammus muticus*), Chiense pomfret (*Pampas chiensis*), King Soldier Bream (*Argyrops spinifer*) and different species of shrimps are the most prominent (Shah et al. 2010)
*Adult Crabs	There are 12 species of carbs are found in the Sundarbans ecosystem. But, the mud crabs (*Scylla serrata* and *Scylla Olivacea)* are the most important for food and trade (Saha and Ahmed 1999; Shah et al. 2010)
*Shrimps	Twenty sixspecies of shrimps are available in the Sundarbans ecosystem. But, giant freshwater prawn (*Macrobrachium rosenbergii*) and giant tiger prawn (*Penaeus monodon*) are the most commercially important shrimp species (Hoq 2007; Shah et al. 2010; Habib et al. 2020)
Post larva and fry collection	Post larvae of *Macrobrachium rosenbergii* and *Penaeus monodon*, and fry of *Liza parsia* are usually collected from the surrounding waterbody of the Sundarbans for the commercial aquaculture. However, the collection of post larvae of *Macrobrachium rosenbergii* and *Penaeus monodon* from the Sundarbans was ban in 2000 for the conservation of the fisheries of the Sundarbans (Shah et al. 2010)
Baby crab for crab fattening farm	The wild baby crab of *Scylla serrata* and *S. olivacea* are collected from the Sundarbans and the surrounding waterbody of the Sundarbans for the crab fattening farms (Mia 2013)
*Mollusks	There are about 31–36 species of mollusks in the Sundarbans. Very small quantities of mollusks are consumed as food in Bangladesh. However, most of them used in shrimp farm as food and shells are used for the production of lime (Shah et al. 2010; Habib et al. 2020)

Table 5.2 Non-conventional non-wood forest product of the Sundarbans

Product	Sources
Edible fruits	The seeds of *A. alba, A. marina*, *A. officinalis* are roasted and consumed. Seed powder of *F. indica* is also edible. Mature fruits of *Pandanus foetidus* can be consumed (Giesen et al. 2006)
Vegetable	Seedlings of *A. alba*; tender leaves of *P. foetidus*; and young shoots of *P. karaka* and *F. indica* can be cooked and consumed as vegetable. The hypocotyls of *B. gymnorrhiza*, *B. sexangula*, *R. apiculata* and *R. mucronata* can be cooked after scraped, washed, soaked, and boiled
Tannin and dye	Bark of *A. rotundifolia*, *D. trifoliate*, *E. indica*; and leaves of *E. indica* and *N. fruticans* are potential sources of tannin and dye
Oil, perfume and chemicals	Fruit pericarp extract of *A. cucullata*; and seed oil of *C. manghas*, *X. granatum* can be used to illuminate. Perfumes can be extracted from the barks of knee root of *B. gymnorrhiza* and *B. sexangula*; and flowers of *P. foetidus*. Bio insecticide are prepared from the fruits and seeds of *C. manghas*
Cords or ropes	Cords or ropes can be prepared from the leaves of *P. paludosa*, barks of *P. pinnata* and leaf stem fiber of *N. fruticans*
Others use	Mates and hats can be made from leaves of *N. fruticans, P. foetidus*, *P. paludosa*. Stem of *F. indica* can be used for woven into fish trap and considere as a good alternative for rattan. Young leaves of *N. fruticans* can be obtain for cigarette-wrapper, and midribs for brooms making. Vinegar, alcohol and molasses are prepared from the inflorescence sap. Aromatic tea can be also be obtained from the processed petals of *N. fruticans*. *Cryptocoryne ciliate* can be used as aquarium plants. Pneumatophores of *S. apetala*, *S. caseolaris* are used in making corks or floats. The ash of *I. cylindrical* can be used as a substitute of salt. The inflorescences can be used for stuffing pillows and cushions and the fiber of leaves can also be used in making paper

Source Bandaranayake (1998), Giesen et al. (2006), Mahmood (2015)

established 93.5 ha plantation of *Nypa fruticans* (the most important thatching material) at the outer side of the embankment close to the Sundarbans in cooperation with the Bangladesh Water Development Board (BFD 2020a). Moreover, plantations of this species have also been established on the private lands close to the Sundarbans for commercial production of thatching material.

5.3 Extraction of NWFPs from the Sundarbans

The use of both the wood and non-wood forest resources of the Sundarbans had started with the beginning of human settlement in that area for their housing, food, daily consumption, and livelihood. The southern parts of the Ganges floodplain where the

Sundarbans is situated was recognized as economic, cultural, and political frontiers during the period of 1200–1750, which ultimately govern the human settlement in the Sundarbans areas (Eaton 1990). With time, people learnt to identify and use different NWFPs from the Sundarbans. Hunter in 1875 recorded that people collected reeds, thatching leaves, honey, beeswax, shell-line, and fishes from the Sundarbans for their household consumption and livelihood. We have identified 21 categories of NWFPs in the Sundarbans (Table 5.1), but 8 of them are commonly collected (BFD 2020b). The NWFPs are collected from the Sundarbans by following a defined harvesting rule for each category (BFD 2010). The extraction procedures and harvested amount of each category of NWFPs from the Sundarbans have been discussed here.

5.3.1 Thatching Materials

The Sundarbans is the major source of thatching materials for the rural settlement of southeastern Bangladesh science long. Leaves of *N. fruticans* are the principle and widely used thatching materials. Along with this, *I. cylindrical* is also used for the same purpose. Bangladesh Forest Department (BFD) has set harvesting rule for the collection of *Nypa* leaves and *I. cylindrical* from the Sundarbans. The mean and range of extractions of *Nypa* leaves are about 38,409 ± 3902 ton and 440–72,428 ton respectively for the last 29 years. However, the mean and range of extractions of *Imperata cylindrical* are about 3705 ± 508 ton and 32–10,157 ton respectively for last 29 years (1991–92 to 2018–2019) (Fig. 5.1) (BFD 2020b). The extracted amount of these resources found to fluctuate significantly with the stocking, market demand, and natural calamities. Frequently tropical cyclones hit the coast of Bangladesh. The super cyclone "Sidor" and "Aila" cross the Sundarbans coast of Bangladesh on 15 November 2007 and 23 May 2009 respectively. The extracted amount of *Nypa* leaf was lowest (only 440 ton) during 2007–2008, which was the intimate effect of the super cyclone "Sidor" that impacted at the beginning of the harvesting time. Interestingly, the extracted amount of *Nypa* leaves during 2009–2010 was not affected because the cyclone "Aila" struck at the end of harvesting time of 2009–2010. The extracted amount of the thatching materials reduces with time and showed a sharp negative trend (Fig. 5.1). This negative trend could be the result of frequent use of corrugated iron sheets in the last two decades instead of *Nypa* leaves and *I. cylindrical* as thatching materials. Nowadays the corrugated iron sheets are more available and durable, and socially prestigious compared to these natural sources of thatching materials.

The mangrove forest of Sundarbans has its own unique system that supports life and living of thousands of local communities who are heavily dependent on the resources of mangrove forests. Bawali (popularly called wood cutters and golpata collectors) are the dominant group of Sundarban who has significant influence in the conservation and sustainability of resources and of the Sundarbans. The following case study reveals the insights of the life and living of a *Bawali*:

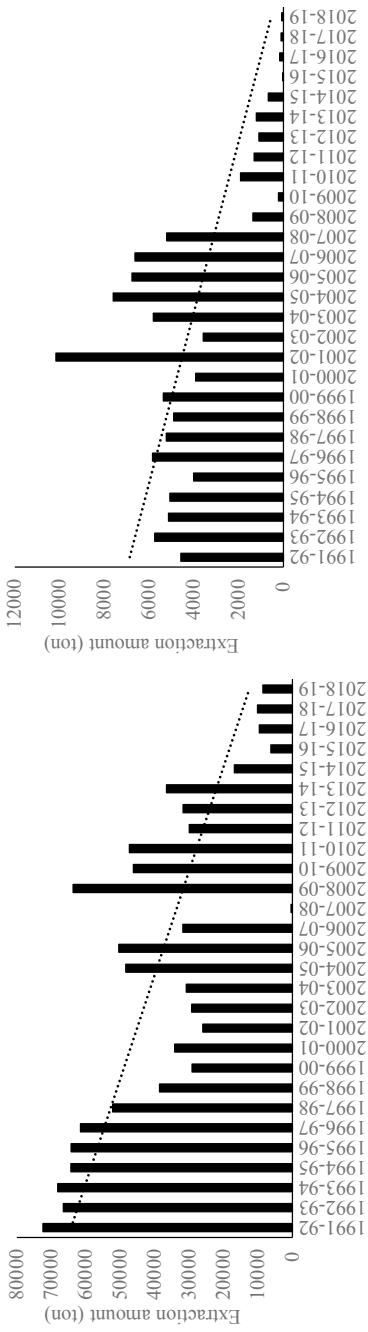


Fig. 5.1 Yearly (1991–92 to 2018–19) extraction of thatching materials **a** *Nypa fruticans* and **b** *Imperata cylindrical* from the Sundarbans (*Source* BFD 2020b)

Box 1: Life of a Bawali (Thatching material collector)

We met Talebur (pseudonym) a man of 50's at Shorankhola forest range while we were resting in a camp and planning our next day field work. Our discussion was mainly centered on Nypa fruticans (golpata- a common thatching grass of the Sundarban mangrove forest).

We started [our chat] to know Talebur's family, [his] hopes, aspirations and the future

(both him and the Sundarban).

For how long have you been engaged in this profession? Answering this question, Talebur stopped a while [to recall] and replied (with a smile) at least 30 years [a vanishing memory].

I, my father, uncle and neighbors used to get into the Sundarbans during the harvesting season [October-February].

Inquiring about the life and livings of Bawalis who are harvesting golpata…. Talebur replied with uncertainty …..look [this resource] grows only in areas [where salinity is less or moderate] nearby river bank, canal side etc. You [will not] find them everywhere. We have a struggle a lot to get a [descent] amount.

Any challenges you [generally] face while harvesting [golpata]?… answering this [question] Talebur stared at the sky for a while and said.. See our [harvesting territory] is shrinking day by day… You know why? …. Growing restriction in accessing and [harvesting resources] to the Sundarbans since protected area [and world heritage site too] coverage is increasing, declining production [due to salinity and natural calamities and availability of alternative thatching materials.

Sustaining livelihood on golpata collection is difficult for many reasons….[harvesting of other tree species is totally banned] posing threat to our profession. Sometimes realizing [your] investment [boat license, revenue, other expenditures during the voyage] became utterly difficult. Pirates disturbances for ransom, illegal influence of the forest staff all add extra [burden] on us. This profession is no more a lucrative means of [survival].

Any clues for future improvement? …..Talebur suggested few important issues [based on his long experience he gained] namely …..plantation initiative of golpata by forest department at all feasible sites, registering authentic bawalis for the sustainable harvesting and management, product diversification [the juice can be used for making molasses, drinks and so on], law enforcement to restrict all sorts of illegal harvesting of natural resources from the Sundarban and the positive mindset of the governing authority.

5.3.2 Honey and Beeswax

Sundarbans is a good source of honey and beeswax. About 50% of the harvested honey of Bangladesh comes from the Sundarbans (Burgett 2000). The hives are found at low height in the Sundarbans. *P. paludosa* and *E. agallocha* dominated sites are preferred by the bees and *E. agallocha* is the most preferred nesting tree for the bees (Baksha 2004). The mean annual and range of harvested amount of honey and beeswax are 175 ± 14 and 46 ± 4 ton; 87–460 ton and 22–116 ton respectively for the last 29 years. Twenty-nine years of harvested data of honey and beeswax showed a slightly positive trend (Fig. 5.2) (BFD 2020b). There are no surveys or inventories on the stocking of honey and beeswax, but expected yearly production of honey and beeswax are forecasted from the harvested amounts of previous years. About 2000 honey collectors (widely dubbed as Mouali) usually enter annually into the Sundarbans for the collection of honey and beeswax.

The following case story (Box 2) reveals the current context of the Moualis in connetion with their livelihood and conservation:

Box 2: Life of a Mouali (Honey collector)

Qumrul Sheikh (a pseudonym), a man of 25 from Joymuni bazar of Mongla Upazilla is a honey collector commonly known as Mouali.

Qumrul was accompanying us in a research expedition (his optional occupation to support his livelihood) as a field crew hence had the opportunity of sharing the extensive experience regarding the non-wood forest products (NWFPs) of the Sundarbans particularly honey.

How long have you been in this profession?…in answer to that, Qumrul started sharing the ins and outs of his profession.

……I am in this occupation for the last five years…. for honey collection. You don't need any critical skills. All you need is the mental and physical strengths. I have learned these from my fellow mates while accompanying them during the honey collection season.

While focusing on the official procedures…. Qumrul started sharing more…

The official season starts at March (fluctuates between mid to late March depending on the rainfall intensity) and ends in May. Forest department issues permits for 15 days (generally 4 times in a season). We enter the forest (5–7 people per boat) and stay until the permit expires.

How about the amount and the variety of the honey (sources)?…

In reply to this (he answered)……It totally depends on luck (favored by the season too). Last season, I had 82 kg of raw honey as share. Goran and khalsi are the major sources of honey.

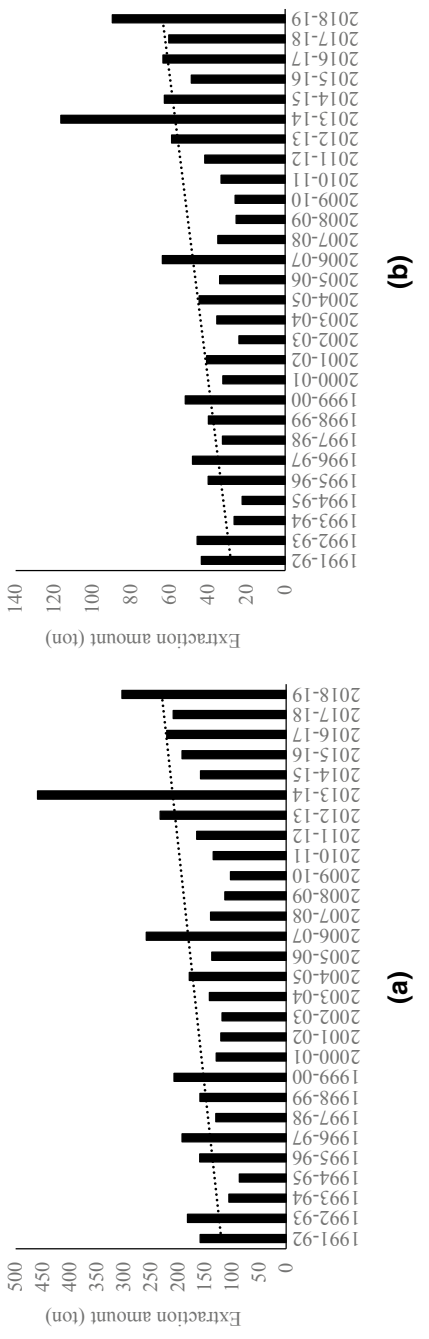


Fig. 5.2 Yearly (1991–92 to 2018–19) extraction of **a** Honey and **b** Beeswax from the Sundarbans

While asking about the factors determining the production of honey.. Qumrul answered confidently-forest health. The less you enter and destroy forest (trees, animals, foods etc.) and favourable weather help boosting production.

Can you sustain your livelihood based on honey collection?….. Qumrul replied with a smile expressing both hopes and dissatisfaction. [No] it is a seasonal occupation (3 months in a year). So [I] need to depend on other options like fish spawn and crab harvesting from the Sundarbans to support my 8 membered family.

How do you see the future of Non-wood forest products of the forest. He replied.. it (The Sundarbans) is a treasure house of NWFPs, sustaining thousands of peoples like me (through thick and thin). All you need to do is possess acceptable [by us and you (FD)] level of empathy for the Sundarbans.

The Sundarbans is like our mother…[we] were born here and want to live the rest of our lives along it by keeping it alive.

5.3.3 Aquatic Resources

5.3.3.1 Fishes (Bony and Cartilaginous Fish)

Fishes are the most important NWFPs of the Sundarbans ecosystem. It includes both the bony and cartilaginous fish species. Since the beginning of the human settlement in the southwest region of Bangladesh, this resource is extracted for household consumption and livelihood. Thousands of people living around and outside the landscape area are directly and indirectly dependent on the fisheries of the Sundarbans. It contributes about 2–5% of the total capture fishes of the country (Shah et al. 2010). The fishermen use 15 categories of gears in the Sundarbans (Hoq 2008), but 8 gears (cast net, canal gill net, gill net, Hilsha gill net, long line, Otter gill net, Pangash gill net, and set bag net) are frequently used for harvesting the bony and cartilaginous fishes of the Sundarbans (Shah et al. 2010). So far there is no formal inventory on the fish stock in the Sundarbans (BFD 2010). But, the yearly harvested amount of fishes are recorded by the BFD for forecasting the stock for the next year. These records showed fluctuation in yearly harvested amount with a mean of 3445 $\pm$ 221 ton and ranged from 1127 to 6192 ton for last 29 years (BFD 2020b). Overall the yearly harvested amount shows a negative linear trend (Fig. 5.3). The yearly harvested amount of fishes from the Sundarbans reported decreasing with time. Fishers, BFD, and people involved with fish marketing business reported that fishery resources of the Sundarbans have decreased about 50% over the years during 2001–2010 (BFD 2010). It is important to consider the long time series data on

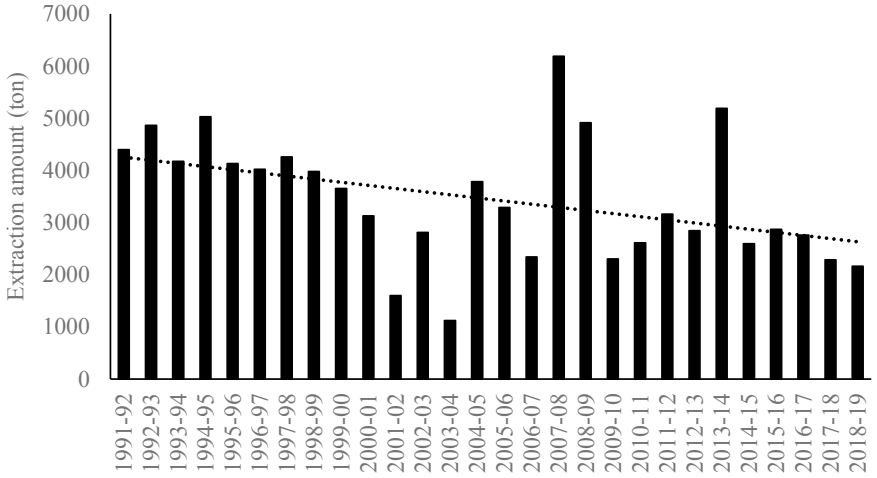


Fig. 5.3 Yearly (1991–92 to 2018–19) extraction of bony and cartilaginous fishes from the Sundarbans

fish harvest, an outbreak of the disease in fish, management and monitoring initiatives at different time period, expansion of the sanctuary areas, the yearly number of permits issued, increase the rate of royalty, the yearly number of precautionary weather signals and cyclonic events, and safety and security condition (the activities of pirates) during the fishing seasons need to be considered before come to a candid conclusion.

Fish—a major non-wood forest products of the Sundarbans playing a crucial role in sustaining livelihood of many of the forest dependent community. The following story (Box 3) of a fisherman reveals some of the context having relation to conservation, knowledge and livelihood context:

Box 3: Life of a fisherman

Montaz mridha (pseudo name) a fisherman aged 52 from Gabura Union under Satkhira Range is engaged in the profession since his childhood. His six membered family solely depends on fishing and related activities.

The scorching sun was melting while we met Montaz near a fishery ghat (went to sell his catch). We started chatting [once he has finished delivering the catch] siting nearby a tea stall. Our (discussion) proceeds while sipping tea…

Being asked about the profession and related aspects…Montaz manifested the gradual development of becoming a fisherman. I used to accompany and help my father to collect shrimp spawn from the river bank while I was young… that was the beginning. [gradually] I came to know the formal (legal) process of fishing [royalty, timing and types of fishing gear to be used].

Fish resources are increasing or dwindling? In reply to this question, he replied.. there is no [short cut] answer to (this). It depends on many [things].. seasonal blessings, good behavior of the water (meant tidal dynamics) and weather (cyclonic events), sufficient offspring in the river, canal and channels and your [skill].

Defining the issues of sustainability and conservation... Montaz [his community as a whole too] reveals some crucial issues [in front]…the fishing areas are reducing day by day [in the name of protection]. Dolphin sanctuary and protected area coverage are expanding and [we] are [confined]… how we can survive with growing [restrictions]. We have [no] other skill to sustain livelihood. Hostage for ransom is also a [big] issue.. you have to satisfy them[the pirate gangs]..otherwise your life and livelihood both will be threatened.

What is your expectation to sustain livelihood and the conservation…. he stared at me and starts saying….Government [Forest department] must find a way for us (alternative livelihood options) otherwise allow us fishing inside the Sundarbans. Controlling [poison fishing] is a must… it is killing our mother nature [The Sundarbans] and our existence [too]. Aquatic plant habitat conservation is also important that in turn [helps] to support fish population.

5.3.3.2 Dry Fish

Fish drying is a quite old-time practice in the Sundarbans and it is the 2nd largest fish drying industry in Bangladesh. The fishing is associated with both the inshore and offshore water, but not to allow fishing inside the Sundarbans. About 60% of the catch is consists of bony and cartilaginous fish and 20–30% are small-sized shrimps. Mostly the small-sized shrimps are smoked dried (Hossain 1984). The produced dry fish are locally consumed and also exported to foreign counties. Fish drying activities are operated at the sea-facing islands like office kella, Majer kella, Alorkol, Narikel baria, Shelar char during the winter season starting from October and ends in the month of March. Every batch of fish requires two to eight days for sun-drying depending on the size and species of fishes. Yearly about 25,000–30,000 fishermen are engaged with fish dry in the Sundarbans. The fishermen mostly from the Southwest region of Bangladesh. BFD issued Boat License Certificate (BLC) to the fishermen as a permit of fish drying for a season. The mean annual and range of produced dry fish for the last 18 years (2001–02 to 2018–19) are 2501 $\pm$ 348 ton and 468–6739 ton respectively (Fig. 5.4) (BFD 2010).

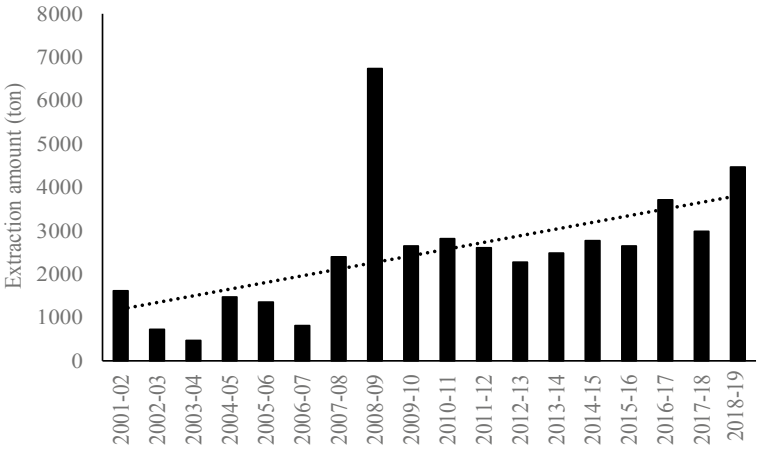


Fig. 5.4 Yearly (2001–02 to 2018–19) extraction of Dry fish from the Sundarbans

5.3.3.3 Crabs

Crabs are the important aquatic resources of the Sundarbans. Crabs are not included in the daily diet of the local people of Bangladesh due to the religious believes. Therefore, major portions of the harvested carbs are exported to foreign countries. *S. serrata* and *S. Olivacea* are the important targeted crab species for harvest. Crab hook and line, and trap with bait are the most common modes of crab harvesting (Shah et al. 2010). The annual mean harvested amount of crabs is 1151 ± 177 ton, and the yearly amount of harvest is found to vary from 71 to 2570 ton from 2001–02 to 2018–19 at a sharp increasing trend (Fig. 5.5) (BFD 2020b).

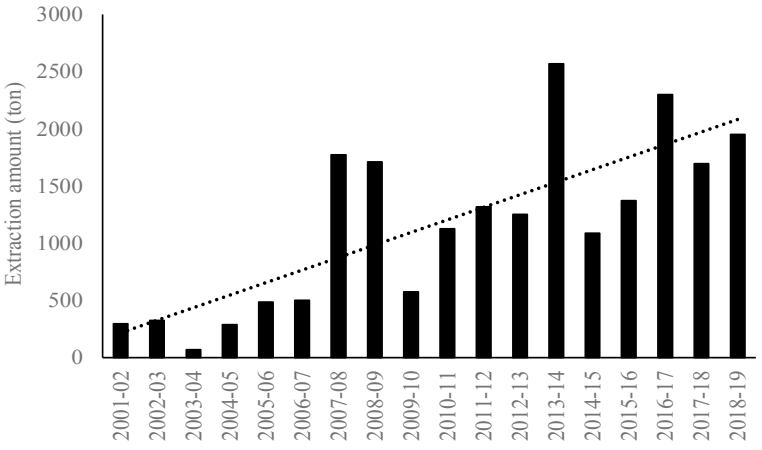


Fig. 5.5 Yearly (2001–02 to 2018–19) extraction of Crabs from the Sundarbans

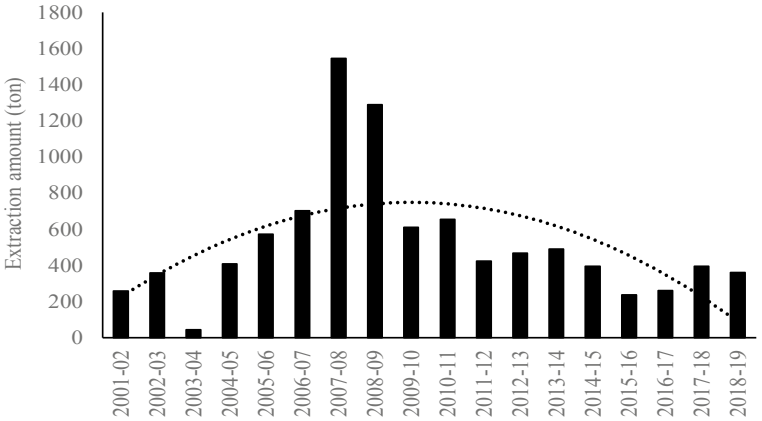


Fig. 5.6 Yearly (2001–02 to 2018–19) extraction of Shrimp from the Sundarbans

5.3.3.4 Shrimps

Twenty six (26) species of shrimps are generally available in the Sundarbans ecosystem. Of which, *P. monodon, P. indicus, Metapenaeus monoceros, M. brevicornis, Palaemon styliferus, Macrobrachium rosenbergii*, *M. villosimanus, M. dyanus, M. dolichodactylus* and *M. rude* are frequently occurs in the river system of the Sundarbans. Most of the shrimp species are locally consumed, but *P. monodon* and *M. rosenbergii* are mostly exported to foreign countries for their higher demand and value (Huq et al. 2001; Shah et al. 2010). Shrimps are caught by different gears, which are used for harvesting the bony and cartilaginous fish. But, rod and line are used to catch giant freshwater prawns (Shah et al. 2010). The annual harvested amount found to fluctuate considerably from 2001–02 to 2018–2019. However, the mean annual harvest and range were 534 ± 91 ton and 45 to 1545 ton respectively (BFD 2020b), and showed a polynomial trend for the last 18 years (Fig. 5.6).

5.3.3.5 Mollusks

Mollusks collection from the Sundarbans is an age old practice for the production of lime (Hunter 1875). The mollusk shells are mainly used for the production of lime for chew with Betel leaf, poultry, and fish meal; and the meats are used in shrimp farms as food. But very few quantities are consumed as food in Bangladesh (Shah et al. 2010; Habib et al. 2020). The peak collection season is November to February. BFD issues Boat License Certificate (BLC) to the collectors. The extracted amount of Mollusks found to decrease sharply with time from 1991–92 to 2016–17 with a logarithmic trend. Presently, BFD is not issuing the permit for Mollusk collection. However, the mean annual extraction is 1298 ± 284 tons with a range of 0 to 4363 tons for the said period (Fig. 5.7) (BFD 2020b).

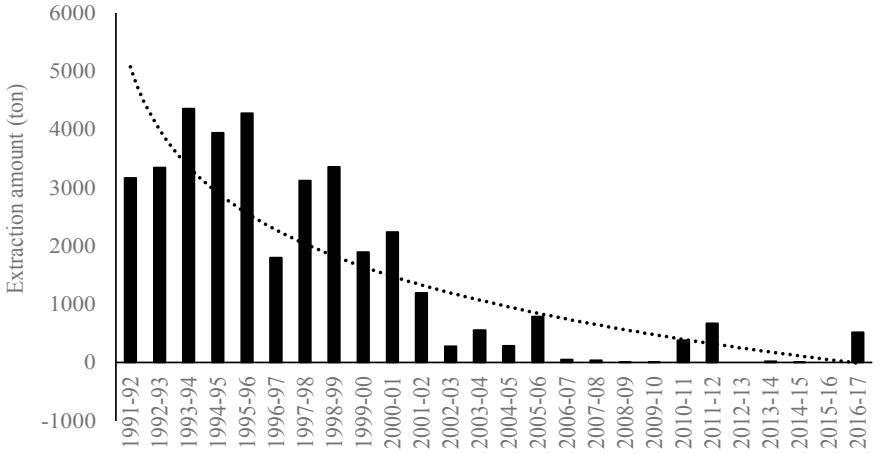


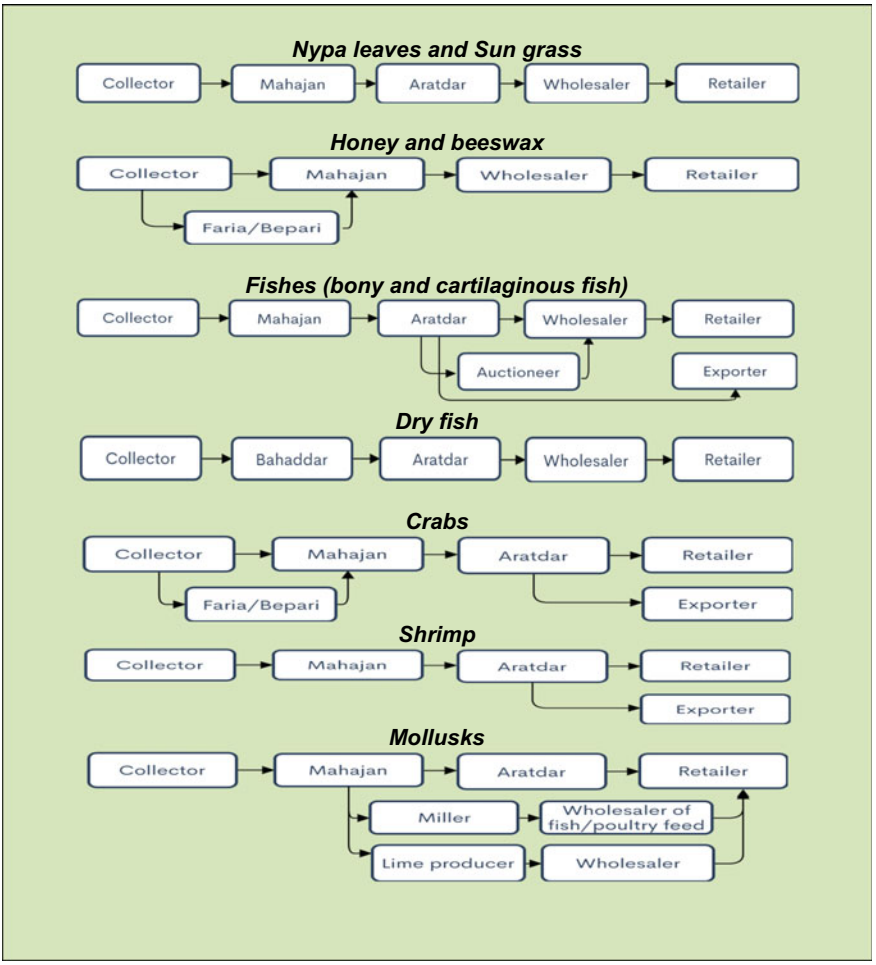
Fig. 5.7 Yearly (1991–92 to 2018–19) extraction of mollusk from the Sundarbans

5.4 Value Chain of NWFPs of the Sundarbans

The resources or products that are extracted commercially from the Sundarbans have to cross at least two and a maximum of five steps in between collectors to the retailers. The basic steps are Collector, *Mahajan, Aratdar*, Wholesaler, and Retailers are commonly involved. Sometimes *Majhi/Faria/Bepari*, *Bahaddar*, Auctioneer, Miller, and Exporters have also involved in certain resources/ products like carbs, large-sized shrimps, shrimp fry, hilsa shad (*Tenualosa ilisha*), mollusks. However, the value chain of some important resources has been presented in Box 4. Considerable value addition is observed in every step of the value chain. The percentages of value addition are varied with the extracted resources and steps involved. However, the maximum percentage of value addition is associated with the resource collector followed by Bepari or Mahajan. The maximum percentage (75%) of value addition at the collector level was observed for giant freshwater prawn and lower percentage (49.7%) was observed for *Nypa* leaf, and Bapari and Mahajon together contribute about 10.7–31.4% of value addition depending on the products (BFD 2010).

(*Majhi*: A boatman usually led a group of collectors; *Faria*: A petty trader with small capital and small volume, and usually, sell their product to Beparies; *Bepari*: Beparis are relatively more professional traders who buy a large quantity of the production from collectors or Farias, and sell directly or through Aratdars to wholesalers; *Mahajan*: Mahajans collect forest products commercially by engaging collectors with medium to high investment. They organize collectors, boats and boatmen, and control trips in overall resource collection; *Bahaddar*: They are the main entrepreneurs in dry fish who invest and manage the whole process of fishing. *Aratdars*: The Aratdars usually serve as the commission agents. They have their own fixed establishment in their market and operate among Mahajans, Farias, Beparis, and wholesalers.

Box 4: The basic steps in common value chain for the NWFPs of the Sundarbans



5.5 Revenue Earned from NWFPs of the Sundarbans

NWFPs of the Sundarbans are extracted based on BLC and permit system. Revenue from NWFPs extractions is earned from issuing BLCs, permits, personnel involved in resource collection, and the extracted amounts. The NWFPs like honey, beeswax, fishes, crabs, and mollusks are weighted at the revenue collection stations of the Sundarbans to get clearance upon the payment of royalty based on weight. However, the revenue rates of NWFPs have been revised with time as demanded. In

some cases, the royalty of certain items and sub-groups of NWFPs are found to identified and include over time. The latest revision of revenue rates was gazette in March 2011. In the last three decades, the revenue rates were revised during September 2003 and January 1986 (GoB 1986, 2003, 2011). The revenue of large sized *M. rosenbergii* and *P. monodon* is highest (294.12 UDS/ton), while revenue for *I. cylindrical* was lowest (0.35 USD/ton) among the NWFPs. The rates of revenue of certain NWFPs of the Sundarbans found to increase significantly especially for crabs and certain groups of fish species. The present and previous rates of royalty (USD/ton) of different NWFPs of the Sundarbans have been presented in Table 5.3.

Table 5.3 Revenue rates (USD per metric ton; 85.00 Bangladesh currency (85.00 = 1 USD) in last 30 years for the extraction of important non wood forest products from the Sundarbans

Resources	Revised on March 2011 (USD/ton)	Revised on September 2003 (USD/ton)	Revised on January 1986 (USD/ton)
Thatching materials			
Nypa fruricans	5.88	1.26	0.63
Imperata cylindrical	0.35	0.25	0.09
Honey and Beeswax			
Honey	88.24	63.04	9.46
Crude Beeswax	117.65	94.56	18.91
Refined Beeswax	235.29	189.12	63.04
Aquatic resources			
Tenualosa ilisha, *Pampas chiensis*, *Pangasius pangasius*, *Lates calcarifer*	141.18	94.56	15.76
Other bony fishes	37.65	25.22	9.46
Cartilaginous fish	44.12	-	-
Dry fish			
Pampas chiensis, and others commercially important fish	176.47	126.08	9.46
Other dry fish	58.82	31.52	9.46
Dry fish trash	2.35	1.26	-
Large sized *Macrobrachium rosenbergii* and *Penaeus monodon*	294.12	189.12	37.82
Small sized other shrimp	29.41	18.91	14.18
Crabs	44.12	0.32	-
Mollusks	2.12	1.58	0.16

Source (GoB 1986, 2003, 2011)

The yearly revenue earned from the NWFPs varied from 89.64 thousand USD to 532.47 thousand USD for the period of 2001–02 to 2018–19 (Fig. 5.8a). This variation in revenue earned is related to the extracted amounts of NWFPs and the revised royalty rate with time (Figs. 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7 and Table 5.3). The comparatively higher amount of revenue was earned from the aquatic resources of the Sundarbans, while the lowest was earned from honey and beeswax (Fig. 5.8a). However, the revenue earned from NWFPs contributes about 32 to 74% of the total revenue earned from the Sundarbans (Fig. 5.8b).

5.6 Management of NWFPs

The Sundarbans forest was divided into 55 compartments to ensure the effective management of the resources. These compartments are clearly demarcated by natural features like rivers, channels, and creeks. The whole management is goverened under two administrative division namely Sundarbans East and Sundarbans West Forest Divisions. A substatial numbers of forest stations (16) and petrol posts (the numbers of petrol posts found to vary depending on the demand and harvesting seasons of forest produces) have so far been established to heaeded by forester and forest guard respectively. The petrol posts are responsible for enforcing the relevant legislation against illegal activities, protecting resource collectors, and also monitor the permitted resource collectors in the remote areas of the Sundarbans. Pirates of the Sundarbans sometimes hostages the NWFPs collectors and demand ransom. However, the Forest Department is solely responsible for the management and protection of the Sundarbans. But, other law enforcement agencies such as Police, Coast Guard, Rapid Action Battalion, Border Guard, and Bangladesh Navy) also work with BFD to control the pirates in and around the Sundarbans. In recent time (2010), a paradigm shifts takes place in the context of Sundarbans management. Local forest dependent peoples are now getting involved in the management and protection of the Sundarbans under the collaborative efforts called co-management.

The management of NWFPs (only the *Nypa* leaves) of the Sundarbans was first noticed in the Working Plan for the period from 1931 to 1951 to ensure its' sustainable supply (Curtis 1933). This working plan was modified by Chowdhury for 1937–51 with the provision of the collection of Nypa leaves and fuel-wood (Pandit 2013). With time, others like thatching materials, honey, and beeswax, aquatic resources have come under management for the sustainable production. A set of management rules are employed for each category of NWFPs of the Sundarbans . Boat License Certificate (BLC) along with permits are issued by the Forest Department for the harvesting of the NWFPs from the Sundarbans. Every boat must have BLC before entering into the Sundarbans for the resource collection. BLC is issued for a single year at the beginning of the financial year (1st half of July) from the revenue stations of Sundarbans forest Divisions. The Revenue Officer inspects the boat capacity (in Quintal) and charge revenue for the boat as a prescribed rate of BLC. In addition to BLC, the resource collector also needs to pay revenue for the collected NWFPs on

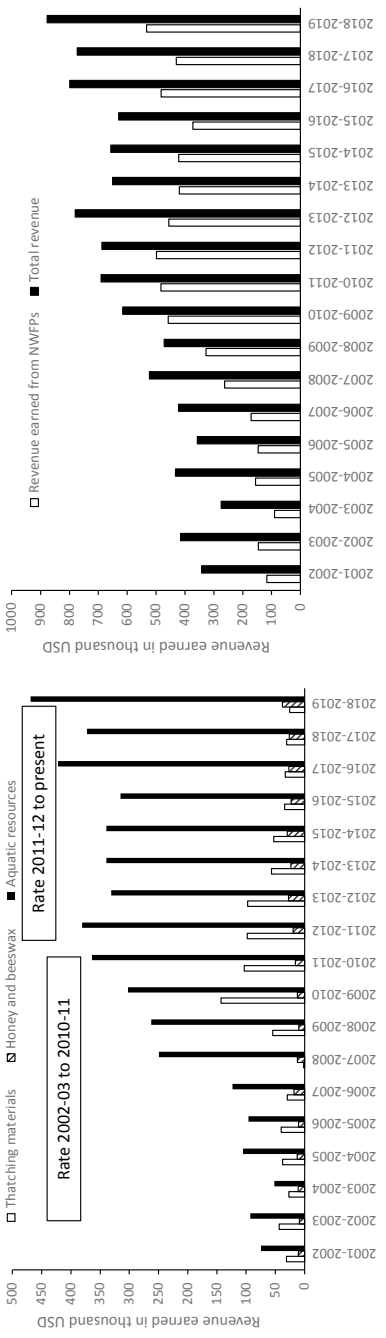


Fig. 5.8 Revenue earned from 2001–02 to 2018–19 **a** NTFPs (hatching material, honey and beeswax and aquatic resources), **b** Comparison of total and earned revenue from the NWFPs

a weight/number basis depending on the product types; and additional revenue has to pay for the overstay than the permitted (GoB 2011).

5.6.1 Management of Thatching Materials

The extraction of *Nypa leaves* is allowed in the non-growing season (November to March) and *I. cylindrical* before the flowering season (November–December). BFD issues permit based on BLC for the extraction of *Nypa* leaves and *I. cylindrical* for the identified annual coupes on first-cum-first serve basis. Harvesting of *Nypa* leaves from the wildlife sanctuaries is strictly prohibited. *Nypa* leaves are harvested on a three-year cycle. The central leaf and one supporting leaf have to remain during the harvesting for the sustainability of the clump. On the other hand, *I. cylindrical* are harvested annually at the ground level which facilitates regeneration. The total stocking and the prescribed Annual Allowable Cut (AAC) for *N. fruticans* in the Sundarbans were 113,887 ton and 64,300 ton respectively (Revilla et al. 1998). BFD monitors the harvesting operation throughout the harvesting season. The collectors need to get a clearance certificate from the BFD before leaving the forest. The Revenue Officer inspects the loaded boats and charges additional revenue for the extra loads and illicit felling of other forest produces (if any).

5.6.2 Management of Honey and Beeswax

Annual harvesting of honey and beeswax starts from 1st April and ends at 15th June (Baksha 2004; BFD 2010). The collectors need to pay advance revenue for one quintal of honey and crude beeswax to get the permit from BFD revenue stations (BFD 2010; GoB 2011). The honey collector needs to follow a set of prescribed rules for honey collection. The honey collectors have to use smoke instead of fire for driven away the bees from the hives, harvest only the portion that containing honey and one-third portion of the hive has to retain for the shelter of bees (Baksha 2004). Proper monitoring during the harvesting operation is not possible for the BFD field staff. But, the Revenue Officer weighs the harvested amount of honey and beeswax; and claim the revenue for the extra harvest before leaving the Sundarbans.

5.6.3 Management of Aquatic Resources

The inshore and offshore fishery are associated with the aquatic resource harvesting from the Sundarbans. The harvested produces from the offshore fishery dedicated only for the production of dry fish during the winter season. The inshore fishing is

permitted all over the Sundarbans except the sanctuary areas and the some designated protected canals as delineated as breeding and shelter ground (BFD 2010). Fishing of certain species is banned during their breeding seasons. Boat License Certificate (BLC) is issued to the fishermen for collecting fish from the Sundarbans. Each boat having BLC will get 8 permits in a year with a maximum of 3 permits in a month. Generally, 5–7 days are allowed for fishing under a permit (GoB 2011). BFD strictly monitors the fishing locations, use of destructive gears, and poison fishing inside the Sundarbans. The harvesters need to collect a clearance certificate from the BFD before leaving the forest at the end of the permitted time. The Revenue Officer inspects the boat, weighted the harvested aquatic resources, and claim revenue according to the prescribed rate for each category of aquatic resources as fixed by BFD (GoB 2011).

5.7 Conservation of NWFPs of the Sundarbans

In most cases, the conservation initiatives of NWFPs are related or linked with the overall biodiversity conservation efforts of the Sundarbans. The Sundarbans was declared as Ramsar site and a World Heritage Site during 1992 and 1997 respectively. Thus Sundarbans received much attention for conservation, which ultimately covers the protection of all the resources of the Sundarbans. At the same time, the Government of Bangladesh has increased the areas coverage of sanctuaries from 15 to 52% during 2017. It is hard to separate the conservation initiatives for the *Nypa fruticans* and harvesting of honey and beeswax from the overall biodiversity conservation of the Sundarbans. But, there are some initiatives and conservation prescriptions for the aquatic resources of the Sundarbans.

The conservation of thatching materials especially the *Nypa* leaves associated with the restricted feeling. Harvesting of *Nypa* leaves is strictly prohibited inside the sanctuary areas and harvesting also restricted during the growing season (April to September). The increase in sanctuary area coverage (52% of the total forest areas) not only restrict the felling of *Nypa* leaves but also restrict the collection of other NWFPs like honey and beeswax, and aquatic resources. The Health and hygiene of *Nypa* clump are important for leaf production for the upcoming years. Therefore, the leaf collectors are given the training to cut the *Nypa* leaf at a height of 22.5 cm from the ground level and to remove the dead or damaged leaf during harvesting (Zohora 2011). On the other hand, the use of smoke instead of fire to drive bees from the hives is recommended and encouraged for the honey collectors. Hand operated honey extractor machine are recommend instead of the traditional squeezing method of honey extraction (Baksha 2004).

Sundarbans is crisscrossed by numerous rivers and canals, which constitutes about one-third of this forest. This waterbody is rich in biodiversity and good habitat for fish and other aquatic animals. It acts as a shelter and nursery ground for numerous marine fauna. The mangrove forest and mudflats provide a crucial breeding ground for wide varieties of finfish, crustaceans, and mollusks (Shah et al. 2010; Mahmood 2015). However, the extracted amount of aquatic resources are

decreasing over time. Considering the decreasing trend, BFD has taken specific conservation initiatives for the fishey resources of the Sundarbans. Among the initiatives, BFD imposed ban on commercial fishing in the identified 18 creeks/canals of the Sundarbans during 1987–1994 to secure undisturbed breeding ground of different species of fish. In addition, a number of fishery resource conservation interventions are practicing in the Sundarbans like fishing ban inside the sanctuary areas, strict control on poison fishing, the seasonal ban on fishing of certain species, ban on specific species, ban on collection of post-larvae of shrimp, seasonal gear ban, prohibited gear, prohibited mesh, the limit of Boat License Certificate (BLC) and fishing permit, the limit of fishing duration under each permit (Shah et al. 2010). Regular patrolling throughout the forest is needed to ensures protection and act as an effective tool of monitoring as well as conservation of resources. In Sundarbans, Spatial Monitoring and Reporting Tool (SMART) has been started since 2011 under a development project "Sundarbans Environmental and Livelihoods Security (SEALS)", which is still continuing from the revenue budget of BFD (BFD 2020b). The suggested conservation initiatives for the aquatic resources of the Sundarbans made by the present Integrated Resource Management Plan for the Sundarbans 2010–2020 have been presented in Box 5 (BFD 2010).

Box 5: Suggested conservation guideline for the aquatic resources of the Sundarbans

- No fishing in the sanctuaries and identified 18 creeks/canals
- No fishing in the 1 km wide zone at the northern periphery of the sanctuary areas.
- Fishing ban in canals less than 8 m wide within 3 km area of BFD field offices throughout the Sundarbans.
- Periodic assessment of the aquatic resources need to conduct.
- Fishing ban in all canals during July–August and in beels (depressed areas inside the forest) during February-May.
- Seasonal ban of *Tenualosa ilisha* and Liza parsia net during September and October.
- Fishing of Pangasius pangasius and Lates calcarifer will be banned on each alternating year.
- Mollusks harvesting will be banned during March to October.
- Harvesting of Crab will be banned in January and February.
- No fishing of *Tenualosa ilisha* and Pangasius pangasius having <23 cm in size.
- Male and female crab having weight of 200 g and 120 g respectively and below are restricted for harvesting.
- Complete ban on set bag net, net jal or current jal and no dewatering for fishing.
- Fishing net with 15 mm mesh is prohibited.

- No use of poison or insecticide for fishing.
- Not more than 12,000Boat License Certificate (BLC) in the Sundarbans that will be equally distributed between the Sundarbans East and West Forest Divisions.
- Maximum 8 permits will be issued to the BLC holder in a year and not more than 3 times for a month.
- The maximum duration under a permit will be 7 days.
- The commercial extraction of mollusk will be allowed only in Sundarbans West Forest Division and ban on collection from March to October.

In addition, different livelihood supports are also provided to the resource collectors to reduce the pressure on NWFPs of the Sundarbans as conservation strategies. The dependent communities/collectors receive training and financial support based on their choice, experience, and willingness. Most of the common trades are crab farming, goat rearing, van, small business tea stall, cloth business, tailoring, etc. which believed to reduce the pressure on a collection of NWFPs of the Sundarbans significantly. These livelihood supports were operated by different projects like Sundarbans Biodiversity Conservation Projects (SBCP) (1999–2005), Integrated Protected Area Co-Management (IPAC) project (2008–2012), Sundarbans Environmental and Livelihoods Security (SEALS) Project (2011–2014), Climate-Resilient Ecosystem Livelihood Project (CREL) (2012–2018), Expanding the Protected Areas System to Incorporate Important Aquatic Ecosystems (2015–2020) (MEFCC 2019).

5.8 Community Dependency on NWFPs of the Sundarbans

About 4–27% of households of the Sundarbans Impact Zone (20 km from the boundary of the Sundarbans) depend on the Sundarbans for their livelihoods. The households' involvement in resource extraction found to vary with distance from the Sundarbans and resource types. Households situated within 0–10 km of the Sundarbans Impact Zone (SIZ) are largely involved in resource extraction, which is almost double compared to the households located within 10–20 km of SIZ (Fig. 5.9) (IUCN 2012).

The Sundarbans provide the livelihood for about 2.5 million people of Southwestern Bangladesh. A considerable population is involved with the resource extraction and others are linked with transportation and trading of the collected resources. Livelihood depending on the Sundarbans can be grouped broadly into thatch collector (Nypa leaf and thatching grass collectors), Mawali (honey and beeswax collectors), Jele (fisher, crab collectors), Chunery (mollusk collectors), Majhi (Boatman) (Sen and Ghorai 2019). Among the resource collectors, the highest about 35% are shrimp fry collectors followed by fisherfolk (33%), and honey collectors (22%). Comparatively less (1%) are involved in the collection of medicinal plants (Fig. 5.10) (IUCN

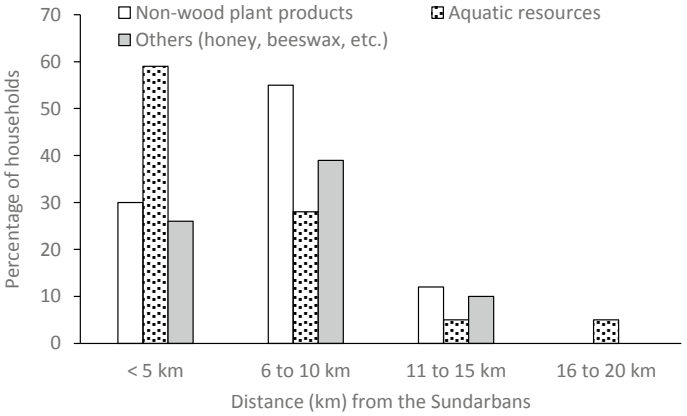


Fig. 5.9 Percentage of households involved in non-wood forest product extraction in relation to distance from the Sundarbans (*Sources* IUCN 2012)

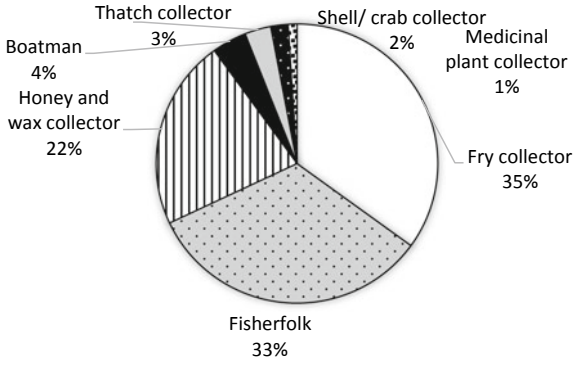


Fig. 5.10 Percentage of livelihood of the resource collectors of the Sundarbans (*Sources* IUCN 2012)

2012). However, these proportions of livelihoods of the dependent people are not constant, it changes with the availability, limit, or ban on extraction of the particular resources. Therefore, resource collectors do not rely on a single type of livelihood; the thatch collectors become honey collector from April to June, and fisher during the monsoon season; the rest of the months (about 6 months) they involved in other livelihoods like agriculture, aquaculture, small trades, day labour, etc. (Shah et al. 2010).

5.9 Issues and Concerns Related to NWFP of the Sundarbans

5.9.1 Over-Exploitation of Resources

The extraction of NWFPs is regulated by issuing boat license certificates (BLC) based on a database indicating the carrying capacity of the boat and the critical harvest limit for each resource. About 30% of unrecorded harvesting was identified by Revilla et al. (1998). Overharvesting of honey and beeswax are also reported. It is recommended to leave one-third of the hive for the bees, but honey collectors frequently collect whole hives and result in dislocation of bees (Baksha 2004). IUCN (2012) estimated about 3.5 times higher extraction of honey and beeswax than the official record. In the case of aquatic resources, monitoring and proper data recording of the harvested amount and scientific database on fish stocks are lacking. The increasing trend of the annual harvest of aquatic resource from the Sundarbans may indicate over-exploitation. Moreover, over-exploitation is thought to be related to the use of destructive fishing gear, fishing and crab collection during the ban season, post-larvae collection, and poison fishing which directly link to the destruction of resources bas (Shah et al. 2010; IUCN 2012).

5.9.2 Habitat Degradation

The Sundarbans is a dynamic mangrove ecosystem that is highly dependent on various environmental factors such as coastal physiography, elevation, climate, current and wave patterns, salinity, dissolved oxygen, soil, and nutrients (Siddiqi 2001; Mahmood et al. 2014). The Sundarbans is rich in both floral and faunal diversity than most other mangrove systems of the World (IUCN 1994; Iftekhar and Islam 2004; Hoque and Datta 2005). However, degraded habitats are also found in the Sundarbans with poor stock on the raised lands, depressions, and vacant canal and riverbanks (Siddiqi 2001; IUCN 2012). The floral and faunal diversity of the Sundarbans believed to relate to the habitat quality, which ultimately influences the production and extraction of NWFPs and other forest products (Siddiqi 2001). However, the habitat quality of the Sundarbans chiefly controls by the soil and water salinity level. The saline intrusion from the seawater and reduced flow of freshwater from the upstream are important factors that are responsible to increase the salinity of soil and water in the Sundarbans (Siddiqi 2001; Islam and Gnauck 2011). It is speculated that higher salinity in the Sundarbans ecosystem may significantly reduce the diversity and abundance of less salt-tolerant species of flora and aquatic resources in the future (Shah et al. 2010; Mahmood et al. 2014).

Pollution from domestic and urban areas, rapid industrialization around the Sundarbans, increased use of agrochemicals in the nearby agricultural fields, large scale aquaculture, mass tourism, increased movement of sea-going vessels, oil spills,

bilge, and ballast water also cause degradation of habitat (Rahman et al. 2009; Begum et al. 2015). Pollution from tourism (e.g. oil and fuel spills from boats and noise) has increased during the last two decades as the Sundarbans has become a more popular destination may cause deterioration of the habitat (Begum et al. 2015). The pollution level has a direct link with the aquatic resources in terms of lower habitat quality which may result in significant loss of aquatic diversity in the Sundarbans.

5.9.3 Influence of Extreme Weather Events on NWFPs

The funnel-shaped Bay of Bengal is the breeding ground for tropical cyclones. Seventy five (75) tropical cyclones and tidal surges have hit the coastal areas of Bangladesh since records began in 1584 and up to the end of 2020. During 2000–2020, five tropical cyclones (Sidr 2007; Rashmi 2008; Aila 2009; Bulbul 2019; Amphan 2020) affected the Sundarbans. The number of Distant Cautionary Signal No. III; (The port is threatened by squally/stormy weather) has increased steadily between 1995 and 2015 (Fig. 5.11). The mangroves are highly resilient against such cyclones, but still suffer consequential effects on vegetation composition, sediment accretion, erosion pattern, and hydrological system. It is estimated that almost 25 years are needed for vegetation structure to recover from each storm (Islam 2008). But, given the frequency of cyclones, the Sundarbans has had little time to recover. This dynamic nature of the mangrove ecosystem, as affected by cyclones and tidal surges, needs to be considered for the future management and conservation of the area. The extreme weather events significantly influence the stocking and extraction of NWFPs from the Sundarbans.

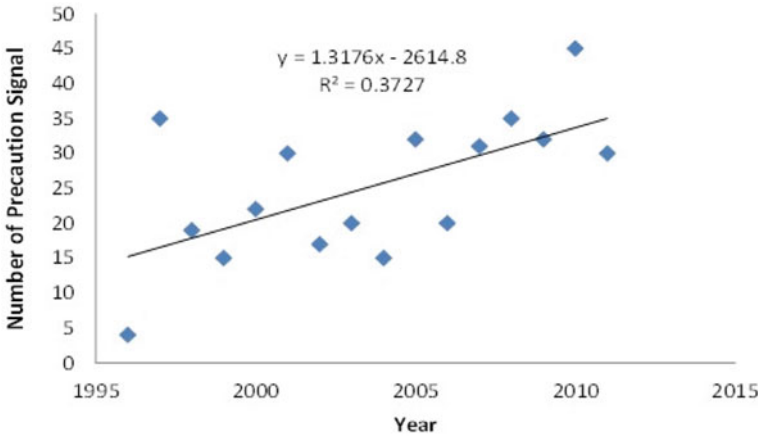


Fig. 5.11 Yearly number of distant cautionary signal No. III (1995–2015) (*Source* Khulna weather office)

5.10 Conclusion and Recommendation

The Sundarbans mangrove forest of Bangladesh provides an array of Non-wood forest products (NWFPs). Mostly the vicinity poor people are engaging in the collection of NWFPs from the Sundarbans for their daily consumption and livelihood for a long time. The extracted amount of some NWFPs found to decrease and the collection of some NWFPs has increased in recent times. Especially the extraction of thatching materials has decreased considerably due to availability, durability, and low price of the corrugated iron sheet (suitable substitute of the thatching materials). Similarly, production of lime from mollusk has decreased due to its' low market demand. In another way, the extractions of honey, beeswax, dry fish, and crabs have increased significantly due to its high market demand. The extracted carbs are mainly exported to foreign countries. In conclusion, the harvested amount of NWFPs depends on the resource base and market demand. The sustainable supply of NWFPs from the Sundarbans is obvious for the livelihood of the local population. Overexploitation of NWFPs eventually reduces the resource base for sustainable supply as well as may influence the loss of biodiversity. Assessing and identifying the resource base and potential threats of respective NWFPs of the Sundarbans; strict monitoring of the harvesting activities at the field level; modernization of record-keeping for the extracted amount of resources; proper implementation of management prescriptions for the NWFPs at the field are prime importance for the sustainable management of the valuable NWFPs of the Sundarbans.

Appendix 1: Medicinal properties of the most common mangrove plant species of the Sundarbans

Species	Medicinal uses
Acanthus ilicifolius	Leaves, fruits and seeds are used to treat cough, asthma, indigestion, rheumatism, neuralgia, internal worms, burns, snakebite (Giesen et al. 2006). Stem and root have anti-cancer properties, and can treat chronic fever (DeFilipps and Krupnick 2018). The whole plant is boiled in water, and the extracted decoction can be consumed to remove kidney stones (Ravindran et al. 2005)
Acrostichum aureum	Rhizome, young and mature fronts have medicinal properties that can cure the fever, constipation, aches, pain, malnutrition, cooling the body and diabetic (Giesen et al. 2006; Mahmood 2015)
Aegiceras corniculatum	Leaf extract/ decoction has an effect on chronic inflammatory diseases due to rheumatism and enhance the cellular immune responses (Roome et al. 2014). Fruit extract can be used to treat diarrhea (Hosen et al. 2021)
Aglaia cucullata	Leaves are used to treat inflammation and *seeds for* rheumatism (DeFilipps and Krupnick 2018)

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Species	Medicinal uses
Avicennia alba	Seed paste used as ointment to treat skin diseases and wounds (Giesen et al. 2006, Mahmood 2015, DeFilipps and Krupnick 2018)
Avicennia marina	Leaves are used to treat burns (Giesen et al. 2006; Mahmood 2015)
Avicennia officinalis	*Roots have* aphrodisiac properties and seeds are used to treat soreness and inflammation (Giesen et al. 2006; Mahmood 2015; DeFilipps and Krupnick 2018)
Brownlowia tersa	Leaf extract has anti-inflammatory properties and roots have antibacterial properties. Traditionally, it is used to treat diarrhea, dysentery, wounds and boils (Mannan et al. 2019)
Bruguiera gymnorrhiza	The bark is used as an abortifacient, and treating for burns, diarrhea, fever and malaria. The fruits have antiviral properties (Allen and Duke 2006)
Bruguiera sexangula	Leaf and roots are used to treat burns. Bark extracts has anti-cancerous properties. Fruits are used to treat *Shingles* (a viral infection that causes a painful rash) (Giesen et al. 2006)
Cerbera manghas	The seed extract is used to treat scabies and itch and ingredient of hair tonic. The bark is used as a laxative, and to treat fever, painful or difficult urination, and ringworm. The flowers are used to treat hemorrhoids (Islam and Ahmed 2017)
Ceriops decandra	The bark has antiseptic properties and used to treat malaria (Mahmood 2015). Leaf decoction is used to stop hemorrhage (Ray 2014)
Clerodendrum inerme	Seeds and roots are used to treat poisoning effect caused by fish and other marine organisms. Leaf extract is used to treat wounds and fruit extract to treat dysentery (MPBD 2012; Giesen et al. 2006)
Crinum viviparum	Leaf extract has antibacterial properties, which is used to treat foot sores. The paste of bulb is applied externally to treat boils and skin allergy (Sharma et al. 2013)
Cynometra ramiflora	The leaves and seeds have anti-herpetic properties. Honeyed lotion can be made from leaves and seed oil. It boiled with milk and applied to treat scabies, leprosy, and other skin lesions (Haryoto et al. 2013)
Dalbergia spinosa	Leaves and stem bark are applied to treat fever and to control internal parasite (Naskar 2004). Root extracts have antimicrobial activity (Senthamarai et al. 2003)
Derris scandens	Dry stem powder and ethanolic extract are used to treat musculoskeletal pain (Puttaraka et al. 2016). Stem extract has also anti-biotic properties (Sittiwet and Puangpronpitag 2009)
Derris trifoliata	Leaf extract has strong antibacterial properties (Suganya and Thangaraj 2014). It is used as a stimulant, antispasmodic and counter-irritant, and against rheumatism, chronic paralysis. Concentrated extract of the roots is used to treat fever and sores (Behera et al. 2006)

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Species	Medicinal uses
Excoecaria agallocha	Plant parts have anti-microbial, anti-cancer and anti-diabetic agent (Kaliamurthi and Selvaraj 2016). Bark is used to treat severe constipation. The root is used as an abortifacient. The root is crushed with ginger and used as an embrocation to reduce swellings. Oil extracted by distillation of the wood or latex is applied to skin diseases (de Padua et al. 1999). The latex is used as a caustic for removing obstinate ulcers. It has vomiting and strongly laxative effect. Small amount of latex are taken orally with coconut juice to treat pneumonia or asthma (de Padua et al. 1999, WHO-Regional Office for the Western Pacific 2009a, b)
Excoecaria indica	Leaf extract has anti-nociceptive properties. Milky juice of leaves is used to treat irritating pain from the fish sting (Ahmed et al. 2007). Leaves are used to cure fever and gonorrhea. Decoction of the root bark is used as purgative and emetic (de Padua et al. 1999)
Flagellaria indica	A decoction of the leaves is drunk to treat asthma, wound, shortness of breath and fevers. The fresh stalk is chopped into small pieces in water and the leached extract is drunk to get relief from stomachaches, dysentery and diarrhea (Kulip 1997, WHO-Regional Office for the Western Pacific 1998, 2009a, b). The root is boiled and the infusion is used as health tonic (de Padua et al. 1999; Kulip et al. 2012). The plant is used as a contraceptive, and the stem is eaten to cause sterility (WHO-Regional Office for the Western Pacific 2009a; b). The whole plant is boiled and the boiled water is used for bathe of the semi-paralytic patent (Kulip 1997)
Heritiera fomes	Different parts of this species have been using as folk medicine to treat diabetes, hepatic disorders, gastrointestinal disorders, goiter, and skin diseases. Leaf decoction is used to stop haemorrhage. A number of investigations indicated that the plant possesses significant antioxidant, antinociceptive, antihyperglycemic, antimicrobial, and anticancer activities (Mahmud et al. 2014; Ray 2014)
Hibiscus tiliaceus	Different parts of this plant are used to treat fever, coughs and dry throat, ear infections, chest congestion, diarrhea, dysentery and typhoid (Giesen et al. 2006, Shaikh et al. 2011). Leaves are wrapped around fractured bones, sprained muscles, skin disease and leaves juice is used to treat gonorrhoea. Bark extract is used to promote menstruation, and to treat skin diseases, eye infections and injuries, and stomachaches. The flowers paste is used to treat sores, cuts, boils and swellings (WHO-Regional Office for the Western Pacific 1998)
Kandelia candel	Bark and leaf is used to treat diabetes (Ray 2014, Sachithanandam et al. 2019)
Lumnitzera racemose	Plant parts are used to treat, herpes, asthma, snakebite and skin disease. They have antifertility, antidiabetic, antibacterial, hepatoprotective and cytotoxic activities (Bandarnayake 1998; D'souza et al. 2010; Ravikumar and Gnanadesigan 2011; Ray 2014; Thao et al. 2014; Jadhav et al. 2019)

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Species	Medicinal uses
Nypa fruticans	Plant parts (young shoots, decayed wood, and the burned roots and leaves) are also used as traditional medicine to treat headaches, toothaches, ulcers, herpes and bites of centipedes (Burkill 1966). Juice from the fruits is used as a digestive agent and to cure stomach infection (Ray 2014)
Pandanus foetidus	Leaves extract is used to treat leprosy, small pox, syphilis, scabies besides heart, brain diseases and diabetes (Yusuf et al. 1994; Joshi 2000). Methanol extract of leaves work on central nervous system (Uddin et al. 2004)
Phoenix paludosa	Plant parts are used to treat fever and anti-inflammation. It has analgesic, antidiarrheal (Saha et al. 2012), and cytotoxic properties (Samarakoon et al. 2016)
Pongamia pinnata	The juice of leaves is used to treat itches, diarrhea, leprosy, herpes and gonorrhea. Leaf decoction used to treat bronchitis, whooping cough. While, young shoots are used to treat muscular and articular rheumatism. Seed oil is used to treat itches and other skin diseases. Flowers are prescribed for diabetes (Giesen et al. 2006; Ghumare et al. 2014)
Rhizophora apiculate	Leaves have inhibitory properties of pathogens and used to treat dysentery and stomach disorder (Onrizal 2010). Root extract is used to treat diarrhea, skin diseases (Pattanaik et al. 2008; Bibi et al. 2019)
Rhizophora mucronata	Plant parts have medicinal properties and used to treat diarrhea, constipation, nausea, elephantiasis angina, haemorrhage, hematuria, and interestingly hematuria, and menstruation disorders (Bibi et al. 2019). Dust of stem bark is used to cure diabetes and to stop haemorrhage (Ray 2014). The mature leaves and roots are used to treat ulcers, diarrhea, fever, burns, and stings of poisonous fish (Ray 2014; Bibi et al. 2019)
Sarcolobus globosus	Traditionally, the plant is used as a relief for rheumatism, dengue and fever (Wangensteen et al. 2005)
Sonneratia apetala	Leaf decoction is used to treat sores, haemorrhage, hepatitis and fruits are used to prevent in diarrhea (Bandaranayake 1998; Ray 2014)
Sonneratia caseolaris	Fruits and leaves are used to treat haemorrhage, piles, sprain poultices (Bandaranayake 1998, 2002). Fruit extract can be used to treat diarrhea (Hosen et al. 2021)
Tamarix indica	Plant parts are used to treat piles, sore throat, ulcers, diarrhea and dysentery. The plant finds its use in infectious diseases, which include skin disease, leukoderma, leucorrhoea and eye disease (Bahramsoltani et al. 2020)
Xylocarpus granatum	Seed oil is used for grooming hair. Plant parts are used to treat cholera, diarrhea, elephantiasis, inflammation, pain, swelling of breasts, fever, malaria, dyslipidemia, hyperglycemia and insect bite (Ravindran et al. 2005; Giesen et al. 2006; Das et al. 2014; Rout and Basak 2014)
Xylocarpus moluccensis	Plant parts are used to treat intestinal problem, aphrodisiac, fever, malaria, (Bandaranayake 1998; Giesen et al. 2006)

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Chapter 6
Role of Non-wood Forest Products in Bhutan's Quest for Gross National Happiness: An Overview

Tshering Dorji

Abstract Bhutan has a very unique and environment-friendly developmental philosophy called Gross National Happiness (GNH) comprised of four pillars, namely good governance, equitable socio-economic development; preservation and promotion of culture and, environmental conservation. Although non-wood forest products (NWFPs) are considered integral parts of people's culture and sustenance in developing countries like Bhutan, there are no literatures that assess the role of non-wood forest products in Bhutan's quest for GNH. This chapter explores the existing literatures on GNH and NWPFs of Bhutan in order to provide an overview of the roles NWFPs can play in persuading Bhutan's quest for GNH. Besides, the chapter bridges the GNH concept and the broad theme of the book.

Keywords Bhutan · Development philosophy · GNH · Environment

6.1 Introduction

Bhutan is a small South Asian country (World Bank 2019) with total surface area of 38,394 km^2 and projected total population of 748,931 for the year 2020 (National Statistics Bureau (NBS) 2020). It is bounded by China's Tibet Autonomous Region on the North, the Indian state of Sikkim on the West, the Indian state of West Bengal on South-West, the Indian State of Assam on the South–East, and the Indian state of Arunachal Pradesh on the East (Dorji 2020) (Fig. 6.1). Topographically Bhutan is a mountainous country with wide elevation range that spans from about 130 m in the foothills to over 7500 m above sea level along the main ridge of the Himalayas just within a distance of 170 km (World Bank 2019). This topographical variation has endowed Bhutan with rich biodiversity (Yangzom et al. 2008; World Bank 2019). The small population along with conservation-oriented development approach has maintained almost intact this biodiversity (Meijboom 2008; Dorji et al. 2019; World bank 2019).

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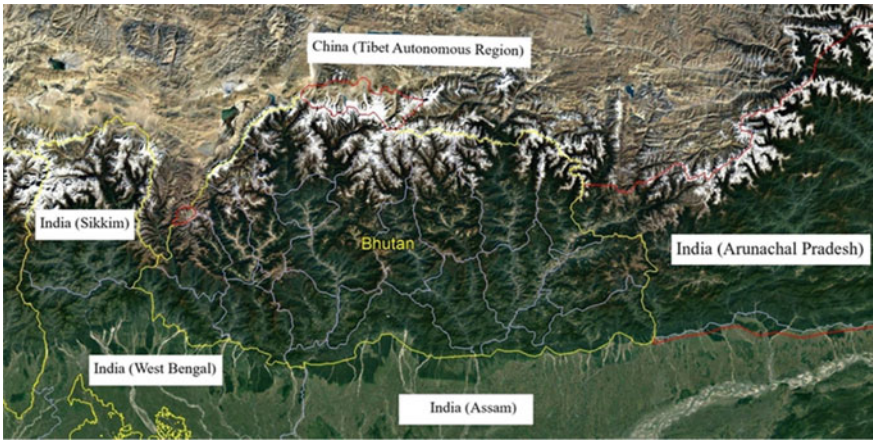

Fig. 6.1 Bhutan and its neighbours. Indian state of Sikkim to west, Indian state of West Bengal to south–west, Indian state of Assam to south–east, and Tibet Autonomous Region of China the entire north. (Image adopted from Google Earth @ 2020 Google)

Sixty-nine percent of Bhutan's population still lives in rural areas and practice subsistence farming (Peldon 2017). Bhutanese people have been depending on forest, and specially on non-wood forest products (NWFPs) from the time immemorial (Yangzom et al. 2008). But the role of NWFPs to the rural household had been taken for granted (FAO 1996) and not assessed adequately (FAO 1996; Peldon 2017). However, in recent times NWFPs are recognized as important component of sustainable socio-economic development (Meijboom 2008; Yangzom et al. 2008; Peldon 2017) including their potential for commercialization (Peldon 2017). With this there is also the danger of over exploitation of the resources (FAO 1996; Peldon 2017). For instance, illegal harvesting of NWPFs is recognized as one of the important conservation challenges in Phrumsengla National Park (Choden 2016).

6.2 A Brief Description of the NWFPs of Bhutan and their Significance

Forest and Nature Conservation Rules 2006 defines 'NWFPs as that constituting resin, varnish, *katha*, *kutch*, plants, flowers, seeds, bamboo, bulbs, roots, fruits, leaves, barks, grasses, creepers, reeds, orchids, cane, fungi, moss, medicinal plants, herbs, leaf-mould, or other vegetative growth, whether alive or dead; wild animals (including fish) and parts or products of wild animals, including the skin, hide, feather, fur, horn, antler, tusk, bone, bile, musk, honey, wax and lac, insect; and boulders, stone, sand, gravel, rocks, peat and soil' (Royal Government of Bhutan (RGOB) 2006; Meijboom 2008). Whereas, the consultant report on developing a national strategy for NWFP development in Bhutan (Tobgay 2008) defines NWFPs as 'goods of biological origin

other than wood, derived from natural forests. In addition, it would also constitute fish found in natural waters within the geographical boundaries of the country.'

Bhutan is considered rich in NWFPs. Already more than 600 medicinal plants, 97 mushrooms, 97 fruits and nuts, 34 bamboos, 14 canes, 25 oil/resin species, 20 spices, 38 fibers, 70 ornamental plants, 181 fodder species, 36 dyes, 12 food crops (yams) and 77 forest vegetables are identified and described (Yangzom et al. 2008). However, there are a substantial numbers of species which are still unidentified and their scientific names are also unknown. This lack of scientific knowledge on NWFPs among the people working within the Department of Forest and Park Services (DoFPS) in the past had led to the practice of NWFP resources protection over their sustainable utilization and management (Peldon 2017). However, since the adoption of National Strategy for the Development of Non-Wood Forest Products 2008–2018 there has been rapid formation of NWFP management groups across the country with 130 such groups reported in 2017 (Peldon 2017). World Bank (2019) mentions formation of 148 Non-timber forest product groups. This development was also facilitated by the release of guidelines for sustainable harvesting of selected and important NWFPs species, and also the inclusion of rules and regulation for NWFP group formation within Forest and Nature Conservation Rules and Regulations of Bhutan, 2017 (FNCRR 2017) (Peldon 2017).

NWFPs have been traditionally used as safety net during times of food shortage (Peldon 2017) and as important off-farm activities (Yangzom et al. 2008). In recent times income generated from the sale of some selected NWFPs has begun to form the ultimate source of rural household income (Peldon et al. 2017; World Bank 2019). Some notable NWFPs species that are marketed in huge quantities are Chinese caterpillar fungus (*Ophiocordyceps chinensis*), Matsutake mushroom (*Tricholoma matsutake*), Lemon grass (*Cymbopogon flexuosus*), Chirata (*Swertia chirayita*), Pipla species (*Piper pedicellatum* and *Piper longum*), and Rubia (*Rubia cordifolia*) (Peldon 2017). Cane and bamboo species are also important NWFPs used for various purposes (e.g., fencing, scaffolding, house construction, product development etc.) (Peldon 2017).

6.3 The Knowledge Gap, Purpose and Importance of the Chapter

Bhutan's unique development philosophy of GNH links culture, society, economy and environment (Meijboom 2008; Sears et al. 2017). NWFPs along with other natural resources from forest drive the country's economy (Sears et al. 2017). Besides, various NWFPs in the form of medicinal plants (Wangchuk and Tobgay 2015) along with many other products developed from various NWFP species (Peldon 2017) are part of Bhutan's living culture and tradition. However, there are no literatures linking the role of NWFPs to that of GNH except for the role of medicinal plants to GNH by Wangchuk and Tobgay (2015). This work reviews pertinent literatures on both

NWFPs and GNH philosophy, and try to present plausible links between the two in order to provide an overview of the role NWFPs play/can play in Bhutan's pursue of GNH. Given GNH is a wholistic approach to development (Ura et al. 2012, Sears et al. 2017) this chapter provides an alternative perspective on NWFP utilization, conservation and management from that of other Asian countries.

6.3.1 Overview of GNH Philosophy

The Fourth King of Bhutan declared 'Gross National Happiness is more important than Gross National Product' in 1972 (Ura et al. 2012), and ever since the country's national policy and development plans were oriented towards GNH (Meijboom 2008, Ura et al. 2012). The widely used definition for GNH is "Gross National Happiness measures the quality of a country in more holistic way [than GNP] and believes that the beneficial development of human society takes place when material and spiritual development occurs side by side to complement and reinforce each other" (Ura et al. 2012). The 10th Five Year Plan of Bhutan formalized the GNH concept and defined four strategic areas called as four pillars of GNH (Ura et al. 2012). They are: 1. Sustainable and equitable economic development; 2. Environmental conservation; 3. Preservation and promotion of culture; and 4. Good governance (Meijboom 2008, Ura et al. 2012).

Currently in order to better articulate the elements of GNH it is further elaborated into nine domains comprised of psychological wellbeing, health, time use, education, cultural diversity and resilience, good governance, community vitality, ecological diversity and resilience, and living standards (Ura et al. 2012). Based on these nine domains a GNH index comprised of 33 indictors (Fig. 6.2) have been developed and used to assess the GNH level of the Bhutanese (Ura et al. 2012). The findings from the GNH surveys are used by the Bhutan Government to formulate their five yearly development plans (Ura et al. 2012).

6.3.2 Overview of Literature on NWFP

The literatures on NWFPs of Bhutan are poor and scattered. There are a very few peer-reviewed journal articles that directly deal with either broad theme of NWFP or specific NWFP species (e.g. Moktan et al. 2007, Tamang 2007, Cannon et al. 2009, Wangchuk and Tobgay 2015) or conference papers (e.g. Meijboom 2008, Peldon 2017). Likewise, there are also very few news reports by the national newspapers (e.g. Wangdi 2016, Cheki 2017, Yonten 2019). However, the official documents like guidelines for harvesting selected NWFP species, legal documents like National Strategy for the Development of Non-Wood Forest Products 2008–2018 (see Peldon 2017) and FNCRR 2017, and reports (e.g. Meijboom et al. 2010) are comparatively more than other literatures. But these literatures are mainly focused on some of the

Fig. 6.2 The nine domains and 33 indicators of the GNH index (after Ura et al. 2012)

prominent NWFP species like Chinese caterpillar fungus (e.g. Cannon et al. 2009, Yonten 2019), Shitake mushroom (Wangdi 2016), lemon grass (Yangzom et al. 2008), medicinal plants (e.g. Wangchuk and Tobgay 2015, Wangchuk, Yeshi and Jamphel 2017), and bamboo and cane products (FAO 1996, Moktan et al. 2007, Dorji and Namgyel 2018).

6.3.3 Role of NWFPs in GNH

Sears et al. (2017) have linked four categories of forest ecosystem services with the four pillars of GNH in their assessment of the relationship between forest ecosystem services and GNH. Whereas, Wangchuk and Tobgay (2015) identified five pillars of medicinal plants that contribute to GNH in order to assess the role of medicinal plants in achieving GNH. Both the studies found forest ecosystem and medicinal plants provided different avenues for achieving different pillars of GNH philosophy (Wangchuk and Tobgay 2015, Sears et al. 2017).

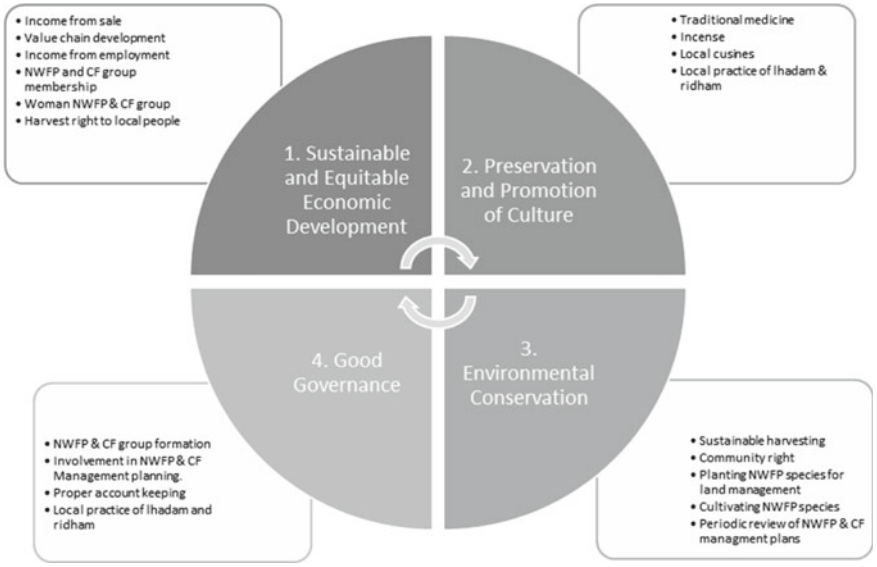

Fig. 6.3 Four pillars of gross national happiness and key activities associated with NWFP that contributes to the pillars

This chapter, following Wangchuk and Tobgay (2015) and Sears et al. (2017), identifies the roles NWFP plays in achieving Bhutan's GNH objectives. I identify different components of NWFP life cycle from harvesting to sell and/or use of NWFP produce/product along with management practices and value chain development activities against the four pillars of GNH. I identify the roles using the available literatures on NWFP and GNH in Bhutan, and provide brief overview against each pillar of GNH below along with key findings in Fig. 6.3.

6.3.3.1 Sustainable and Equitable Economic Development

Given poverty is mainly a rural phenomenon in Bhutan (National Statistics Bureau 2020) NWFP can play important role in sustainable and equitable economic development. NWFP has been directly linked to reduction in rural poverty (e.g. Namgyel 2005, Cannon et al. 2009) or their potential to do so is recognized in Bhutan (Yangzom et al. 2008, Gross National Happiness Commission 2009, Meijboom et al. 2010). Further, harvesting right vested only to the households legally living within the given locality where the NWFPs are found like that of Chinese caterpillar fungus (DoFPS, 2018) has helped improve the livelihood of people living in remote areas (Yangzom et al. 2008, Cannon et al. 2009, Tempel and Beukeboom 2007).

6.3.3.2 Environmental Conservation

GNH philosophy of development in Bhutan has always aimed for conservation of nature (Sears et al. 2017). Likewise, the Department of Forest and Park Service, the nodal agency for conservation, have always approached NWFP utilization with caution (Meijboom 2008, Peldon 2017). NWFPs group formation with appropriate harvesting guideline for high-value species and right to harvest vested on local residents have enhanced NWFPs conservation through sustainable utilization of NWFPs (Peldon 2017). Some NWFPs species like broom grass is also utilized for soil management (CSO Grant Facility Bhutan 2018). Further, harvesting guidelines have been updated constantly for important NWFPs like Chinese caterpillar fungus over the year (Dorji et al. 2019). It is also mandatory to review the performance of community forestry (CF) and NWFP management group after every ten years in order to decide on the continuity of the groups (Peldon 2017).

On the other hand, there has been concern about issue of litter in the alpine meadows due to Chinese caterpillar harvesting (Wangchuk, Norbu and Sherub 2012). In order to tackle this issue Bumthang Territorial Forest Division made it mandatory for every Chinese caterpillar collector to bring back 5 kgs of non-biodegradable waste from the campsites (Kipchu 2020). Besides sustainably harvesting NWFPs, the Community Forestry (CF) and NWFPs management groups also carry out plantation of harvested species (CSO Grant Facility Bhutan 2018). However, for many low-value NWFP species their sustainability is unassessed and no harvesting guidelines are available (Peldon 2017). Further, there is no management intervention for wild edible insect species other than the national rule that prohibits harvesting (Tshering 2015).

6.3.3.3 Preservation and Promotion of Culture

Bhutan has long history of traditional medicine system called *sgo-ba rigpa*, and it is one very important component of Bhutanese culture (Krug and Milliken 2008, Wangchuk et al. 2017). Bhutanese traditional medicine system uses plant materials as bulk medicine (Wangchuk et al. 2017). The medicinal herbs harvested by local communities not only help them earn income but also help preserve traditional medicine system by supplying the ingredients required (Wangchuk et al. 2017). In fact, annual harvesting of medicinal plants in Lingshi was allowed to promote Bhutanese traditional medicine which was integrated into national health system (Krug and Milliken 2008).

Besides the use of herbs as medicine, Bhutanese people also burn numerous herbs and leaves directly as incense or are used as ingredients to manufacture incense sticks (Meijboom et al. 2008, Urwin 2021). While household use can preserve religious practice locally, the sale of Bhutanese incense sticks in the international market can promote Bhutanese culture worldwide (Urwin 2021). Also, recently initiated festivities to market NWFPs like Shitake mushroom through Ura Shitake Mushroom Festival can not only help collectors earn higher prices but also promote culture and

local cuisines (Gyeltshen 2017). The use of edible wild plants is an age old tradition of Bhutan (Matsushima, Minama and Nemoto 2012). On the other hand, income generated from harvesting of Chinese caterpillar fungus among the highland communities has made yak herding less appealing livelihood option to younger generations (Wangchuk and Wangdi 2015).

6.3.3.4 Good Governance

Good governance is one of the four pillars of GNH, and it is also one of the nine domains of GNH aimed to enhance wellbeing of the Bhutanese people (Ura et al. 2012). The common dimensions of governance are participation, rule of law, transparency, accountability, effective delivery of services and equity (Ura 2012). NWFP and community forest group formations promote grassroot level decision making, transparency, accountability and equity among the members (Namgyel 2005) thus promoting good governance.

6.4 An Alternative Perspective on NWFPs

This chapter used wholistic approach in studying the role of NWFPs in Bhutan, unlike other literatures that focus directly on one or more components of NWFP or specific species or groups. For example, most literatures focus on poverty reduction and/or conservation (e.g. Temphel and Beukeboom 2007, Cannon et al. 2009, Wangchuk et al. 2012, Wangchuk and Tobgay 2015), commercialization (e.g. Namgyel 2005, Yangzom et al. 2008, Peldon 2017) and medicinal plants (e.g. Wangchuk et al. 2017). Cursory look into regional (e.g. IUCN 2008, Durst et al. 2010, Gurung 2017, Hooping, Chignell, and Lambin 2018) and international (e.g. Muimba-Kankolongo et al. 2015, Meinhold and Darr 2019) literatures also show similar trends. The literature review revealed the knowledge gaps for most of the NWFP species in Bhutan (though not the focus of the chapter). The negative consequences that could result from use of NWFPs for economic and social benefit without thorough knowledge on the status of NWFP species has been prevented due to conservation oriented GNH philosophy of development (Meijboom 2008, Matsushima et al. 2012).

6.5 Conclusion

The chapter provides overview of the role of NWFP in fulfilling Bhutan's quest for GNH guided development. I find many avenues through which NWFP can contribute to the four pillars of GNH philosophy. However, there are also negative impacts of NWFP development to achieving GNH in Bhutan. The use of holistic approach like assessing the role of NWFPs in other countries through the framework of GNH could

also help mainstream NWFP development. The literatures revealed the focus was mainly on high-value NWFP species and lacked knowledge on low-value species. However, there is need for thorough review of literatures to ascertain to what level my findings are true given the focus was only to provide an overview.

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Chapter 7
Enhancing Sustainability and Productivity of Bamboo in the Philippines: Some Initiatives

Ramon A. Razal

Abstract Bamboos are the most widely known non-wood forest product (NWFP) of the Philippines, being ubiquitous and the most highly urban of them all. It has also received the greatest attention from government in the last two decades, with at least three top government agencies advocating the resource to promote community livelihood and environmental protection. Institutional arrangement i.e., Philippine Bamboo Industry Development Council has been established to oversee the Philippine bamboo industry, and a Bamboo Industry Roadmap was formulated to guide its development. Although bamboo is legally considered as a forest product, bamboo has also been declared as a high value crop, which makes initiatives on bamboo research and businesses eligible for various government assistance programs. As a priority species, bamboo is also used in government greening programs as an alternative to wood and to support community-based enterprises. In research, bamboo was used as a novel source of chemicals, while innovative structural applications such as the development of novel bamboo connectors, the fabrication of engineered bamboo, and the architectural use of bamboo for typhoon-resistant houses and as sports venue had been demonstrated. Bamboos are also projected to help economic recovery from the Covid-19 pandemic with its potential to spur income and job-creating enterprises in bamboo-rich regions of the country. Limited knowledge, supply and market information gaps needs to be addressed through intensified research, policy changes to enhance the investment climate, and increased marketing efforts.

Keywords Philippines · Bamboo · Product innovations · Policy initiatives · Inventory and mapping

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7.1 Introduction

Among the non-wood forest products (NWFP) in the Philippines, bamboos are the most easily recognizable, being ubiquitous and urban as they thrive in forestlands and riverbanks and in home gardens, roadsides, parks, and other landscaped spaces. In recent years, bamboos have also attracted much attention from government, the private sector and the research and academic communities. Bamboo is the only NWFP for which an industry roadmap was crafted by the Department of Trade and Industry (DTI). Meanwhile, the 6th largest island, Panay (12,011 km^2) in central Philippines, is being pushed by former Secretary Roy Cimatu of the Department of Environment and Natural Resources (DENR) to be designated as the country's bamboo capital (Panay News 2020). For his part, the Department of Agriculture Secretary William Dar declared bamboo as a high value crop in 2020 (Philippine Star 2020). Many local government units have adopted bamboo as their flagship commodity under the "One Town, One Product" program. The town of Bayambang in the northwestern province of Pangasinan, home to a modern engineered-bamboo manufacturing plant that has just begun operations, erected a 50 m tall sculpture of its patron saint, Vincent Ferrer, which is recognized by the Guinness World Records as the tallest bamboo sculpture in the world.

In the 1975 Presidential Decree 705 (Revised Forestry Reform Code of the Philippines), bamboo was, apart from timber, among six minor forest products that included rattan, gums and resins, beeswax, gutta-percha, and almaciga resin that were declared not exempt from forest charges. [Sect. 72 of P.D. 705. *Charges on Minor Forest Products.—All other forest products of forestland … shall be exempt from any of all forest charges, except rattan, gums and resins, beeswax, gutta-percha, almaciga resin and bamboo which shall be charged at ten percent (10%) of the actual FOB market price*]. Curiously, in a previous section defining forest products, bamboo was not listed, although grass was mentioned. [Sect. 3. Definitions. ***Forest products*** *means timber, pulpwood, firewood, bark, treetop, resin, gum, wood, oil, honey, beeswax, nipa, rattan, or other forest growth such as grass, shrub, and flowering plant, the associated water, fish, game, scenic, historical, recreational and geologic resources in forest lands).*" No formal definition of minor forest products was offered, and Sect. 72 was only apparently added to emphasize the taxable nature of the six aforementioned non-timber products. The document contained no other reference to this group of products as regards their protection, development, or planting in forest lands.

The terminologies "non-wood and non-timber forest products" are interchangeably used in the Philippines, although the Food and Agriculture Organization (FAO) of the United Nations issued definitions that highlighted the distinction between these two terminologies (FAO 1999). But for decades, the label "minor forest products" was how these products were referred to, starting from the early years of American occupation of the Philippines. Whitford (1911) provided the first documented record of clustering these forest products together under such group. His book titled "The Forests of the Philippines" (Whitford 1911) defined minor forest products to "include everything derived from the forests with the exception of timber." There were eight

product categories in Whitford's grouping of minor forest products, which include (1) woods for fuel; (2) barks; (3) dyewood; (4) resins and oils; (5) gutta-percha and rubber; (6) resins; (7) bamboo; and (8) erect palms. Whitford only provided a rather brief discussion about these products, so it was Brown's 3-volume series titled "Minor Products of Philippine Forests" (Brown 1920, 1921a, b) that called greater attention to them. One could surmise that one of Brown's legacies was the term "minor forest products" which remained officially in use in the Philippines until the 1970s.

Even when Whitford, Brown, and Fischer derisively labeled the non-timber-producing plant resources as "minor forest products," their importance to Filipinos was not lost on them as they noticed substantial domestic use and even foreign trade in these products. They classified the products based largely on their uses, an acknowledgment that these products had economic and trade value. Of course, there were other product groups such as bamboo, palms, and mangroves which comprise several species that have multiple uses. Obviously, they cannot be categorized as belonging to just one of the other groups, hence, they make up their own class with an understanding that many members could have more than just one uses. Brown's series of work on several "minor forest products," either on his own or with co-workers such as Fischer and Merrill (1920–1921), added several other categories to Whitford's list, such as fiber plants, sources of paper pulp, seed oils, essential oils, wild food plants, ornamental plants, plants used as soap substitutes or scouring materials, medicinal plants, poisonous plants, and miscellaneous wild plants.

Among Filipinos, an indication of changing perceptions towards these products and of the heightening appreciation for their importance was the 1978 work by prominent Filipino professors and scientists, Tesoro, Bello and Pollisco (Tesoro et al. 1978). In the unpublished book titled "Forest Industries of the Philippines," they signified their preference for a change in terminology by stating that "*a number of* ***non-timber forest products*** *specifically bamboos, rattans and palms are sources of construction materials*." They elaborated further that these products "*are also used as raw materials for furniture and handicraft*" and that "*the forest abounds with plant growths that provide much needed fuelwood, food, raw materials for paints, varnish, dyes, tanning materials and others*." Three decades later, another work from the academe by Razal and Palijon (2009) used "Non-Wood Forest Products of the Philippines" as the title for their textbook. It now serves as a primary reference in the teaching of the Commission on Higher Education prescribed subject, "Properties and Utilization of Non-Wood Forest Products," under the collegiate Bachelor of Science in Forestry program (CHED 2019).

While the basic Philippine forestry law remains unchanged, terminology usage in official government documents was slowly shifting from "minor" to both "non-timber" or "non-wood forest products." In the Philippine Forestry Statistics (PFS) that is issued yearly by the Forest Management Bureau (FMB, 1990–2019), the glossary section used to contain the definition, "*Non-timber forest product—includes all forest products except timber. Also known as minor forest product*." Starting in 2005, however, the glossary entry was changed to "Non-timber forest products. *All biological materials and derivatives other than timber, which are extracted from forests for human use. Synonymous to Non-wood forest products*." DENR Administrative

Order 1993–59 updated the rules and regulations governing the transport/shipment of logs, lumber, plywood, veneer, non-timber forest products and other forest-based products/commodities. Said policy prescribed the issuance of a certificate of non-timber forest products origin (CNFPO) as a mandatory document to accompany the transport of non-timber and non-wood-based forest products. The CNFPO must contain the following information to be deemed valid: volume, type of product, place of loading, conveyance used, date of transport, source, and destination/consignee of the products. It can be obtained upon request in writing from the local Community Environment and Natural Resources Office (CENRO) of the DENR. The same DAO 1993–59 also requires that a Certificate of Verification (CoV) be procured when moving non-timber forest products like bamboo if they come from private or alienable and disposable (A&D) lands. This latter provision is seen as too regulatory and has been the subject of debate, which will be discussed later.

The first time that non-timber resources were mentioned in a context other than to regulate them was through Executive Order (E.O.) No. 318 (Promoting Sustainable Forest Management in the Philippines) by President Arroyo in 2004. One section of E.O. 318 highlighted the economic and ecological importance of non-timber forest resources, and the E.O. broke ground by calling for their development and promotion. The explicit mention of such provision in the E.O. was a much welcome step in the right direction, but no further actions materialized thereafter to prop up NWFPs as a group, except on bamboo. Government must keep farmers, consumers, and industry people's hope that the changes on paper are not mere cosmetic changes to keep abreast with the global trends in the nomenclature and appraisal of these products.

7.2 Objective of the Chapter

The main purpose of this chapter is to demonstrate efforts designed to improve the bamboo value chain in the Philippines and how it had been affected by inappropriate government policy, among others. It is hoped that this illustrative case on bamboo would shed light on approaches that could serve as models for other non-wood forest products, provide bases for recommending innovations to enhance their overall contribution to the lives of Filipinos and the economy of the country, and avoid some pitfalls and missteps that would be detrimental to their development.

7.3 Bamboos in the Philippines

There are now over 100 species of bamboo, both erect and climbing, in the Philippines (Baja-Lapis et al. 2016) and the increase in the number of species is largely due to the introduction of new ones from China and other neighboring Asian countries, mostly for ornamental purposes. Among the 42 erect species of bamboo that were described by Rojo et al. (2000), only two species, namely **bayog** [*Bambusa merrilliana* (Elmer)

Rojo and Roxas, *comb. nov.*] and **buho** [*Schizostachyum lumampao* (Blanco) Merr.] are endemic to the Philippines. In addition, six other erect species are native to the Philippines. Of the fifteen climbing species, thirteen are endemic or found only in the Philippines, while two species are native to the country (Escobin et al. 2005). The erect endemic species have been used in many traditional applications, although the most preferred species are the naturalized **kawayan tinik** (*B. blumeana* J.A. and J.H. Schultes syn. *B. spinosa Roxb .)*, which is widespread and cultivated in almost all parts of the country, and **giant bamboo** or **botong** (*Dendrocalamus asper (*Schultes f.*)* Backer *ex.* Heyne), an introduced species that grows better in high elevation and lower temperatures, such as the province of Bukidnon in the southern island of Mindanao. The climbing species have little commercial value except for the species *Cyrtochloa puser* which is used in the northern province of Abra for handicrafts such as trays, baskets and hanging ornaments. *Cyrtochloa* was reported in 1998 as a new genus of climbing bamboo discovered in the Philippines (Dransfield 1998).

In 2015, the Philippines ranked 5th after China, the European Union, Indonesia, and Viet Nam, among the world's top exporters of bamboo (and rattan) products valued at US thirty-two million dollars (INBAR 2015). This was a very distant no. 5 ranking, as the dollar value of Philippine exports was only 2.88% that of China's. Exported largely as furniture, bamboo-made furniture items account only for a very small percentage (2.7%) of the country's total forest-based furniture exports, with an average value of US$391,124 between 2009–2013. Annually, the average bamboo pole production over a span of twenty-three years is 962,058 poles, although in the last five years (2015–2019), the average pole production increased by more than 20% to 1,159,244 poles per year. This indicates increasing domestic demand for bamboo culms. Given this volume, the corresponding total forest charges on bamboo in the last five years amounted to only forty-one thousand six hundred fifty pesos (Php41,650), or not even US$200 on average per year. The adverse side of the low contribution to tax collection is that decision-makers could use it as bases for by-passing the resource in terms of interventions and development programs. On the good side, the low tax rate implies that the bulk of bamboo culms harvested and transported were coming from planted stands, possibly from plantations in private lands and even from tenured forest lands with resource use permits to cultivate and harvest bamboo. Republic Act No. 7161 (1991) exempts planted forest products from private and tenured lands from the collection of forest charges.

The depletion of the country's forests and the consequent diminished timber supply contributed to the emerging interest on bamboo in the Philippines. Beginning in the 1980s, the Philippines became a net importer of timber. Once lush in dipterocarps, good quality wood from these premium trees became scarce and expensive. Logging bans aggravated the lack of timber, as access to natural timber and even to planted trees had been prevented by backlash from the public who largely blamed the denudation of forest for flash floods and other calamities. Bamboo is seen as an alternative to timber for construction, furniture, and a host of other domestic household products. Enamored by the success of China's bamboo industry, especially in their ability to fabricate wood-like products called engineered-bamboo, some government leaders and private individuals began their strong advocacy to promote bamboo in the

Philippines, convinced that the country stands a good chance of replicating China's experience. Bamboo is ubiquitous in the Philippines, and being a tropical country, the good mix of sunshine and rain is suited for the cultivation and fast growth of bamboo. Not even the fact that an average of 20 typhoons visits the country each year could dampen enthusiasm towards bamboo. After all, bamboo is a resilient crop. Strong winds can topple the culms, but new shoots readily emerge to replace the broken ones, and within three to four years, mature culms become available for cutting.

But an unstable supply of bamboo culms to feed factories that need them as raw material inputs remains a deterrent to the full development of the Philippine bamboo industry. The bamboo industry roadmap projected that for the five-year period, 2021–2025, the estimated combined demand for bamboo culms of the various bamboo industry sectors would be at 30.7 M culms per year (Tesoro 2018). At the current annual average production rate of 1.2 M culms, an acute shortage is therefore anticipated. Clearly, incentives should be put in place to encourage planting, including reforming policies that discourage the establishment and development of bamboo plantations.

7.4 Initiatives for Bamboo Development in the Philippines

a. Product innovations

Several product innovations and industry start-ups are among the tell-tale signs of private sector enthusiasm towards bamboo. Generally regarded as green products, articles made of bamboo are increasingly gaining more acceptances and are regarded to be fashionable. Many restaurants that carry Filipino menus in the Philippines and even in foreign countries with a significant Filipino community feature bamboo-embellished interior designs, including furniture and utensils that are made of bamboo. The bamboo furnishings like tables, chairs, counters, trays, lamps, and dividers add to an inescapably Filipino ambiance. Also increasingly becoming more common are roadside restaurants where customers can enjoy their meals in separate, variously sized bamboo-nipa huts to cater to different number of guests. Beach or nature resort hotels that provide accommodation, relaxation and dining amenities in bamboo cottages and structures have also grown in number. Filipinos, generally known to use spoon and fork during meals, are becoming adept at using chopsticks, the use of which has increased with the influx of Chinese, Japanese, and Korean food chains. Recyclable and/or personalized straws made from small-diameter bamboo have replaced plastic straws, and stirrers and toothpicks made of bamboo are now more commonly used than same items made of plastic materials in restaurants, cafes, and tea houses (personal observation).

As wood became scarce, wood carving communities in the Mountain Provinces in northern Luzon and in Paete, Laguna (south of Manila) were faced with scarcity of wood that threatened livelihoods and income earnings. With support and encouragement from the Philippine Bamboo Foundation, Inc. (PBF) especially its President,

Fig. 7.1 **a** Samples of carvings of religious icons and native symbols on bamboo culms. **b** Philippine Bamboo Foundation President and former Undersecretary Edgardo Manda delivering a lecture on his advocacy work to promote bamboo carvings and artwork. [Photo credits **a** Edgardo Manda; **b** Rosalie Mendoza]

Edgardo Manda, wood carvers were introduced to the use of bamboo as material for carving. The artisans quickly adapted their skills to using bamboo culms in carving religious images and native Filipino scenes and symbols (Fig. 7.1). The PBF helps by conducting training, competition and selling carved bamboo artworks through exhibits and presentations in bamboo conferences, with each carving fetching as high as Php10,000 apiece, and sometimes more in exceptional cases.

Not only could bamboo culms replace wood in sculpture but as mentioned, bamboo is seen as an alternative to lumber in furniture-making and construction. The technology for making engineered bamboo which entails cutting the bamboo into strips and then assembling with glue and pressure had made this even more likely. The local process for making engineered-bamboo products was described by Razal et al. (2012) and includes material preparation, conversion into slats, preservative treatment, drying, gluing and assembly, and finishing. Treatment with preservatives, drying, and uniformity in the dimensions of the slats were most critical in ensuring good quality of the assembled bamboo boards. The bamboo species that are preferred for engineered bamboo are kawayan tinik because of its density and strength, and giant bamboo whose grain characteristics make for attractive board plane surfaces. Other characteristics of the bamboo culm that influence product quality, material recovery and ease of processing include the length and straightness of the culm, diameter and taper of the culm, internode length and number of internodes per culm, culm wall thickness, and age of bamboo culm (Razal et al. 2012). The Bureau of Product Standards of the Department of Trade and Industry recently adopted grading standards for bamboo structures (PNS 1SO 19,624-2020 and PNS ISO 22157-2020) which prescribe procedures for testing bamboo culms which could be useful for determining their suitability for engineered-bamboo products.

Several engineered-bamboo processors had been established in the Philippines in the last twenty years or so, but most had limited success. Some faced problems with the supply of quality bamboo culms; others had management issues, but most

were unable to compete with cheaper engineered-bamboo products imported from China. Labor was often cited as a factor for the higher production cost of Philippine made bamboo products but imported inputs such as adhesive and machinery and low material recovery were contributing to manufacturing costs.

The CS First Green Agri-Industrial Development, Inc. (CS First Green AIDI) pilot plant recently established in the northern province of Pangasinan in Luzon aims to avoid some of the problems encountered by the early ventures by securing the supply they need for the pilot plant through planting several hundreds of hectares of denuded forest lands with bamboo. The company describes its operation as an integrated process starting from bamboo production to processing and envisions an agro-industrial bamboo economy that would stimulate spin-off local bamboo business enterprises in the area. The plant would produce engineered bamboo with zero wastes by integrating bamboo charcoal production and distillate recovery to maximize utilization of the bamboo culms. With 27,500 poles processed per month, the company aims to become the largest bamboo factory in the country and at the same time contribute to community livelihood, protect the environment and develop ecotourism, and mitigate climate change.

Meanwhile in Bukidnon province, a similar venture has been underway since 2019 with a bamboo processing plant established by the Bukidnon Giant Bamboo Resources Corp. (BGB) in Barangay Aglayan in the capital city of Malaybalay (Personal communication with Bioco, R., Chairman, BGB). Bukidnon lies on an extensive plateau (average elevation = 915 m) and is critical to Mindanao because of its almost central location and its seven river basins that drain to farmlands and residential areas in the surrounding lowland provinces. Bukidnon is home to indigenous peoples (IPs) with tenure rights to ancestral lands through their ancestral domain titles and/or community-based forest management agreements with government. BGB had put up a plant designed to operate as a post-harvest facility that would treat, dry and process giant bamboo culms into slats. BGB was able to send container-loads of insecticide-treated Giant bamboo slats to Vietnam and the United States with positive market feedback, but because of the pandemic, operation had temporarily stopped. These bamboo slats could, aside from being exported, be integrated into local production of finished engineered bamboo products. When situation normalizes, the BGB plans to resume operations and engage the rural communities, especially the IPs in restoring the denuded watersheds by planting them with giant bamboo. The venture is supported by several government agencies, particularly the Mindanao Development Authority (MinDA).

The Philippines is prone to typhoons that became more severe with climate change. The country also lies along the Pacific rim of fire which is known to have frequent volcanic eruptions and earthquakes. These pose many challenges in providing safe, durable, and affordable housing especially for the large segment of the country's population who are poor. Government and non-government organizations alike, such as the private foundation Base Bahay, aim to contribute to sustainable housing for Filipinos. To achieve this, Base Bahay conducted research that resulted in the development of cement-bamboo frame technology for use in building socialized

housing units in many parts of the country. Said technology comprises "prefabricated frame system using load bearing bamboo with metal connections and mortar cement plaster," which Base Bahay claims to have been tested for resistance to earthquake, typhoon, fire, and insect infestation (Base Bahay, undated). As of 2020, Base Bahay reported to have built more than 800 housing units in Luzon and the Visayas. Residents of a Base Bahay-built village in Sorsogon, a province that lies on a path that can be directly hit by 2–3 typhoons each year, said that their houses, which were built using the cement bamboo frame technology in 2017, withstood several typhoons including the 195 km/h wind speed of Quinta and the 315 km/h wind speed of category 5 Typhoon Rolly in 2020.

Speaking of connectors for bamboo, Servañez et al. (2018) fabricated five types of bamboo connectors using GI pipes available from local hardware stores. The connectors were used to build bamboo houses using patong, the local name for a species of bamboo that grows well in the island province of Romblon. Three houses with slightly different structural designs and using labor force with varying skills and experience were erected. The duration it took to build the structures, taking into account the skill sets of the workers, was used as a measure of the ease of use of the connectors. Additionally, the structures were assessed after the occurrence of strong typhoons in the area, including Typhoon Haiyan (Yolanda) in 2013. Table 7.1 summarizes the comparison, using several parameters, between the structure that used traditional bamboo joinery systems involving lashings, holes, and dowels plus the metal starfish connector at the top, and a structure that used all the fabricated bamboo connectors in joining the different bamboo structural elements.

Recently, the use of bamboo in modern architectural construction was showcased in constructing the Polo Pavilion (Fig. 7.2) that was used for the 2019 Southeast Asian Games. Built in Calatagan, Batangas province (south of Manila). It took a period of less than four months to build the structure, which was erected on an area of a little more than 1000 sq m with a floor area of 700 sq m. Tapped to design and construct the pavilion was Sangay Architects, the company of Architect Christian Salandanan who caught national attention with his BS Thesis, Casa Kawayan, which he conceptualized to serve as an integrated Bamboo Research and Development Complex. This thesis project earned various awards for Architect Salandanan including being selected as one the 12 best students' projects by the Archi-World Academy in 2015.

To expand market opportunities for bamboo growers in the Philippines, a study was conducted on producing nanocellulose from bamboo. Nanocellulose is a novel product extracted from renewable lignocellulosic materials such as wood and bamboo. Because of its numerous desirable physical and morphological properties, it can be used for a variety of applications such as in composites, restorative medicine, capacitors, paper and packaging, paints and coating, among others (Trache et al. 2020). Screening of four erect and one climbing species (bikal) of bamboo was done by evaluating their chemical properties. Due to the high cellulose content and low lignin content of kawayan tinik (*Bambusa blumeana syn. B. spinosa*), it was chosen for experimental production and testing of cellulosic nanocrystals. Kawayan tinik culms between 6 months and less than a year old were best in terms of recovery of nanocellulose. Preliminary treatments of the bamboo culm entailed, in sequence,

Table 7.1 Comparison between traditional joinery (with starfish connector at the roof top) versus all metal-fabricated connectors in the construction of bamboo structures in Romblon, Philippines (Servañez et al. 2018)

Parameters	Traditional joinery	Use of fabricated metal connectors
Representative joint	 (Traditional post-top chord-beam connection with starfish metal connector at the top)	 (Post-top chord-beam connected with fabricated metal connector)
Ease of construction	Carpentry skills needed	Do-it-yourself (DIY) construction
Number of man-days to finish skeletal structure	Twenty (20) skilled man-days plus ten (10) unskilled man-days	Two (2) skilled man-days plus two (2) unskilled man days
Strength	May withstand strong typhoons	Survived typhoons that hit the area since 2013
Fire resistance	Starfish connector remained while traditional joints burned	All the developed connectors were recovered from fire
Versatility in construction	Limited by skilled artisans and carpenters	Unlimited pentagon house sizes and designs
Cost considerations for skeletal construction	30 man-days + materials	4 man-days + materials + plus cost of connectors. (Cost of connectors is offset by savings in labor cost, timeliness in construction and disaster resiliency)
Acceptability potential	Low	High
Potential market	Low-end homeowners	Resorts, hardware stores, DIY shops, LGUs, social services and disaster relief organizations

mechanical grinding, Kraft pulping, bleaching and alkali treatment to remove residual cellulose and hemicelluloses, to yield cellulose that was used as feedstock for the hydrolysis reaction to produce cellulosic nanocrystals. Atomic force microscopy (AFM) (Fig. 7.3a) and transmission electron microscopy (TEM) (Fig. 7.3b) of the products indicated that nano-sized products were obtained, with dimensions of 6.89 and 417.58 nm from the AFM micrograph and an average diameter and length of 4.05 and 90.5 nm from the TEM image (Razal et al. 2015). Subsequent tests to incorporate the nanocellulose in xylan film showed improvements in rupture strength and

Fig. 7.2 The polo pavilion used for the 2019 Southeast Asian games, designed, and constructed by Sangay architects, Inc. (Photo courtesy of Arch. Christian Salandanan)

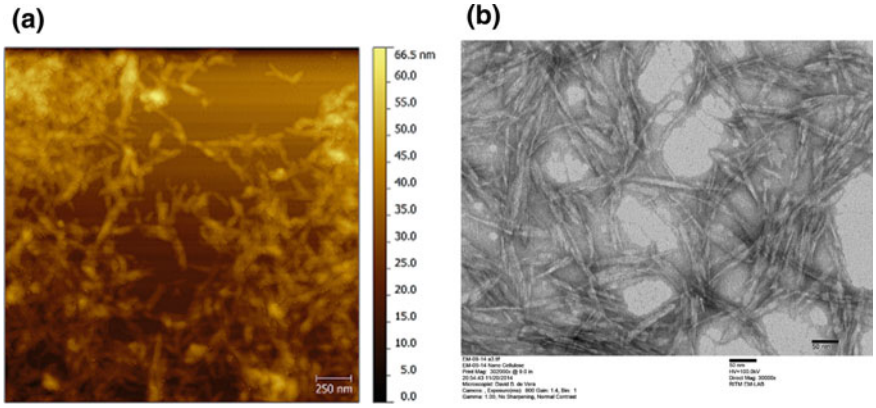

Fig. 7.3 **a** Atomic Force Microscopy (AFM) and **b** Transmission Electron Microscopy images of cellulosic nanocrystals extracted from *Bambusa blumeana syn. B. spinosa* (Razal et al. 2015)

lowered water vapor transmission rate with small additions of bamboo nanocellulose to the xylan matrix (Bayani et al. 2016).

To take advantage of the soft tissue of bamboo shoots owing to the low lignin content, Jara et al. (2019) tested the use of 60 cm long shoots from Kawayan killing

(*Bambusa vulgaris* Schrader *ex* Wendland) collected from Mount Makiling Forest Reserve in Laguna province for nanocellulose extraction. In the preparatory steps to extract the cellulose, the usual pulping step to remove lignin was replaced with simple soaking in warm water (80 °C) for four hours, followed by mild bleaching and alkali treatment. Thereafter, the hydrolysis reaction of the cellulose with sulfuric acid was performed, which led to the formation of rod-like cellulose nanocrystals, as shown by atomic force microscopy imaging of the samples. The acid hydrolysis condition that gave the highest yield involved the combination of 45% acid concentration, 45 °C temperature, and reaction time of 30 min. The aspect ratio of the nanocrystals was also highest with milder hydrolysis conditions (Jara et al. 2019). Trials to fabricate polyvinyl alcohol (PVA) films incorporated with the bamboo shoot nanocrystals resulted in higher tensile strength and Young's modulus for films containing 2 and 4% nanocellulose compared with the neat PVA films (Jara et al. 2019).

The Forest Products Research and Development Institute (FPRDI) under the Department of Science and Technology (DOST) is the government agency primarily responsible for the conduct of utilization research on non-wood forest products in the Philippines, including bamboo. This was affirmed in Executive Order 879 which instructed the DOST to "undertake research and transfer of technologies to reduce production costs and increase salability of bamboo products such as bamboo shoots processing and packaging, alternative adhesives and finishes, and effective and affordable treatment and preservation techniques." To name a few, FPRDI's research and development efforts have led to the design and fabrication of a bamboo veneer lathe and a bamboo flattening machine to provide components for structural and decorative bamboo panels. FPRDI also fabricated a bamboo charcoal kiln that allows the recovery of the charcoaling distillate, the pyroligneous liquor which is claimed to be useful for medicinal, cosmetic, and cleaning purposes while the charcoal could be used as fuel, adsorbent or further activated for medicinal and industrial uses (FPRDI, undated). At the start of the lockdown due to the COVID-19 pandemic in 2020, FPRDI speedily fabricated novel face shields mounted on bent thin bamboo frames to be used as personal protective equipment by health workers and the public (Fig. 7.4).

Bamboo is reputed to be a multipurpose plant. In line with this, the social enterprise Filbamboo Exponents, Inc. develops commercially viable products from bamboo shoots and leaves which include food products, beverages, and cosmetic items. Within a year from its conception in 2010, the company produced 20 different kinds of food products. One of its snack innovations using bamboo shoots, aptly called BamSnacks (Fig. 7.5) won the grand prize under the food category in the INBAR-sponsored product ideas competition held in the World Expo 2010 in Shanghai, China. The same product was acclaimed winner in the 2011 Business in Development (BiD) challenge under the auspices of the Philippines Business for Social Progress. The product packaging describes it as "delicious, healthy and unique" being produced from bamboo shoots which are known to be low in calories and fat but are rich in fiber and minerals (Caasi-Lit et al. 2010; Dransfield and Widjaja 1995). Other innovative food product items from bamboo shoots developed by Filbamboo include bamboo pastry, bamboo viands, pickled bamboo, and native delicacies enriched with bamboo

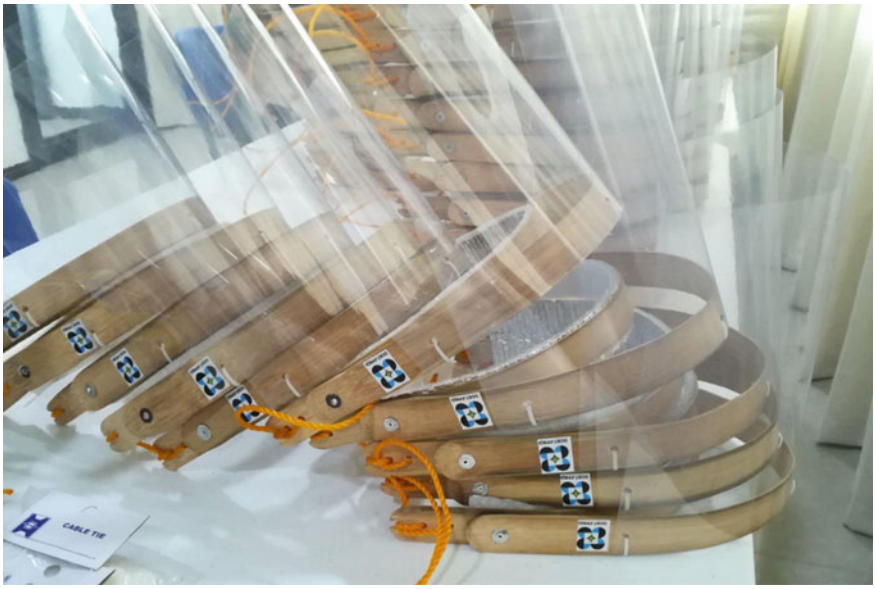

Fig. 7.4 FPRDI-fabricated face shields that can be used as a personal protective equipment against the Covid-19 virus. (Photo credit: Forest Products Research and Development Institute, Philippines, 2020)

shoot flour. Filbamboo also came up with a product line called Bambu Tisane, which is tea beverage from the leaves of bamboo and is available in powder and ready-to-drink form. Filbamboo buys its bamboo shoots from its partner communities, asserting that as a social enterprise, it helps capacitate communities by training them on product and sustainable livelihood development (Personal communication with Punzalan, D., CEO Crea 8 Innov 8 Marketing and World Bamboo Ambassador).

Noting the emerging use of local bamboo leaves for commercial tea products, it was important to show that these plant parts of local bamboo species contain healthful nutrients and are free from toxic components. Toward this end, the proximate composition of the leaves of the native species buho (*S. lumampao*) and bolo (*Gigantochloa levis*) were analyzed. Table 7.2 summarizes the results of the proximate analysis done for these the two species.

Phytochemical screening tests were also conducted on the ethanolic and aqueous extracts of both species (Table 7.3). These tests detect for the presence of phytochemicals beneficial to the human body, on one hand, and on the other hand, they reveal components that can cause toxic reaction, such as for example, neurological damage from cyanogenic glycosides. It can be seen from Table 7.3 that the phytochemical profiles of both species are almost similar, with no components that could render them unsafe for use as tea or herbal supplement. Likewise, the presence of flavonoids and tannins in the extracts indicate their anti-oxidant potential. The leaves of *G. levis*

Fig. 7.5 Assorted food and beverage products of Filbamboo Exponents, Inc. **a** and **b**—Prize-winning bamboo shoot snacks c) pastries and coffee (Bambubrew), d) pickled bamboo shoots, **e** and **f** variants of bamboo tea, in ready-to-drink and powder form. (Photo credits: Atty. Dulce Punzalan)

Table 7.2 Proximate chemical analysis of the leaves of buho (*Schizostachyum lumampao*) and bolo (*Gigantochloa levis*)

Component (%)	Buho (*Schizostachyum lumampao*) (Tongco et al. 2014)	Bolo (*Gigantochloa levis*) (Tongco et al. 2016)
Ash	30.5	15.8
Crude protein	22.1	22.6
Crude fat	1.6	1.2
Crude fiber	28.7	29.3
Total sugar (as difference)	7.2	19.7

Table 7.3 Qualitative phytochemical screening of ethanolic and aqueous extracts of *Schizostachyum lumampao* and *Gigantochloa levis* leaves

Phytochemical test	*Schizostachyum lumampao*[b]		*Gigantochloa levis*[c]	
	Ethanolic	Aqueous	Ethanolic	Aqueous
Alkaloids (Wagner's test)	–	–	–	–
Carbohydrates—reducing sugars (Benedict's test)	–	–	–	–
Cardiac glycosides (Legal's test)	–	–	–	–
Anthranol glycosides (Modified Borntrager's test)	–	–	–	–
Cyanogenic glycosides (Picrate paper test)	–	–	–	–
Saponins (Froth test)	+	+ +	+	+ +
Diterpenes (Copper acetate test)	+ +	+	+ +	+
Triterpenes (Salkowski's test)	+	+	+	+
Phenols (Ferric chloride test)	+ +	+	+ +	+
Phytosterols (Liebermann—Burchard's test)	+	-	+	–
Tannins (Gelatin test)	+	+	+	+
Flavonoids (Alkaline reagent test)	+	+	+	+
Amino acids (Ninhydrin test)	–	–	–	–
Proteins (Nitric acid test)	–	–	–	–

[a] Legend: (–) not detected/present, (+) present in low amounts, (+ +) present in high amounts; [b] Tongco et al. (2014); [c] Tongco et al. (2016)

were further analyzed for mineral content, and energy dispersive X-ray spectrometry showed the presence of silicon (74.88%), potassium (9.60%) and magnesium (7.06%), and smaller amounts of aluminum, phosphorus, calcium, manganese, and iron, among others (Tongco et al. 2016).

7.5 Policy Initiatives on Bamboo

7.5.1 Executive Order No. 879

Executive Order (E.O.) No. 879 issued by former President Arroyo on May 14, 2010 is often touted as the government policy that paved the way for increased government support to bamboo production and development. Among others, E.O. 879 created the Philippine Bamboo Industry Development Council (PBIDC) whose overriding mandate was to provide the overall policy and program direction for bamboo industry

development in the country. The E.O. sought to intervene by proposing measures to increase both the demand for, and supply of bamboo. To boost demand, the E.O. directed the Department of Education to procure bamboo school desks and armchairs for 20% of its yearly requirements, and that government offices prioritize the use of bamboo for their furniture and fixtures and construction needs. On the production and supply side, E.O. 879 directed the Department of Environment and Natural Resources to plant bamboo in 20% of its annual reforestation and rehabilitation sites. E.O. 879, although signed in the waning months of the Arroyo administration, gained support from the Aquino administration that took over. To signal its support for bamboo initiatives, the Aquino government issued Memorandum Circular (M.C.) No. 30 to rally government agencies to continue to abide by the E.O.

More than 10 years later, however, the bamboo industry still seems to be floundering, and supply of bamboo culms remains inadequate to meet projected demands. Coming short of expectations, several senators and congressmen filed bills in Congress to shore up the bamboo industry by proposing to create a more permanent body to oversee bamboo industry development, with regular fund allocation and permanent staff to man its operations. In the E.O., only an initial fund of P20M was allocated. Another factor that may have contributed to the lack of effectiveness of the council created through E.O. 879 was its composition, having Department Secretaries as members, who are often too busy and would delegate their duties to junior staff. Another problem faced by the council was the abolition of the Cottage Industry Technology Center, whose Executive Director was supposed to head the Technical Working Group tasked to assist the PBIDC.

7.5.2 E.O. 26 National Greening Program and E.O. 193 Expanded National Greening Program

The administration of President Aquino (2010–2016) launched an ambitious tree planting program called the National Greening Program, the main target of which was to reforest 1.5 Million hectares of land with 1.5 Billion trees. This program was mandated in the 2011 Executive Order No. 26 as a convergence initiative among several government departments, with the DENR spearheading the efforts. Bamboo was labeled as a commodity crop selected along with other forest, fruit, and non-timber species for planting as part of the program, with more than 54,000 hectares of land targeted to be covered with bamboo by 2016. Aside from bamboo, the other commodity crops and non-timber species slated for replanting were rattan, rubber, cacao, and coffee, while indigenous and mangrove species were planted in protected forest areas. Buoyed by reports that the Philippines was gaining ground in reducing forest cover loss, President Aquino signed in 2015, E.O. 193 extending implementation of the nationwide planting program from 2016 to 2028 to reforest the remaining unproductive, denuded, and degraded forestlands. The implementation period was beyond his term, but the expanded National Greening Program was adopted by the

succeeding administration which identified bamboo as a priority species for planting. Citing high survival rate and usability of bamboo as timber substitute, Sec. Cimatu urged to increase bamboo planting from 20 to 40–45% (Austria 2019). Contributing to the efforts of producing more bamboo planting materials is the Bamboo Plantation Development Project (BPDP) led by the Ecosystems Research and Development Bureau (ERDB), an agency under DENR. BPDP helps build capacity in bamboo propagation, nursery and plantation establishment, and in monitoring newly established bamboo nurseries and plantations. According to the BPDP website, it would develop "critical watershed, marginal areas, creek lines, riverbanks, and areas prone to erosion" by planting them with bamboo.

7.5.3 The Certificate of Verification (CoV) Requirement

The inclusion of grass, particularly bamboo in the list of forest products enumerated in P.D. 705 is seen as the primary reason why the harvest, collection, movement, and transportation of bamboo in the Philippines are subject to regulation by the government. The law presumes that natural bamboo stands abound in forestlands, and correspondingly, the P.D. aligned bamboo with timber among forest products with imposed forest charges. The basis for this is unclear, since data on the forest area covered with bamboo is lacking. Likewise, as pointed out earlier, the collection and harvest of bamboo appears to have been largely confined to preferred commercial species of bamboo that had been planted, ostensibly in low lying areas, backyards and small bamboo plantations in private and A&D lands spread throughout the country. In high elevation areas, available bamboos are buho and the climbing species, some of which are cleared by the government to give way to the planting of fast-growing timber species.

In line with the Philippine Constitution and P.D. 705, the DENR, being the national agency that has jurisdiction over the country's natural resources, would enforce rules and regulations to protect resources inside the forests, which include bamboo. For DENR, such measures are necessary to enable them to carry out their functions to prevent illegal collection, overharvesting and other forms of exploitation of forest resources. One such rule is Department Administrative Order (DAO) No. 59 s. 1993, which is meant to guide officials and the public on the requirements for the shipment and transport of timber and non-timber products, from both forest and private lands. In DAO 1993–59, a specific provision (2.6) described the certificate of verification (CoV) as a "document issued by DENR local officials at the CENRO level to show that the logs, lumber or any other non-timber forest products come from either private lands or A&D lands." Considered as a non-timber forest product, the harvest and transport of bamboo could not be spared from this requirement. As we shall see later however, there are some regions in the country that do not oblige harvesters and transporters of bamboo to comply with this documentary requirement.

Complying with the CoV requirement entails added cost and delays the movement of bamboo needed by bamboo product makers. The Forestry Development Center

(FDC)-study (Dolom et al. 2019) funded by PCAARRD tend to agree with the contention of the private sector, having obtained evidence that substantiates delays, inefficiency, and even abuse of the CoV requirement by some officials in government. Conditions for issuing the CoV include the submission of a written intent, inventory of bamboo, and payment of fees. The inventory has to be done by CENRO personnel who normally do not have the resources to go on field work and who must find time between their other office duties to accommodate the farm visit. Certainly, this pre-inventory of bamboo is one requirement patterned after the requirements for timber harvesting, which are easier to count and for which there are clearly defined inventory rules. Thus, the burden piles up on the private landowner, who would need to patiently wait for the availability of CENRO personnel to do the "bamboo inventory" and to sign the documents, consequently incurring added costs to secure, and in desperate cases, to "facilitate" the release of the needed documents. The practicality of limiting the validity of the CoV to three days is also debatable, considering difficulties in transport owing to poor road and unpredictable weather conditions, long shipment distances from the source to destination, and the presence of checkpoints on highways. The latter, by the way, is another source of aggravation for shippers, who involuntarily deal with checkpoint personnel through more cash to avoid harassment and further delays. There were also alleged reports of "recycling" of the CoV to circumvent the hassles of the application requirements and save on costs.

7.5.4 Benefit–Cost Analysis

Parallel to the FDC study was the benefit–cost analysis to determine if economic considerations would justify removing the CoV requirement in harvesting and transporting bamboo poles from private lands. This was done through benefit–cost analysis under two scenarios, one with the continued implementation of the COV requirement, and the other, where the COV requirement was removed in the same regions where it is implemented (Daracan et al. 2019). The methodology involved incremental analysis, using region-specific pricing of labor and bamboo poles, and the foreseen benefits of higher income, avoided costs (on the part of landowners) like application and inspection costs, and other economic advantages associated with the increase in bamboo plantation areas if the CoV were removed. Computed as costs were the presumed higher forest protection cost and added expenditures that would result from increased bamboo plantation areas supposedly encouraged by a less restrictive policy. Sensitivity analyses were also done to test how the economic measures, net present value (NPV) and benefit-cost (B/C) ratio, would be affected by changes in interest rates, price of carbon, price of bamboo, and number of poles per hectare. Table 7.4 is a partial summary of the results of the study, showing the computed incremental NPV and B/C ratio in the 10 regions of the country, using 10% interest rate, US$ 5 per ton CO_2-e, and 1000 harvestable bamboo poles per hectare.

Table 7.4 Summary of incremental NPV (in millions, PhP) and BCR values at i = 10%, 1000 poles/ha, Carbon price = 5US$ (Daracan et al. 2019) of removing the Certificate of Verification requirement in harvesting bamboo poles in selected regions in the Philippines as opposed to the status quo. (Daracan et al. 2019)

REGION	Net Present Value (NPV) (in millions, PhP)	Benefit-Cost Ratio (BCR)
CAR	42.89	1.41
Region 1	42.85	1.47
Region 2	47.56	2.39
Region 3	139.44	3.15
Region 4A	198.47	3.13
Region 4B	47.86	2.79
Region 5	93.16	2.90
Region 7	683.78	2.53
Region 10	197.04	2.35

Using the assumptions listed in the heading of Table 7.4, the results of the calculations for NPV and BCR indicated that benefits of the proposed policy removing CoV exceeded the identified costs. If the regions would stop imposing CoV as a requirement for the harvest and transport of bamboo poles, these would lead to benefits that would outweigh the costs. Interestingly, the highest NPV was obtained in Region 7 at PhP683 Million, where the largest plantation area was projected for establishment there. Region 3, on the other hand, produced the highest BCR value because bamboo pole prices were highest in the region. The sensitivity analyses showed that variations in the parameters used did not change the desirability of removing the CoV requirement. This economic study, together with the survey results that showed the CoV requirement was deemed counterproductive, bred corruption, and did not amply protect bamboo forests, could be used to craft an alternative policy that would simplify requirements for transport and harvesting of bamboo poles. Happily, the pending bills in Congress provide for deregulating bamboo in the country, having taken cognizance of industry sentiments and possibly heeding the research results. (Note: At the time of publication, the DENR had already issued Department Administrative Order 2021–26 which abolished the certificate of verification (CoV) requirement for the harvest and transport of bamboo from private lands).

7.5.5 Bamboo Information Readiness Through Inventory and Mapping

Aside from policy impediments, uncertainty in the supply of bamboo resources in meeting current and projected demand is an often-cited reason for worry among potential bamboo investors. Information gaps on available bamboo resources dampen efforts to attract modern factories that require consistently large volumes of bamboo

poles for profitable and sustainable operation. The inventory of bamboo resources in the Philippines had been attempted on several occasions in the past. In 2008, Virtucio reported a total of 9,978,330 clumps and 48,913 ha of bamboo stands all over the country. The inventory done by the FDC at the University of the Philippines Los Baños College of Forestry and Natural Resources (UPLB-CFNR) in 2012 reported a total of 15,857.23 ha of bamboo plantations in combined forest and private lands. For this effort, FDC relied on reports provided by CENROs and PENROs, which could have been limited by the non-reporting of private bamboo plantations in the registry at the CENROs. In 2011 to 2013, the ERDB-DENR conducted a survey of commercially important bamboo resources and the results are shown in Table 7.5. ERDB-DENR located a total of 10,065.49 ha of plantations which was even smaller than that earlier reported by FDC. Kawayan tinik was the species with the highest area coverage.

The previous inventory studies were one-time surveys that did not allow updating and verification of information. But the actual volume of bamboo could be in a constant flux because of its ecological and economic nature. Bamboo poles senesce, they could be toppled by winds during typhoons, and people cannot be prevented form gathering culms year-round. On the other hand, expansion of clumps could occur alarmingly fast in less disturbed areas, which explains why bamboo had been labeled as an invasive species in some instances.

Table 7.5 Survey of eight commercially important bamboo species in the Philippines (ERDB 2013)

Species	Number of clumps	Number of culms	Area (ha)
Kawayan tinik *Bambusa spinosa Schult.f*	580,480	16,617,991	6,679.00
Giant bamboo *Dendrocalamus asper* (Schultes f.) Backer ex Heyne	69,458	2,396,754	740.91
Bulo *Gigantochloa levis* (Blanco) Merr	53,565	1,457,454	548.34
Buho *Schizostachyum lumampao* (Blanco) Merr	184,908	9,449,909	511.63
Laak *Sphaerobambos philippinensis* (Gamble) S. Dransf	98,074	3,529,635	795.33
Bayog *Bambusa merrilliana* (Elmer) Rojo & Roxas	41,490	1,324,258	302.84
Kawayan kiling *Bambusa vulgaris* Schrad. ex Wendl	39,655	1,314,804	450.34
Kayali *Gigantochloa atter* (Hassk.) Kurz	12,395	374,143	37.10
Total	1,080,025	36,464,948	10,065.49

A PCAARRD-funded project addressed these issues by coming up with a replicable and participatory inventory methodology that engaged stakeholders (Razal et al. 2020). The study was done in three provinces, one each for each island cluster, Luzon, Visayas, and Mindanao. Remote sensing was used to process satellite data and classify land cover in the selected provinces. Sentinel-1 and Sentinel-2 data, and Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Digital Elevation Model (DEM) were obtained, processed, and used as layer variables in the classification of projected bamboo, and stacked together along with spectral bands and other indices. Training sets for bamboo stands were delineated and collected through visual and manual interpretation of Google Earth Pro images (Zhao 2018). Other land cover categories (Impervious, Bare land, Agriculture, Tree Orchards, Forest, Water) and two extra categories (Clouds and Shadows) were also collected. Community inputs from the local mapping exercises were also identified and delineated on the Google Earth Pro maps.

Following the application of classification algorithms and Geographic Information Software (GIS), bamboo class maps were generated, and by intersecting with the Database of Global Administrative Areas, the projected bamboo distribution of municipalities per province was estimated. The bamboo distribution maps were refined based on the inputs from the local communities and stakeholders. Meanwhile, on the ground, thirty quadrats measuring 30 m × 30 m were subjected to bamboo inventory in each municipality. Opportunistic sampling, which involved geo-tagging of bamboo stands outside the sampling quadrats, was also conducted. The species were identified, bamboo culms were classified based on age, and measurements of diameter and length, number of culms and diameter of clumps were done.

Shown in Fig. 7.6 is one of the maps obtained from the combined mapping and bamboo inventory activities in the province of Iloilo in the Western Visayas region. Based on this map, the total bamboo cover for the Province was projected at around 8671 ha. This covers 1.84% of the total land area based on the province's GADM administrative boundaries. Most bamboo clusters occurred adjacent to river networks and significant bamboo clusters were projected in the province's central location, which coincides with the towns of Maasin, Janiuay, and Alimodian, where sampling quadrats were established.

Only 3 species of bamboo were found in the three municipalities surveyed in the province of Iloilo as shown in Table 7.6. Kawayan tinik is the dominant species, at 97.67%.

Table 7.7 shows the projected harvestable culms for the entire province. While bolo was found during the inventory in the province, none of the culms was mature for harvesting, hence the study reported no harvestable bolo culms there.

Using remote sensing technology, the study was also able to project with good accuracy the distribution of bamboo in three provinces in the Philippines. The results of the image classification were harmonized with the ground scenario through community mapping with participation by local stakeholders, who affirmed the maps showing bamboo distribution during the results presentation. The projected distribution of bamboo was affected by elevation, slope, and proximity to rivers and roads. There is now a follow-up study being planned where the methodology developed

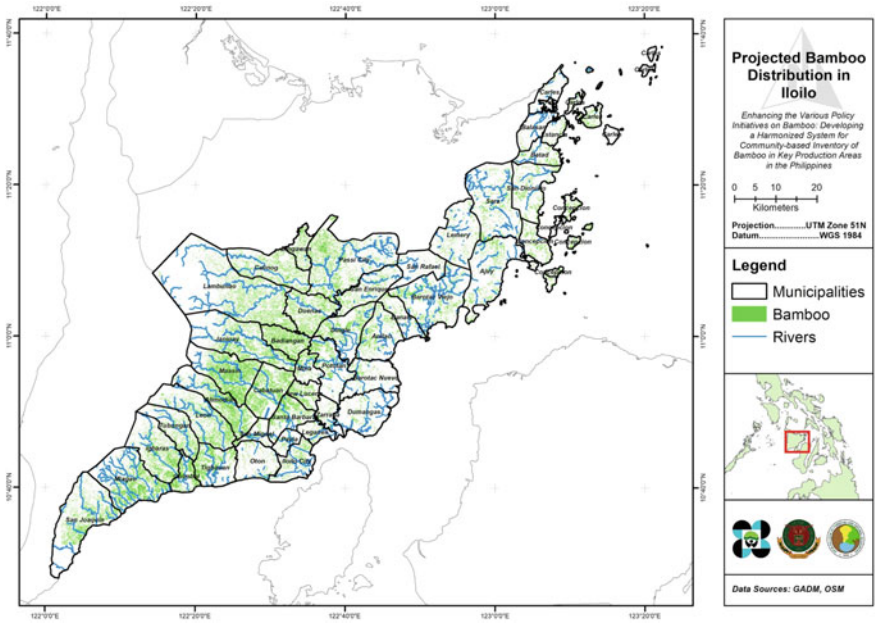

Fig. 7.6 Projected bamboo distribution map in the province of Iloilo, Philippines

Table 7.6 Number of clumps per species per municipality in Iloilo

Species	Alimodian	Janiuay	Maasin	Grand Total
BOLO/BUTONG *Gigtochloa levis* (Blanco) Merr	–	1	–	1 (0.33%)
GIANT BAMBOO *Dendrocalamus asper* (Schultes f.) Backer ex Heyne	–	–	6	6 (1.99%)
KAWAYANG TINIK / KAWAYAN *Bambusa spinosa* Roxb	91	79	124	294 (97.67%)
Grand Total	91	80	130	301

Table 7.7 Projected harvestable culms per species in the province of Iloilo

Species	Density (Harvestable culms/ha)	Projected bamboo coverage (ha)	Projected harvestable culms
Dendrocalamus asper (Schultes f.) Backer ex Heyne	7	219	1,619 (0.03%)
Bambusa spinosa Roxb	482	10,710.98	5,173,005 (99.97%)
Grand Total		10,966	5,174,624

for mapping and projecting available bamboo resources would be used to estimate bamboo resources throughout the country.

7.6 Conclusion and Recommendations: Role of Bamboo in Knowledge Generation, Conservation and Community Livelihood

From time immemorial until today, bamboos have provided benefits to Filipinos especially in rural areas where traditional uses of bamboo-made products in agriculture, fishing, and domestic households persist. Filipinos' fondness for celebrations, fiestas and community activities are marked with events where bamboos play significant role as material for props such as arches, lanterns and torches, as tools for games and merriment, and in transporting people and preparing food. Interestingly, current trends in interior design lend refreshing ways by which traditional products such as the "bilao" or winnowing basket are utilized as decorative wall art with startling prices far above what they could ordinarily command (Malasig 2021). Beyond the traditional uses, new technologies are allowing the use of bamboo for modern applications such as engineered structural materials and products that are catching on in the cities and urban areas.

Bamboos have no rival among the country's NWFPs in terms of attention, recognition, and familiarity to people. The Department of Trade and Industry Secretary announced in March 2021 that Php22B was allocated by the government for the current year, 2021 and for 2022 to support bamboo projects such as planting more than 60,000 hectares of land to bamboo, extending technical assistance to agribusiness and bamboo processing by micro, small and medium enterprises, among others. The shift in the Department of Education curricula had integrated into the learning programs at the elementary and high school levels opportunities for using bamboo instruments to develop rhythm among students and in performing as members of "Pangkat Kawayan," an ensemble that assembles different kinds of bamboo instruments (Department of Education 2016). Many Philippine universities have their own bamboo nurseries that produce bamboo planting materials; others have workshops with tools and equipment for making bamboo products, and several other state colleges are running their own research programs on various aspects of bamboo production, conservation, and utilization. Indeed, government is pinning its hopes on bamboo as a resource that will help in a post-pandemic economy because bamboo has "good export potential, wide industry application, and (can help in) jobs creation" (Magkilat 2021).

Although most bamboo initiatives are led by government, there are indications that the private sector is contributing its share to boost the local bamboo industry. A *bambusetum* planted with several bamboo species was established by the Carolina Bamboo Garden in Antipolo City in Rizal Province (Luzon Island) which also serves as venue for the conduct of training on bamboo propagation and production. This

company also produces planting materials for sale to bamboo growers and has partnered with various research institutions on the conduct of research on bamboo, such as tissue culture and the use of bamboo for textile production. There is a similar venture in Balamban, Cebu (in Visayas, Central Philippines), that of the Kabilin Nature Farms and Bamboo Center which had planted more than 100 species of bamboo for "timber," ornamentals, and for food. It also engages in seminars on bamboo nursery and plantation establishment and postharvest processes. In the mining sector, companies are complying with a government directive to use bamboo as planting material to cover at least 20% of their declared mining area to help in the rehabilitation of their mined-out areas. Prior to the pandemic, private companies that make novelty bamboo products like bamboo bicycles and motorbikes, boats made of bamboo panels, contemporary furniture designs, fashion accessories, and sporting goods regularly participated as exhibitors to the bi-annual Manila Furnishings and Apparel Manufacturers Exchange (FAME) held at the Manila World Trade Center in April and October each year. This event is organized by the Center for Trade, Expositions and Missions (CITEM) under the DTI to assist in promoting the products of micro, small and medium enterprises.

In 2021, as part of the celebration to commemorate its establishment, the Philippine Bamboo Industry Development Council spearheaded four regional bamboo summits (one each for Northern and Central Luzon, the National Capital Region and Southern Luzon, the Visayas Region, and lastly Mindanao) that culminated in the National Bamboo Summit. For each region, bamboo players representing local government units, academe, and private industry, shared their initiatives on bamboo while national government agencies presented their programs (such as shared service facilities, technical assistance, and loan programs) that are designed to boost bamboo not only as an economic crop but also as one that can reduce atmospheric carbon and protect the environment. The newly-organized Philippine Bamboo Society of Advocates Inc., an organization whose core members represent scientists, educators, civil society leaders, and investors and entrepreneurs led the conduct of a Bamboo Conference on Earth Day 2021. The event was marked by the launch of a bamboo database management system which aims to provide a digital platform that collects and makes available data on bamboo that will help decision making by government, farmers, investors, and researchers. Along with the push in Congress to pass a law that will strengthen the bamboo industry, these developments portend a future where relentless efforts by multisectoral groups to harness bamboo for livelihood and poverty reduction, enterprises, and environmental conservation will continue.

Challenges and Way Forward

There are gaps in knowledge, supply of bamboo materials, and market information (KSM) that need to be filled to be able to realize the full potential of bamboo to contribute to the country's sustainable development goals. Knowledge gaps include lack of understanding by the general public of the intricate differences among the different bamboo species and their suitability for various end-products and uses. Bamboo is generally used as a generic term for all bamboo regardless of the species and their characteristics. This affects decisions on which species to propagate in plantations, the determination of appropriate planting sites, and the choice of species in

manufacturing products that meet customer specifications. Bamboo scientists need to play a more active role to educate bamboo growers and product manufacturers and even consumers on the importance of proper selection of species to meet their specific objectives. Research on the interchangeability of species for variety of products, especially those with increasing demand in the international market have to be undertaken.

Supply gaps in bamboo culms are also anticipated with the expansion of manufacturing in the furniture, panels, textiles, and other emerging bamboo products. Investors are worried that if they increase their production capacities and acquire new equipment, the limited supply of bamboo would imperil their capacity to recoup their capital. Policies on bamboo harvesting and transport that were crafted in the past as if bamboo were similar to timber trees have not been updated and serve as disincentive to private landowners in opening their land holdings for bamboo plantation development. There is therefore a need for government to ease such regulations to encourage bamboo planting by the private sector. Improving regulations will also lessen transaction costs for permit applications and during transport that burden traders of bamboo. Likewise, many idle forest lands should be identified and made available to peoples' and private organizations that can easily tap resources for bamboo plantation development. To increase planting materials, assistance in bamboo nursery establishment in strategic locations as well as efforts for developing tissue culture protocols of commercially important species should be supported.

Finally, the Philippine bamboo industry stakeholders need better access to market information to enhance the bamboo value chain—one that cannot just meet domestic demand for bamboo products but also can compete with the global market. Evidently, just responding to the local market is not enough to modernize and propel the bamboo industry forward. There is need for better global market information and to convey relevant information to various levels of the bamboo value chain for greater efficiency and more equitable sharing of benefits among the bamboo players, i.e., bamboo growers and farmers, traders, product manufacturers, and consumers. Bamboo growers should be assisted by providing them with the knowledge and skills on how to grow better quality culms so that they can find buyers who will be willing to pay reasonably good prices for their bamboo. The climate for investing in bamboo enterprises should be improved to make it more conducive than other countries, in order for the Philippine bamboo industry to be more competitive in the global market. Thus, incentives for procuring state-of-art machines or for engineers to design and fabricate suitable equipment should be provided. Government agencies tasked to promote local products should be more aggressive in tapping new markets and in highlighting the unique advantages such as the high level of craftsmanship and innovativeness that go into Philippine-made bamboo products. The value of bamboo as a green material that contributes to sustainable development, reducing poverty, enlivening cultural traditions and in protecting the environment cannot be overemphasized.

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Chapter 8
Non-wood Forest Products of Nepal: Status, Issues, and Challenges

Shreehari Bhattarai

Abstract Forests provide enormous goods and services not only to mankind but also to all living organisms thus being the lifeline in the world. Non-wood forest products (NWFPs) are the most important provisioning services people obtain from the forest. The importance of these goods and services is even more significant to the people living in the remote mountainous regions of the Himalayan countries where rural livelihood is dependent on these resources due to the absence of alternative activities for an economy generation. This chapter aims to explore the present status, trade, processing, contribution, and challenges of NWFPs in Nepal. The unique position of Nepal in terms of geography provides harbor for thousands of potential NWFPs on which the livelihood of many people living in and around is associated. It has been reported that, around 2331 species of valuable NWFPs are distributed in the unimodal patterns along the altitudinal gradient. People harvest NWFPs mainly from the wild and sell them either in raw form or with a little processing for value addition. It is therefore, the utmost requirement to shift from traditional methods of harvesting and processing to scientific ones to address issues of commercialization of NWFPs, access to the national and international markets, sustainable harvesting and value addition activities.

Keywords Value addition · Medicinal and aromatic plants · Processing · Trade · Livelihood

8.1 Introduction

Human beings are known to use natural resources in different ways since the time of civilization (Kunwar and Bussmann 2008) thus indicating the existing close relationship between plants and people throughout the world. There exist abstract and concrete types of relationships between plants and people. The concrete relationship deals with the direct use of the plants by people whereas the abstract relationship

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indicates the faith, taboo, and indirect relationship existing between them since long back showing that the plants to be not only useful natural resources but also an integral part of human life. Most of the people if not all in Nepal worship forest in the name of 'Bandevi' while entering and extracting the goods and services from the forest to date. This shows the respecting mindset of the people towards the forest and their attitude in due course of conservation of natural resources.

People in all countries of the world largely depend on the plant resources, which provide a wide range of useful products widely categorized into the timber and non-timber forest products. Non-timber forest products (NTFPs) consist of goods of biological origin other than timber derived from forests, other wooded lands, and trees outside forests (FAO 1999). The non-wood forest products (NWFPs) though used synonymously with NTFPs excludes all woody raw materials viz. timber, chips, charcoal, fuelwood as well as small wood such as tools, household equipment, and carvings are excluded. NWFPs are interchangeably used with the words NTFPs, medicinal and aromatic plants (MAPs), *jadibuti* or minor forest products in Nepal. Traditionally these are a source of food, medicine, timber, fodder, ornaments, etc. obtained from the forests which meet the daily requirement of human life. Wild edible plants that have nutritive values have been used since long back for fulfilling dietary requirements (Dangol et al. 2017). These plants have important contributions to food security by providing staple and supplement foods and also income-generating opportunities to both local livelihood and national economy.

Medicinal and aromatic plants (MAPs) are an important part of NWFPs. It is estimated about 21,000–30,000 medicinal vascular plants throughout the world to which 80% of people in developing countries rely on their health care, nutritional needs, and income generation (WHO 2004; Bandaranayake 2006). The use of medicinal and aromatic plants (MAPs) is not only limited to traditional use and regions or countries with prominent indigenous cultures and beliefs but also expanding to developed western countries where over 100 million citizens use MAPs in their healthcare (WHO 2013). This expansion in the use of MAPs has led to a dramatic increase in demand in both national and international markets (Hamilton 2004; Lange 2006). The Himalayan region alone harbors about 12,000 MAP species, supporting the livelihood of about 600 million native inhabitants (Pie 2001).

The unique position of Nepal in the center of the Himalaya with diverse microclimatic conditions enables it to host thousands of plant species having the economic NWFPs and is one of the major suppliers of these plants to India since time immemorial (Edward 1996). The mountainous regions country with varying altitudinal gradients and aspects create countless physiographic features ranging from the plain of Terai to the world's tallest peak Mt. Everest thus representing almost all ecological regions of the world. The vegetation comprised of tropical, subtropical, temperate, subalpine, and alpine regions are, in fact, very valuable and possess the potential to bear highly valuable morphological, anatomical, physiological, chemical, and ecological properties though the diversity of medicinal plants are higher at low elevation (Rokaya et al. 2012).

8.2 Status and Distribution Pattern of NWFPs in Nepal

The varying ecological regions created due to altitudinal gradient starting from tropical to alpine and snow-covered high mountainous zones of Nepal provide shelter to thousands of potential species. As a result, the country shows disproportionally high species richness in comparison to the smallness of the area it embodies. The country comprises about 0.1% of land area on the global scale and so far, 13,067 plant species consisting of algae (1001), fungi (2467), lichens (792), bryophytes (1213), pteridophytes (580), gymnosperms (41) and angiosperms (6973) (Chaudhary et al. 2020). It has been estimated that there are over 2000 species of plants in Nepal that are known to be potentially useful, including about 1600–1900 species commonly used for medicinal purposes (Shrestha et al. 2000; Baral and Kurmi 2006; Ghimire 2008) though proper documentation of Nepalese NWFPs is still lacking. For instance, experts estimate that 700–2331 species of MAPs occur in Nepal; however, the Department of Plant Resources (DPR) has recorded just 690 species of MAPs. On the other hand, the Medicinal and Aromatic Plant Data Base of Nepal (MAPDON) has listed 1624 species having ethnobotanical importance and some studies have also recorded up to 2331 useful medicinal and aromatic plants categorized into 7 different life forms (Table 8.1) in Nepal (Rokaya et al. 2012) thus increasing the number of plant species with ethnobotanical values.

The distribution pattern of NWFPs shows a unimodal relationship with elevation (Ghimire 2008; Rokaya et al. 2012). The distribution of NWFPs could be found from low-lying forests (< 100 m) up to the high alpine and trans-Himalayan regions (> 5500 m). Some of the species like *Corydalis hendersonii*, *Delphinium brunonianum*, *Gentiana urnula*, *Lamiophlomis rotate* etc. are also reported from 6100 to 6300 m (Ghimire 2008). Though the preliminary analysis of the distribution pattern of MAPs group of NWFPs along the altitudinal gradient shows that the lower sub-tropical level (below 1200 m) harbors a proportionally maximum number of species (679), the subalpine (3000–4000 m) and lower alpine (4000–4500 m) levels provide important habitats supporting to highly valued species by national as well as international trade (Bhattarai and Ghimire 2006). The lower number in the higher elevation could be due to harsh climatic conditions, area effect, topographic and edaphic features. But, interestingly these areas provide better quality and quantity of secondary metabolites thus increasing the medicinal properties of the plant though it is largely governed by the genetic constituent of the plant and other ecological features (Mahdavi et al. 2013). Moreover, the majority of the naturally growing MAPs (28.5%) reported from Nepal are also endemic to the Himalayan region (Ghimire 2008). Tiwari et al. (2019) have reported altogether 312 species of endemic plants to Nepal Himalaya. The largest number of endemic plants has been reported from altitudinal gradient of 3800–4200 m in especially in the central regions of Nepal probably being the transition zone between the eastern and western Himalayas. Increased endemism in the higher elevation regions may be due to geographic isolation created due to isolated mountain peaks thus promoting isolation and speciation.

8.3 Objectives of this Chapter

The main objective chapter is to gather information on the status, uses, processing, trade, and challenges of NWFPs and their role in the local and national economy. Likewise, this chapter aims to explore contribution of NWFPs in sustaining the livelihood of the local people.

8.4 Status, Issues, and Challenges of NWFPs

8.4.1 Production of NWFPs in Nepal

A large amount of NWFPs is harvested from the wild whereas the agroforestry system and cultivation of selected species also contribute a small amount to the total volume. KC (2018) reported that more than 80% of the total volumes of NWFPs are harvested from the wild whereas about 20% have been collected from agroforestry systems or cultivated farm-land. The NWFPs are equally famous in the intercropping system with crops. The cultivation of *Zanthoxylum armatum*, *Juglans regia*, *Valeriana jatamansi* and *Swertia chirayita* along with *Rhododendron arboretum* and *Alnus nepalensis* in Dailekh and hilly part of Surkhet district and plantation of *Thysanolaena maxima* under *Cinnamomum tamala*, *Quercus leucotrichophora*, *Myrica esculenta* and *Choeospondias axillaris* in Baitadi are notable examples of adoption of intercropping practices of NWFPs in agroforestry systems (FRTC 2019). The government of Nepal has prioritized 33 NWFPs (Table 8.2) for research and cultivation (DPR 2016). *Aconitum heterophyllum*, *Neopicrorhiza scrophularifolia*, *Morchella conica*, *Zanthoxylum armatum*, *Berginia ciliata* are few selected examples of prioritized species for research and cultivation.

8.4.2 Sustainability Issues of Harvesting NWFPs

Though the plants are renewable natural resources, they also require a certain period to grow and maintain maturity. If the resources are used beyond their natural regeneration, the population of such resources would be declined and finally become rare thus leading to the extinction from the entire world. The larger the market for the NWFPs, the higher becomes its value and the greater the overexploitation. This necessitates a more careful assessment of NWFPs resource base as well as devising a sustainable harvesting system to conserve the resources for long-term benefit (Ojha et al. 2001).

Harvesting is the process of gathering materials from different sources. The basic concept of sustainable harvesting is that a biological resource should be harvested within the limits of its capacity for self-renewable. In other words, it is the manner

of harvesting biological resources so as not to degrade the environment in other ways. Sustainability is the use of plant resources at levels of harvesting and in such ways that the plants can continue to supply the products required indefinitely (Wong et al. 2001). However, the increase in the demand for NWFPs in both national and international markets led to indiscriminate and unscientific collection without any consideration for the quality of the material collected.

As most of the NWFPs are collected from wild sources and there is growing competition in the harvesting of NWFPs thus the sustainability issue is always questionable. Still today local people use traditional knowledge to determine the timing of harvesting, material to be harvested, harvesting techniques, harvesting equipment, and even storage system and there is almost no use of advanced scientific tools and techniques adopted for gathering the valuable pant parts or as a whole. The key issue is due to the heterogeneity of life form, seasonality, distribution pattern and part/s used of the NWFPs the sampling methods and methods used for quantification are consequently diverse, depending on nature and product. Thus, the traditional knowledge-based lifelong experience of the local people is widely practiced as the key factor for the utility and accuracy of an inventory. Moreover, due to the less effective government's enforcement mechanism to the remote mountainous areas, it is not sufficiently strong to protect forest resources in many areas thus the NWFPs resources especially in remote areas of the mountains of Nepal have become 'no men's property' and the scenario has resulted as the 'tragedy of the commons'. Likewise, most of the high-value MAPs are long-lived perennial with slow growth and show high habitat specificity, increasing commercialization of certain selected high valued NWFPs, premature and over-harvesting by uprooting or cutting of the whole plant is one of the serious concerns for the sustainability of such species (Ghimire et al. 2008; Deb et al. 2015). Moreover, in many cases, the immature extraction of fruits, roots, tubers, etc. has drastically reduced not only the quality as well as quantity of the raw product to below critical level but also created huge pressure on the natural population due to very low rate of regeneration.

8.4.3 Traditional Knowledge-Based Management Practices for NWFPs

Still today, people have been using traditional knowledge-based management practices especially in the mountainous areas for the long-term availability of valuable species. Plantation of religious, ornamental, food and fodder valued plants are no new practice for Nepalese societies. The plantation of religious plants (*Ficus religiosa*, *Ficus bengalensis*) in public places like roadside, near and above watersprings and wells is still in practice. Likewise, various social and religious rules are useful for conservation and management. For instance, Shingi-nava, one of the important community level traditional knowledge of the Himalayan people, living in high mountainous regions. In Sherpa language, Singi means wood or trees and nava means

to ask thus the literal being to ask someone before cutting any trees or woods (Basnet 1992). Subedi (1997) highlighted various traditional knowledge-based management practices to address sustainability issues for the wild NWFPs as -

8.4.3.1 No Management

The species which have occasional use for domestic purposes by a limited population and also have very low trade demand are just used without any control management. This management option does not let the resources deteriorate in their natural habitat due to very low demand and the extraction of resources does not exceed the production capacity.

8.4.3.2 Controlled Harvesting

It is the practice of collecting valuable NWFPs leaving enough healthy and mature individuals for natural regeneration. It is a simple, easy, and effective method to address the sustainable issue of management. This option ensures the natural regeneration of healthy individuals in an area and checks the over-exploitation of NWFPs. It can be endorsed either by.

Rotational Harvesting

This is the most common and widely applied mechanism to manage the natural population of economic species. For instance, people have been managing *Nardostychys grandiflora*, *Picrorrhiza scrofulariiflora*, and several other commercial NWFPs species in Humla and other remote mountainous areas where elite people decide which area is suitable for collection and which to be left for this year. Though these people may not have scientific knowledge about ecology, reproduction biology, and the rotational period of the particular species, they use traditional knowledge and decide an average rotation period or by treating them separately. The rotational harvesting strategies having a defined year or season is found to be effective method in conservation of valuable species (Rokaya et al. 2017).

A Fixed Quantity of NWFPs Harvesting

In this system, a certain area is allocated for the collection of a certain quantity of NWFPs. For this, the quantity of harvestable species from an area has been assessed and allowed permission for collection for a fixed amount. This method can be applied for managing NWFPs as the extraction does not exceed the annual regeneration rate of the species. However, care should be taken whether a certain part of an area nearby households or easily accessible is heavily exploited.

Selective Harvesting

This management practice is highly applicable for those NWFPs that have specific harvesting requirements of season, age, or maturity when higher quality and quantity of the product can be assured. For instance, Pine trees of a certain range of diameter are selected for resin tapping. But under mature and over mature products which are going to waste could be used by selecting for harvesting. This measure is beneficial when the same species have different properties or different products on different time series of life.

8.4.3.3 Intensive Management

In this system, all stages of life form including production have been focused on. As the term indicates there is intensive care for a specific species by cleaning the site, providing light, space, and other regular management like thinning, coppicing, etc. as per need are regularly applied to uplift the propagation effectiveness in natural conditions, and to optimize the productivity. Though it is tedious, laborious, costly, and time-consuming and management system thus being rarely applied, it is useful for the production of higher quality and quantity. Though this is almost impossible to apply in large areas, it can be applied for specific species having high economic value and a high risk of population declination.

8.4.4 Processing Practices of NWFPs in Nepal

Processing is a process of converting raw material into semi or finished products for marketing and wider use/application thus becomes the key for value addition. The process undergoes several operations after harvesting such as washing/cleaning, drying, sorting/grading, bundle making, and storing of all plant products (Chandel et al. 2018). The processing and value addition is the amount by which the value of an item/material is increased at each stage/level of its production exclusive of the initial cost. It is a very important process and becomes crucial for commercial exploitation. However, the practices of processing and value addition in Nepal are still traditional ones and usually guided by local healers just following the traditional knowledge and their own experiences as a result NWFPs receive only 32% of the final price in India (Edward 1996).

For instance, the number of active enterprises undertaking to process of MAPs exists 233 in Nepal, though it has increased about ten-fold in the past two decades (Chapagain et al. 2019). Although the distribution of highly valuable species of NWFPs is high in western Nepal especially Karnali province, the processing centers are centralized in Bagmati province (Fig. 8.1). Chapagain et al. (2019) found that the number of active processing enterprises to be highest in Bagmati province (49.4%) followed by Lumbini province (21%) and Province 1 (16.3%). Likewise, the number

decreased to be 4.3% in Gandaki province, 3.9% in Karnali province, and 1.7% in Sudurpashchim province. This result shows that the processing practices of NWFPs in Karnali and Sudurpashchim provinces are almost negligible, indeed, both of the provinces constitute about 85% of medicinal plants harvested from Nepal (GIZ 2011), and also far-west Nepal alone contributes about one-third of the total traded volume from Nepal (Kunwar et al. 2015). Thus, there exist an inverse ratio between the richness of the NWFPs and processing enterprises. As a result, most of the NWFPs are being traded mainly to India without or just following a simple processing and value addition. Only a small proportion of NWFPs collected are processed within Nepal by a few processing industries like production of resins, turpentine, kattha, paper, essential oils, etc. or cottage industries using fibers and non-wood materials. The weaving of *Girardiana diversifolia* for clothes, *Arundinaria falcate* for baskets, mats, honey production industries from bees, incense making, *Aesandra butyracea* oil production, *Daphne bholua* for handmade paper are selected examples practiced for various type of forest-based enterprises (Lamsal et al. 2017).

8.4.5 Extraction of Essential Oils

The practice of extraction of essential oils in Nepal is no new. Both native and exotic species have been used to extract essential oils and utlised in different products as major or minor constituents. Large cardamom oil, Palmarosa oil, French basil oil, Lemongrass oil, Citronella oil, Vetiver oil, Spikenard oil, Jatamansi oil, *Zanthoxylum* oil, Turpentine oil, Himalayan Silver Fir- needle oil, *Artemisia* oil, Cinnamon oil, Wintergreen oil, Juniper needle 7 berry oil, Calamus oil, *Litsia* oil, Sugandhakokila oil, Valerian oil, *Anthopogon* oil and Lichen resinoid or Lichen extract are common extraction from the native plant species whereas Chamomile oil, Palmarosa oil, Peppermint oil, French basil oil, Medicinal eucalyptus oil, Cornmint oil, Japanese mint oil, Lemongrass oil, *Citronela* oil are extracted from the exotic plants cultivated in farm-land (Adhikari 2018).

8.4.6 Trading of NWFPs in Nepal

NWFPs have been used by billions of people to fulfill their daily requirements. Indeed, it is estimated that over 70% of the worlds' population depends exclusively on MAPs, an important aspect of NWFPs, for their healthcare needs (WHO 2002). In recent years, there has been a surge in the international trade of medicinal plants and their derivatives with some 3000 species traded in response to demand for herbal products (Schippmann et al. 2006). Vasisht et al. (2016) find that the average global exports of medicinal plants were valued at approximately USD1.92 billion and involved 601,357 tons per annum in 2000, reaching 702,813 tons with a value of USD 3.6 billion, in 2014. The World Bank (2018) reported that the global medicinal

plant export value be 2.6 billion USD in 2016 suggesting the increasing demand for natural products from the international market. Likewise, GIZ (2017) reported that the global trade in medicinal plants has increased 3% annually since 2010, with an estimated total trade of 673,564 tons in 2014 valued at 2.7 billion USD.

These varying ecological regions provide shelter to thousands of potential species thus leading to the country one of the major supplies of them. However, the quantification of trade had started a few decades ago when Edwards (1996) estimated 10,000 tons of MAPs from more than 100 species were harvested in and from Nepal. However, there is still a general lack of reliable trade data that constrains the estimation of the total amount of NWFPs in trade. The data generated by the Department of Forest, Ministry of Forests and Soil Conservation of Government of Nepal seems to be far lower than expected thus indicating the lack of transparency in the market circuit (Maraseni et al. 2006; Humagain and Shrestha 2009). Despite the historical and contemporary importance, there is no comprehensive overview of what species in how much amount are traded and from Nepal, hampering identification and conservation priorities though some studies have estimated the number of traded species at 100–170 (Subedi 2006; Bhattarai and Ghimire 2006; Ghimire et al. 2016). For instance, Subedi (2006) estimates a total of 161 plant-based NWFPs harvested for commercial purposes whereas Bhattarai & Ghimire (2006) listed a total of 143 species for commercial purposes. Thousands of tons of different species of plant-based non-timber forest products are harvested annually in Nepal and exported mainly to India and China thus being one of the important reservoirs of the supply of MAPs in Asia including India and China (Olsen 2005a; Pyakurel and Oli 2013). It was estimated an average of 20,000 tons of raw materials, made up of 125–178 medicinal plant species (Srivastava 2009). For instance, Olsen (2005b) estimated the export of 14,500 tons of crude MAPs worth USD 16 million to India and China. Similarly, Ghimire et al. (2015) estimated the export of 10,770 tons of MAPs worth US$ 60.09 million from Nepal in 2014. Notably, 85% of medicinal plants of Nepal are harvested from Mid- and far-western regions of Nepal (GIZ 2011), and also far-west Nepal alone contributes about one-third of the total traded volume from Nepal (Kunwar et al. 2015). The no. of species is estimated up to 300 different species exported from Nepal to more than 30 countries mainly in Asia, America, Europe (Pyakurel et al. 2018, 2019).

India is the major market of Nepalese NWFPs with more than 90% of the products being exported to India in raw form (Olsen 2005a), with the growing global market, trans boundary trade of these valuable species is in the discussion. Among the few existing studies, the focus is limited to trade between Nepal and India although the huge volume of MAPs exported to China and other third countries (Kunwar et al. 2013, Choudhary et al. 2014). Export of some high valued NWFPs collected especially from high mountains including *Swertia chirayita*, *Sapindus mukorossi*, *Paris polyphylla*, essential oils, *Elaeocarpus*, and *Ophiocordyceps* has been initiated to China especially after 2011 when the value of traded plants increased more than ninefold (Pyakurel et al. 2017; He et al. 2018). During the past decade, some high-value NWFPs, such as essential oils and handmade paper is processed and the majority of them are exported even to Europe and the USA (Bhojvaid and Khandekar 2014). In

general, the trade channel follows collectors → village traders/middlemen → district traders → regional traders → export to India, Tibet, and abroad. NWFPs with local utilization along with national/international commercialization have provided opportunities to local people and also created a new market of such plants and opening up new markets, NWFPs have evolved as an important source of income for many rural communities in Nepal. These NWFPs are commonly gathered by local communities in the remote rural villages of Nepal and are sold to road-head businessmen and nearly 90% of which are exported to India in crude form, which is then supplied to other countries by the Indian wholesalers (Maraseni et al. 2006; Pandit 2008; Thapa Magar 2008).

8.4.7 Volume Versus the Value of Traded NWFPs

The trade status of NWFPs would be better if analyzed on a volume and value basis as the value of 1 kg *Ophiocordyceps sinensis* may equivalent to tons of volume of *Phyllanthus emblica* and so on. Thus, top most NWFPs in terms of volume and value traded from Nepal (Tables 8.3 and 8.4) have been analyzed just following DoF (2015). The data shows that *Sapindus mukorossi* to be the most traded species in terms of volume (625.4 ton) followed by *Polyganatum* sp. (523.2 ton). However, *Ophiocordyceps sinensis* though does not come even under the top ten most traded species, provides maximum revenue (239 million). The total volume of NWFPs traded from Nepal and the total revenue generated through these traded species have been shown in Figs. 8.2 and 8.3 following KC (2018). Notably, there is a big difference between the domestic and custom value of highly valuable species (Fig. 8.4) thus showing the lack of transparency in the trade (KC 2018; Chapagain 2020). The hidden economy and informal practices of trade of valuable NWFPs are more likely to be used to escape the complex governmental processes and royalties. The researchers estimate that the legal export value of Nepalese NWFPs is many times less than the amount exported.

8.4.8 Role of NWFPs in the Local and National Economy

NWFPs, especially medicinal and aromatic plants (MAPs) have been identified as one of the potential high-value commodities in recent years due to their high demand in both the national and international markets. Of the present total contribution by the forestry sector of approximately 15% to the national GDP where NWFPs alone is estimated to contribute about 5% (Ghimire 2008; Poudel 2011). The Government of Nepal Forest Act, 2019, and Regulation 1995 have categorized 248 NWFPs species into 9 different categories especially for collecting the royalties (Table 8.5). Likewise, 10–100% of households are reported to be involved in commercial collection of medicinal plants and other NWFPs, and in certain rural areas this provides up to

50% of the family income thus being recognized as a key component of health care, biodiversity conservation and livelihood in mountainous areas of Nepal (Smith-Hall and Larsen 2003; Shrestha 2011).

8.4.9 Role of NWFPs in the Local Livelihood

The common consensus that livelihood is about the ways and means of making a living. The primary needs of human beings viz. food, shelter, and clothes are always derived from the plants especially NWFPs as these plants provide various goods and services except timber (though bamboo is a good alternative to the timber for construction to some extent) to the mankind. People have been using NWFPs as food, animal beddings, beverages, dying/tanning, exudates, fiber and fiver yielding, fodder, fruits and nuts, fumitory and masticators materials, insecticides and herbicides, legumes or pulses, medicinal plants, soap/cosmetics, spices and other flavoring agents, starches and cellulose products, vegetable oils and fats, vegetables, handicrafts, construction material, ornamentals, bio-fuel, support for climbers, veterinary medicine, religious plants, seeds and also become an alternative source of income since long thus showing the role of NWFPs to be far more integrated into our daily life in comparison to the timber (Maharjan and Khatri Chhetri 2006).

Among the many NWFPs, medicinal plants play a vital role in sustaining the livelihood of many rural people living in the Himalayan regions who are largely dependent on the collection, use, and trade of these plants (Bista and Webb 2006) as there is no other suitable alternative for economy generative activities. It has been estimated that 70–80% of the people in the world rely on NWFPs not only in their primary health care but also for income generation activities and improving livelihood (Larsen and Olsen 2007). Manandhar (2002) has estimated that at least 651 plant species of wild plants are commonly used by the local people as food and fruits and 696 plant species are used for a variety of purposes like firewood, fodder, fiber, construction, dyes, washing, ornamental, etc. in Nepal. Traditional herbal medication system has been used since ancient time especially in remote areas where the formal and modern healthcare is limited. *Baidhya*, *Amchi*, *Kabiraj*, local herbal medicine, tribal lore are equally practiced medication systems in remote mountainous regions of Nepal. Besides, due to the lack of good alternative income generation activities, people in the remote mountainous regions have to be comparatively more dependent on these species. The importance of such plant resources has not been declined rather a huge no. of wild plants are still widely used in Nepal (Table 8.6) for different food purposes such as vegetables, fruits, pickle, jam, spices and condiments, oils etc. (Dangol et al. 2017).

NWFPs have played a significant role in uplifting the livelihood standards of local people especially in the areas where marketing opportunities and transportation facilities are feasible. Each component of the production network (collection, cultivation, processing, marketing, value addition, and manufacturing) provides an opportunity for value addition thus providing enough opportunities to the locals to

economy generation activities especially to the local people. As a result, the government of Nepal (GoN) has recognized forest and environmental-based small enterprises as a means to address poverty (Paudel et al. 2018). NWFPs not only fulfill the subsistence needs of the rural population but also contribute to generating cash-income. Many of these NWFPs have market demand, so they offer an opportunity to earn cash income especially in cash-constrained rural economies where alternative sources of cash-income generating employments are very limited. Likewise, many of them have medicinal and socio-cultural values and provide a source of cash income for many of the rural population in Nepal (Chhetri and Gupta 2006; Rijal 2008; Kunwar et al. 2009). For instance, a comprehensive study done by FORWARD (2001) reported that NWFPs form a source of cash income for 11%, 5%, and 3% of the sample households in Chitwan, Dhading, and Gorkha districts respectively. Thapa Magar (2008) in Chitwan district shows that NWFPs contribute 18.14% of the total household income, and average income earned from NWFPs was higher for poor households compared to medium and rich households. Likewise, more than 15% households of Baitadi district were engaged in commercial harvesting of MAPs contributing to 9.5% of the total annual household income (Pyakurel et al. 2017) though this economic contribution of NWFPs was a little bit lower than previous findings of Bista and Webb (2006) where it was estimated to be 11.7% contribution from NWFPs in Baitadi thus indicating a probable lowering of the benefits generated from the wild sectors. Similarly, Kunwar et al. (2013) estimated 20% income from the sale of MAPs in Darchula, Baitadi, and Dadeldhura; whereas Smith-Hall and Larsen (2003) estimated 12% contribution of MAPs in higher elevations in Nepal. Likewise, Shrestha et al. (2017) reported 65% of the total household cash income from *Ophiocordyceps* in Jumla district. Similarly, forest based micro and small enterprise sector have also contributed good source for both rural and urban areas especially in the remote mountainous regions of the developing countries as ESCAPES (2011) reported over 60% of the jobs in the private sector, generating 30–40% of the total employment.

8.5 Cross Cutting Issues

8.5.1 Policy Issues

To date, about 90% of NWFPs are harvested from the wild. It has been recorded 300 species in trade which are mainly concentrated in subtropical and lower temperate regions indicating ease domestication but promotion is negligible. Likewise, about 39% of commercial species are formally protected, including through bans on collection and trade of certain species but this approach does not appear to protect species from commercial harvesting, driven by increasing demand and higher prices (Pyakurel et al. 2019). As a result, few high-altitude species like *Nardostachys jatamansi*, *Rheum australe*, and *Picrorhiza scrophulariiflora* are the most vulnerable

traded species. Thus there is urgent need to revise and enforce policy promoting to the locals for cultivation of valuable NWFPs as far as possible. Likewise, in many cases the implemented policy tools do not correspond to the aims of formulated policies and the field reality is still different so NWFPs policy formulation, implementation and the field reality are weakly connected (Larsen et al. 2000).

8.5.2 Conservation and Management Issues

In Nepal, the conservation and management aspect of NWFPs is challenged by multiple factors, and sometimes the resources are also called the tragedy of the commons. Over-harvesting, premature harvesting, and unsustainable harvesting are the major challenges to conserve the species in the natural state. Along with these, habitat destruction, livestock grazing, forest fires, etc. are also responsible for the depletion of valuable species in their natural population (Uprety et al. 2010).

8.5.3 Domestication and Cultivation

Indeed, the domestication of valuable NWFPs in private farmland, community forest land, and leasehold forest land can contribute a lot, very little effort has been applied for the domestication of useful species. NWFPs producing species are almost non-domesticated in Nepal and most traded NWFPs are of wild origin collected from available sources (Subedi 1997; Pyakurel and Baniya 2011). Though few species like *Nardostachys grandiflora*, *Neopicrorhiza scrophularifolia*, etc. are very hard to domesticate, most can be domesticated or cultivated in private or fallow lands and few species like *Swertia chirayita*, *Valeriana*, *Zanthoxylum*, *Asparagus*, etc. are already in practice and there is the possibility of cultivating some high-valued NWFPs like *Rauvolfia*, *Taxus wallichiaa*, etc. (Pyakurel and Baniya 2011). The government has also prioritized about 33 species for cultivation and also 120 species are in cultivation or have been naturalized (Sharma 2007) but still very little is known about the interest of local people to cultivate economic NWFPs in their cultivated land due to the lack of adequate technical knowledge, facilities and awareness along with the issues of equitable benefit sharing if cultivated in community forests (Chowdhary 2004). The complex government rules and regulation especially during release order, unpredictable fluctuation in the market price of the products, the trader-controlled market, and weak bargaining power of the farmer in Nepalese societies has been always a major hindrance for NWFPs domestication and marketing (Dhakal 2010). Besides, there is variation in the price to the species collected from wild and cultivated land as medicinal properties in plants are mainly due to the presence of secondary metabolites which the plants develop under natural condition under stress and competition which perhaps would not be expressed under cultivated monoculture conditions (Schippmann et al. 2006).

Though the domestication of economic NWFPs can provide many economic opportunities to locals, there are certain challenges due to which domestication of useful plants is still in the infant stage. Dhital (2016) highlights the government's complicated procedure regarding NWFPs transaction, monopolistic market structure, no proper dissemination of technical knowledge, lack of onsite value addition process to be the major enhancing factors for domestication. Moreover, availability of seed, proper dissemination of technical knowledge of know-how domesticate and cultivate economic species, management of cultivated species, appropriate processing technology at the local level, legal access to and control over the resources, access to capital, the available and accessible market for the products, selection of ecologically viable and economically feasible species are other possible constrains of domesticating and cultivating valuable species.

8.5.4 Processing Status of NWFPs

Though there exists a high possibility of existing NWFPs in contributing socioeconomic status at the local and national level, most of these resources are being traded in raw form mainly to Indian markets. Most of the MAPs provide ranges of chemical quality and can have a very high economic contribution but are traded at the same price irrespective of their quality (Bhattarai et al. 2018). The general lack of sustainable production practices, inappropriate harvesting, and post-harvest practices, product adulteration, inappropriate value addition, poorly organized marketing information system, and lack of standardized production system has hindered international recognition of Nepalese NWFPs. The existing support services such as communication, storage, organization, transportation, and credit facilities are also the added challenges of NWFPs marketing system in Nepal.

Though there exists a high possibility of existing NWFPs especially from mid-hills and high mountains in contributing socioeconomic status at the local and national level, most of these resources are being traded in raw form mainly to Indian markets. The high mountains are highly admired for high-value but low-volume NWFPs, hence fetching higher prices. However, Nepal has not been able to adequately utilize them. General lack of sustainable production practices, inappropriate harvesting, and post-harvest practices, product adulteration, inappropriate value addition, poorly organized marketing information system, and lack of standardized production system has hindered international recognition of Nepali NWFPs as major challenges to maximize equitable economic returns. The existing support services such as communication, storage, organization, transportation, and credit facilities are also the added challenges of NWFPs marketing system in Nepal. Further, NWFPs collectors, traders, and other categories of entrepreneurs are discerned to be harassed by the prevailing system of multiple taxes/ levying at local levels, insufficient duration of collection and transport permits, high royalty rates, cumbersome IEE/EIA provisions, insufficient manpower to identify/certify the products (whether from sustainably managed

source, organic, etc.), undesignated authority to certify the products as a food supplement and so forth. Thus, it is an urgent need to empower the existing traditional methods of utilization of economic NWFPs, which have just been collected and traded in raw form, to create employment generation, involve youth, and strengthen the socio-economic condition of local people by implementing scientific tools and techniques at every level of collection, processing, and trade.

8.5.5 Challenges in NWFPs Sector

Though many studies document the contribution of collection and trade of NWFPs to the local economy and livelihood outcomes and their significance, especially for poor communities living in mountainous areas (Rayamajhi et al. 2012; Shrestha and Bawa 2013), a large number of studies, on the other hand, also reveal the challenges on management and conservation issues including unsustainable harvesting due to overexploitation (Ghimire et al. 2004; Larsen and Olsen 2007; Shrestha et al. 2014) and uneven benefit-sharing due to poor legal frameworks (Gauli and Hauser 2011). The aggregated effect of increasing global demand, rise in price, and contribution to the household and local income could lead the MAP species towards overexploitation and may cause threats to their sustainability. Further, studies suggested that most of the MAPs traded in and from Nepal are wild-harvested (Ghimire et al. 2015) and are considered as common property resources (Pandit and Thapa 2003).

However, the over role of middlemen like controlled market information so being able to capture very large profit margin (Olsen and Helles 2019) due to access to price information, middlemen controlled market, fluctuating market prices and physiographic inaccessibility are the major limiting factors for getting the real benefit at local levels as inaccessible terrain is one of the major constrains that is why most of the forest based micro and small enterprises in rural areas are only involved in raw material collection and primary processing (Lamsal et al. 2017). Forest gatherer communities who rely on NWFPs for their livelihood are often poorly organized and sometimes they have great difficulties in selling the products even at local markets due to the overwhelming role of middlemen. Also, the price paid to gatherers for NWFPs collection is often very low in comparison to the market price of the products. Larsen and Olsen (2007) concluded that the Terai-based traders, the exporting central wholesalers, control market information and capture a very large profit margin whereas village-based traders get benefited from the local collectors in the same way. Also the insecure and seasonal fluctuation in market price of the products, trader-controlled market and weak bargaining power of the collectors/ farmers are also equally important problems in NWFPs sectors.

The processing of NWFPs in Nepal is still in the infant stage and follows mainly the traditional methods. For instance, *Diploknema butyracea*, a famous butter tree, is used to extract edible oil (ghee). Still today the oil is extracted using a traditional method in many areas. For this a traditional grinder (Dhiki) is used to convert the seed into a fine powder and then placed on perforated plate over the boiling pan and

steamed before expelling the oil. However, with the use of technology the quality was found to be lower than that expected though the quantity of the oil was increased from 25–30 to 40–45% (Koirala, 2009). This is because the technology does not require powdering seeds and steaming the powder rather the seeds were directly fried in a fry pan. The number of local processing and manufacturing industries is few, thus the bulk of NWFPs still leaving Nepal in raw form. The main difficulties are proper market information and access to market and relevant technology, (Subedi 1997) which can be pointed as -

- Lack of marketing infrastructure—still today, the harvesting and trading systems are traditional and there is the need of sustainable harvesting and value addition as far as possible;
- Imperfect wholesale market for NWFPs created by the following conditions: a) limited number of wholesalers, b) controlled price information, and c) government the major buyers for some products;
- Less developed market for many products and high price fluctuations—in many cases the price is regulated mainly by Indian markets;
- Many producers with small quantities of products—receive only a small portion of the total income;
- Role and services of brokers and middlemen—myths and reality (exploitation by middlemen versus their services: cash advances, controlled market information, transport, storage, risk-taking, etc.);
- Lack of market information: current marketing channels, amount of each product, price variation as well as future supply and demand of the products, processed product, development and future price projection;
- Most of the traders with inadequate marketing knowledge and skills;
- Limited access to the availability of information and technology for product development;
- Difficulties in matching market requirements by suppliers due to several uncertainties such as production fluctuation, a decreased collection due to early snowfall, inconsistent quality of products coming from many sources, and guaranty of collection permits.

8.6 Recommendations

- national data regarding status, distribution, traditional uses, and economic importance of NWFPs should be assessed
- bioprospecting of each potential species should be started with suitable biochemical researches
- biochemical screening and their quality should be assessed for all potential NWFPs
- grading of chemical constituents and royalty rates of MAPs should be revised based on their chemical quality

- traditional ecological and ethnobotanical knowledge should be acknowledged and used for scientific researches
- the government bodies should encourage local farmers to cultivation and marketing of economic NWFPs with suitable policy
- the government should establish a reliable market and provide information about the market need to local farmers
- promote local farmers for commercial cultivation of economically valuable species and secure their market
- promote trade/export of NWFPs only after processing and value addition
- research to identify the chemical constituents and promote the trade in chemical level rather than in the crude form
- explore the national and international market and check the over role of middlemen.

8.7 Conclusion

The possibility of life in the world is possible only because of the presence of plants. If there was no plant on the earth, there would be no life at all since most of the requirements if not all to sustain a life on the earth are fulfilled by plants. Both wood and non-wood products are among the most important provisioning services provided by the forest ecosystem. The role of non-wood forest products is more crucial to the people living in the mountainous regions of the Himalayan countries since the people do not have any other suitable alternative for income generation. People harvest various forms of non-wood forest products and either sell in local markets or use them in traditional ways. More than 80% of the total volumes of NWFPs have been harvested from the wild. *Sapindus mukorossi*, *Polyganatum* sp., *Zanthoxylum armatum*, *Cinnamomum tamala* etc. are some of the most commonly traded species on large scale. However, *Ophiocordyceps sinensis* provides maximum revenue though traded comparatively a small amount. Collection and trade of some of the valuable species contribute to 65% of the total family income in the mountainous regions of the country.

Annex 1 (Tables Used in the text)

See Tables 8.1, 8.2, 8.3, 8.4, 8.5 and 8.6.

Table 8.1 Life forms of medicinal and aromatic plants

S. No.	Life form	No. of species
1	Herbs	1292
2	Shrubs	458
3	Trees	356
4	Climbers	137
5	Ferns and fern-allied species	81
6	Bamboo	7
	Total	2331

Table 8.2 Government prioritization for the cultivation of NWFPs

S. No.	Species	Local name
1	*Aconitum heterophyllum*	Atis
2	*Phyllanthus emblica*	Amala
3	*Juglans regia*	Okhar
4	*Neopicrorhiza scrophulariifolia*	Kutki
5	*Mrochella conica*	Guchchi chyau
6	*Tinospora sinensis*	Gurjo
7	*Swertia chirayita*	Chiraito
8	*Tagtes mintua*	Jangali sayapatri
9	*Nardostachys grandiflora*	Jatamansi
10	*Parmelia cirrhata*	Jhyau
11	*Zanthoxylum armatum*	Timur
12	*Cinnamomum tamala*	Tejpat
13	*Gaultheria fargrantissima*	Dhasingre
14	*Azadirachta indica*	Neem
15	*Rheum austral*	Padamchal
16	*Bergenia ciliate*	Pashanved
17	*Dactylorhiza hatagirea*	Paanchaunle
18	*Piper longum*	Pipla
19	*Aconitum ferox*	Bikha
20	*Acorus calamus*	Bojho
21	*Dioscorea deltoidea*	Bhyakur
22	*Rubia manjith*	Majitho
23	*Ophiocordyceps sinensis*	Yarshagunma
24	*Sapindus mukorossi*	Riththa

(continued)

Table 8.2 (continued)

S. No.	Species	Local name
25	*Podophyllum hexandrum*	Laghupatra
26	*Taxus wallichiana*	Lauthsalla
27	*Valeriana jatamansi*	Sugandhawal
28	*Cinnamomum tenuipile*	Sugandhakokila
29	*Asparagus racemosus*	Satavari
30	*Rauvolfia serpentina*	Sarpagandha
31	*Paris polyphylla*	Satuwa
32	*Fritillaria cirrhosa*	Kakoli
33	*Curculigo orchioides*	Kalo musali

Table 8.3 Top most commonly traded NWFPs from Nepal based on volume

S. No.	Species	Nepali name	Amount (Ton)
1	*Sapindus mukorossi*	Ritha	625.4
2	*Polyganatum* sp.	Setak chini	523.2
3	*Zanthoxylum armatum*	Timur	505.8
4	*Cinnamomum tamala*	Tejpat	271
5	*Berginia ciliata*	Pakhanbed	160.7
6	*Persea odoratissima*	Kaulo	115.3
7	*Juniperus* sp.	Dhupi	97.8
8	*Phyllanthus emblica*	Amala	93.6
9	*Rheum austral*	Padamchal	59.1
10	*Valeriana jatamansi*	Sugandhawal	50.54

Table 8.4 Top most NWFPs traded form Nepal based on value

S. No.	Species	Nepali name	Revenue (Million)
1	*Ophiocordyceps sinensis*	Yarsagumba	239
2	*Zanthoxylum armatum*	Timur	40
3	*Polygonatum* sp.	Setak chini	26
4	*Sapindus mukorossi*	Ritha	18.8
5	*Persea odoratissima*	Kaulo	17.3
6	*Morchella conica*	Guchchi chyau	8.08
7	*Berginia ciliate*	Pakhanbed	8.01
8	*Valeriana jatamansi*	Sugandhawal	7.58
9	*Rheum australe*	Padamchal	5.9
10	*Neopicrorhiza scrophulariifolia*	Kutki	5.33

Table 8.5 Categories of NWFPs

S. No.	Classification type	Species number
1	Roots and rhizome	48
2	Bark	25
3	Leaf and Stems	30
4	Flower and Fur	16
5	Fruits and Seeds	66
6	Whole plant	21
7	Gum, Resin and Lac	8
8	Minerals	8
9	Others	26
	Total	248

Table 8.6 Uses of wild edible plants

S. No.	Use category	No. of species
1	Vegetable	246
2	Fruits	126
3	Pickle	44
4	Jam	11
5	Spice and condiment	10
6	Fermenting substrate	9
7	Roasted seeds	8
8	Boiled seeds	6
9	Juice	5
10	Soup	4
11	Tea	2
12	Nectar	2
13	Liquor	2
14	Jelly	2
15	Chewing	2
16	Vinegar	1
17	Cutch	1
18	Baking paste	1

Annex 2 (Figures Used in the Text)

See Figs. 8.1, 8.2, 8.3 and 8.4.

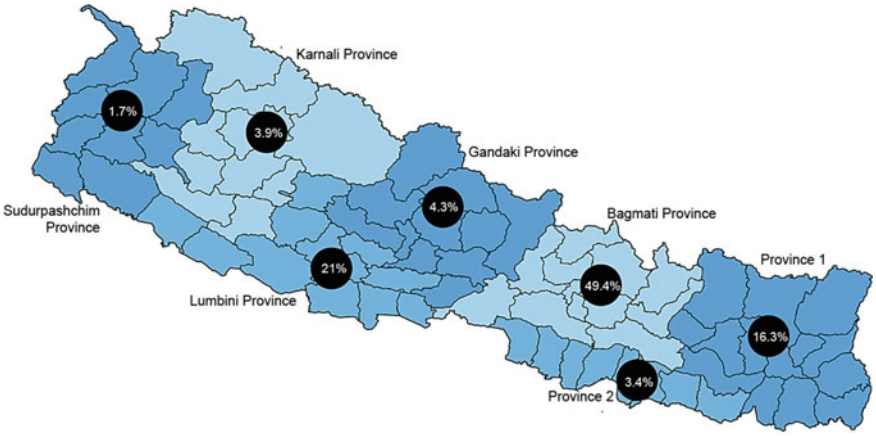

Fig. 8.1 Distribution of active forest based processing enterprises in Nepal

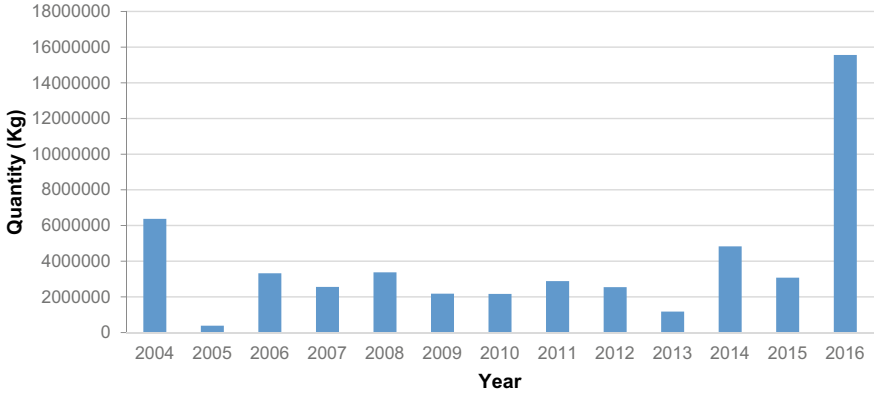

Fig. 8.2 Total amount of NWFPs traded from Nepal

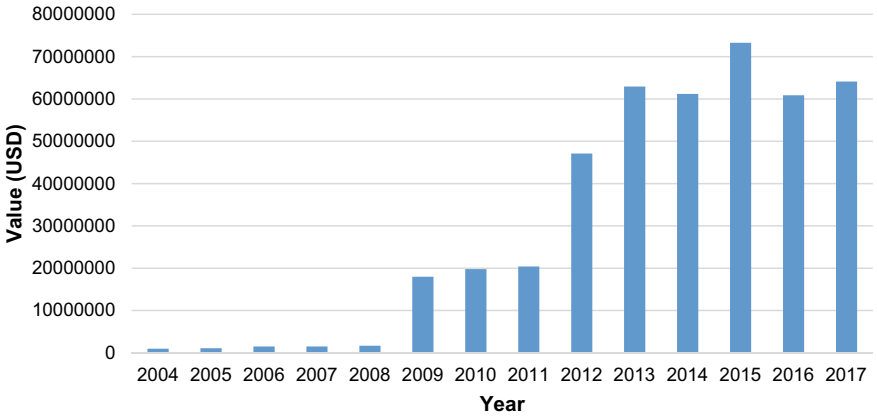

Fig. 8.3 Total revenue generated through the trade of NWFPs from Nepal

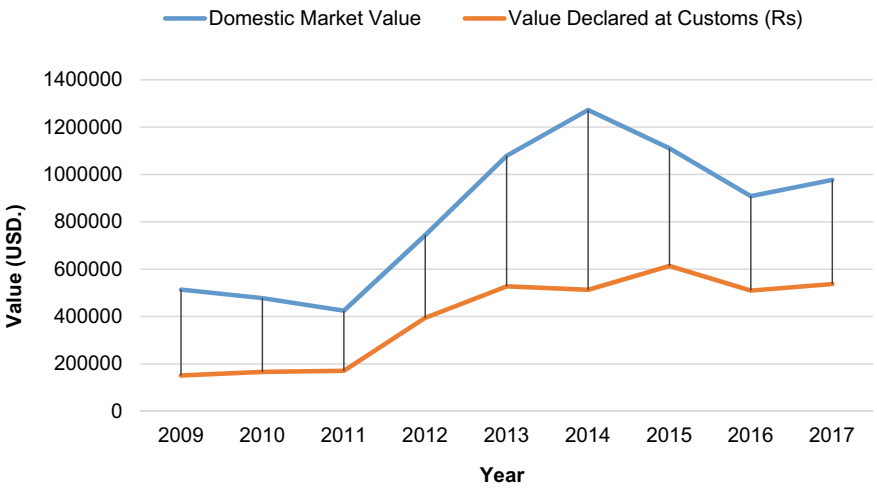

Fig. 8.4 Differences between domestic and custom value of NWFPs

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Chapter 9
Consumption and Marketing Pattern of Non-timber Forest Products in a Rapidly Changing World: Insights from North-Eastern Bangladesh

Sharif A. Mukul

Abstract Non-timber forest products (NTFPs) and their associated products received huge attention from development workers, practitioner and researchers in the past decades for their potentials for rural development. It is widely recognized that promoting the sustainable harvest and utilization of NTFPs can contribute to forest conservation. Nevertheless, with the development progressed in many regions, substitutes for NTFPs becoming readily available in the markets, challenging the NTFPs. A survey was conducted in an urban fringe of north-eastern Bangladesh to explore the NTFP-based product diversity, marketing pattern, challenges in a rapidly changing environment. A total of 38 NTFPs and NTFP-based secondary products were recorded from twenty-five markets, including- 16 permanent, 7 temporary (semi-permanent), and 2 mobile shops. Bamboo and rattan-based products had the highest demand in the locality and at the same time they also suffer from a scarcity of raw materials. A decreasing trend in the consumption of NTFPs-based goods for urban domestic use was evident. To cope with the competitive markets, sellers mainly emphasized creative marketing strategies and durability of products. New policy guidelines and active government support targeting medium and small entrepreneurs are essential for the sustenance of this industry. Besides, an efficient product's supply chain, technical advancement in the production process, and skill development of the relevant stakeholders can secure the future of these products and dependent livelihoods.

Keywords Bamboo and rattan-based products · Consumption pattern · Small-scale traders

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9.1 Introduction

Non-timber forest products (NTFPs) are defined as products mainly of biological origin other than commercial timber, which is derived from either natural or managed forests (de Beer and McDermott 1996). Examples include bamboo, cane or rattans, grasses, and their finished products (Mukul et al. 2010). Non-timber forest products play a significant role in the quality and even survival of large numbers of rural poor in most tropical developing countries (Shackleton et al. 2011; Pimentel et al. 1997; Arnold and Ruiz Pérez 1996). In fact, NTFPs' role and importance to households are diverse, and it helps households achieve self-sufficiency, food security, income generation, accumulation of savings, and risk minimization (Mukul et al. 2016; Mukul and Rana 2013; Arnold and Ruiz Pérez 1996). It has also increasingly recognized that the collection and use of NTFPs are ecologically less destructive, and development and promotion of such products could provide a sounder basis for sustainable forest management and community upliftment (Mukul et al. 2010; Mukul 2007; Arnold and Ruiz Pérez 2001). In fact, NTFPs are still more important resources than timber for the livelihood of many people (Mukul et al. 2014). It is also evident that smallholders living in forest margins in diverse parts of the world earn between 10 and 25% of their household income from NTFPs (Wunder 2000). Another study suggests that tropical forests in parts of south-east Asia provide as much as 50 US$ per month per hectare to local people from exploiting forest resources, without considering the commercial value of timbers (Sedjo 2002; Caldecott 1988). Asia is undoubtedly the worlds' largest producer and consumer of NTFPs (Vantomme et al. 2002). According to de Beer and McDermott (1996), about 27 million people in Southeast Asia rely on NTFPs. However, as the development progressed rapidly in that region in the last years, alternatives or substitutes of NTFPs and associated products become more available in the market, and presumably in the next day's such natural products will have to compete with available synthetic/substitute products that are seemingly more durable, attractive, and cheap (Mukul 2011).

Bangladesh, being situated in a tropical climate, and Gangetic alluvial plains are endowed with a wide variety of flora, including many non-timber forest products (Mukul et al. 2020, 2018). Banik (1998) reported 33 species of bamboo (represented by nine genera and includes 18 naturally occurring species), seven species of rattans/canes, several palms, grasses, and many other NTFPs from the country. In Bangladesh, the collection, processing, and selling of NTFPs provide significant employment opportunities to the ultra- poor communities of about 300,000 (Basit 1995) and contribute approximately Tk 1.3 billion annually to the country's economy (GOB 1993). According to the Bangladesh Small and Cottage Industries Corporation (BSCIC), there are about 45,000 registered NTFP-based small-scale cottage enterprises distributed over the country, which provides employment and income provisions to thousands of millions of peoples (Banik 1998). Several studies have so far been conducted in Bangladesh that covers various aspects of NTFPs including utilization (e.g. Akhter et al. 2008; Mukul et al. 2016, 2012, 2007; Miah and Chowdhury 2003; Alam 1992), cultivation and management (e.g. Rashid et al. 2014; Ahmed

et al. 2007; Chowdhury et al. 2007; Uddin et al. 2006) and socio-economic potentials of NTFPs to rural livelihoods (e.g., Rana et al. 2010; Mukul 2008a, b; Uddin et al. 2008; Motaleb and Hossain, 2008; Uddin and Mukul 2007; Ahmed et al. 2007; Alamgir et al. 2006; Nath et al. 2000; Khan and Khan 1994). This chapter based on a case study in the northern Bangladesh, tries to provide a preliminary outlook of what have so far happened in the urban NTFPs markets in a rapidly globalized world, how traders/sellers coped with the changing situations, what attitudinal changes took place in the urban consumers/users of NTFPs, and what is required to uphold the NTFPs market in a more competitive world.

9.2 Materials and Methods

9.2.1 The Study Area

The study was conducted in Sylhet Sadar—the most populated *upazilla (*sub-district; administrative entity) of Sylhet division located in north-eastern part of the country. Geographically this *upazilla* located between 24° 43′ and 25° 05′ north latitudes and between 91° 40′ and 92° 01′ east longitudes. On the north, the *upazilla* is bounded by Companiganj and Gowainghat *upazillas*, on the east by Golapganj and Kanaighat *upazillas*, on the south Balaganj and Fenchuganj *upazillas*, and on the west by Bishwanath *upazilla* and Chhatak of Sunamganj district (Fig. 9.1). The *upazilla* occupies an area of 517.43 km^2, including 19.22 km^2 of government forest area (BBS 1996). The forests surrounding the area are mainly hill forests and swamp forests (Khan et al. 2007). The average annual temperature is 23.6 °C, with an annual rainfall nearing about 5048 mm (Karim et al. 2020). The *upazilla* is famous for some specific NTFPs in the c*upazilla*ountry, such as rattans or cane (mainly *Calamus* spp.), murta (*Schumannianthus dichotoma*), agar (*Aquilaria agallocha*), reeds, and several species of bamboo (Chowdhurry et al. 2003, 2004, 2007; Uddin et al. 2008).

9.2.2 Data Collection

Fieldwork for this study was conducted between late 2007 and 2008. Both quantitative and qualitative data were collected from field visits and interviewing the respondents (i.e. traders/sellers and consumers/buyers of NTFPs). A total of 25 NTFP shops were surveyed. A semi-structured questionnaire was used to collect data where the NTFPs and finished products available in the shops, local or trade name, origin, major uses, trends of trade, and respondents view on the major challenges of NTFPs trading were recorded. For collecting information from the consumers (n = 12), an open-ended but short discussion was held in the NTFPs shop/stall upon their consent.

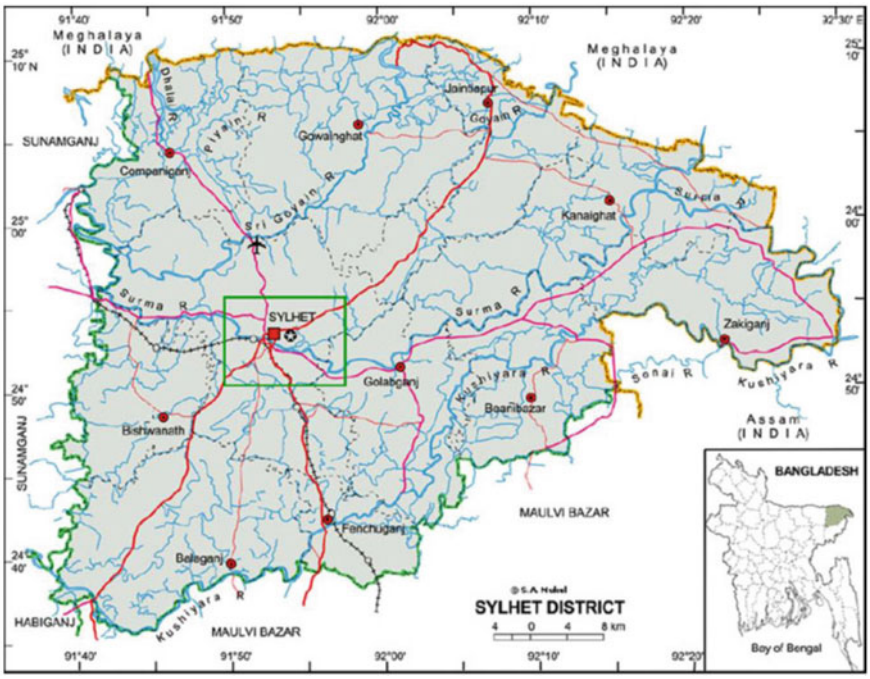

Fig. 9.1 Location map of the study area in northern Bangladesh. *Source* Banglapedia (2009)

9.2.3 Data Analysis and Interpretation

Both quantitative and qualitative data were collected through direct field visits and interviewing the respondents (i.e. traders/sellers and consumers/buyers of NTFPs). Descriptive statistics were used for data analysis. For data input and analysis, MS Excel was used. Income of the NTFPs traders during 1997–98 and 2007–08 from selling NTFPs were collected. Estimated annual revenues of the shops were adjusted by deducting from total sales the production costs, wages for labor (including a provision for self-labor), rent of the shops (where appropriate), and miscellaneous costs (e.g. electricity, supplies, and taxes on sales in the case of permanent shops). To avoid complexity for the respondents (i.e. traders) and to assure the quality of the data, only operating costs were taken without keeping any provisions for permanent or fixed costs (e.g. furniture, machinery), and the amounts represent the cumulative value from selling both plant-based and synthetic NTFPs.

9.3 Results and Discussion

9.3.1 General Information

Altogether, 25 urban NTFPs traders and 12 consumers were surveyed. All the respondents were male (100%). Most of the traders were illiterate (64%); where all the consumers were educated (100%). The average age of the traders and consumers were 41 and 34 years, respectively. Around 72% of the traders were found in that profession for at least ten years, whereas the remaining were relatively new in this profession (< 3 years). The selling of NTFPs was the main occupation for about 64% of the traders, and the share of NTFP based income to respondents (i.e. traders) gross annual income was found to vary from 28 to 100%.

9.3.2 The Marketing of NTFPs and Associated Products

Among the surveyed NTFPs shops, around 64% were permanent, 28% were temporary (or semi-permanent), and 8% were mobile (Fig. 9.2). The permanent shops were usually located in multi-storeyed buildings and found to sell mainly luxurious (decorative) goods for household and corporate use. These products were mostly manufactured from rattan or canes (*Calamus* spp. and *Daemonorops jenkensianus*). The average labor force employed in these shops was about 2.4 people. On the other side, the temporary or semi-permanent shops were on the roadside, and they usually reside in a semi-permanent or temporary structure or even sometimes found in open spaces. The mobile shops were arranged in a specialized vehicle, and they used to sell mainly domestic utensils, cleaning materials such as house broom at a reasonable price.

A total of 38 NTFPs and associated goods from 25 surveyed NTFPs shops were recorded (Table 9.1). Among the products, 18 were based on bamboo, 15 were made using rattan or cane, and nine were based on other NTFPs/raw materials. Table 9.1

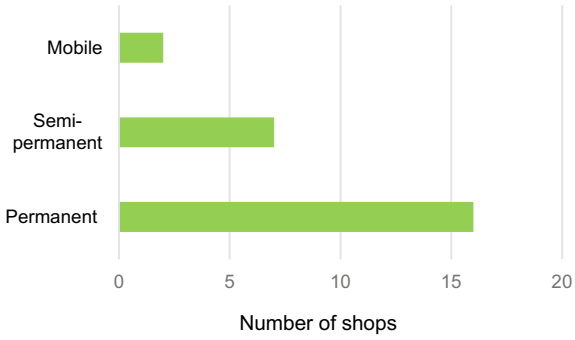

Fig. 9.2 Types and number of NTFPs shops surveyed

Table 9.1 The diversity of NTFP's and associated products in local market in the study area in northern Bangladesh

S. No.	Article(s)		Raw material(s)	Price range (Tk)[a]	Availability[b]	Major use(s)	Remarks[c]
	Common name	Local/trade name					
01	Bamboo culms	Bansh	*Bambusa* spp.	20–150 Tk/culm	12 (48)	Construction, domestic utensil	↑
			Melocanna baccifera				
02	Basket	Jhuri	*Melocanna baccifera*	25–50 Tk	16 (64)	Domestic utensil	– , √
03	Basket	Tukri	*Bambusa* spp.	75–200 Tk	06 (24)	Construction work (for laborer)	↑
			Calamus spp.				
04	Birdcage	Pakhir khacha	*Bambusa* spp.	75–200 Tk	09 (36)	Domestic (luxurious good!)	↓, √
05	Bookshelf	Bookshelf	*Bambusa* spp.	100–250 Tk	11 (44)	Domestic	↓, √
			Melocanna baccifera				
06	Bookshelf	Bookshelf	*Calamus* spp.	500–1000 Tk	11 (44)	Domestic (luxurious good!)	↑
			Daemonorops jenkensianus				
07	Broom	Phul jharu	*Thysanolaena maxima*	20–50 Tk	23 (92)	Domestic	↓, √
08	Broom	Jharu	*Cocos nucifera*	30–50 Tk	13 (52)	Domestic	–
09	Brush	–	*Melocanna baccifera*	25–50 Tk	08 (32)	Domestic	↓, √

(continued)

Table 9.1 (continued)

S. No.	Article(s)		Raw material(s)	Price range (Tk)[a]	Availability[b]	Major use(s)	Remarks[c]
	Common name	Local/trade name					
			Phoenix sylvestris				
10	Cage (chicken)	Khacha	*Bambusa* spp.	75–150 Tk	07 (28)	Domestic	↓
11	Ceiling cleaner	–	*Melocanna baccifera*	20–65 Tk	04 (16)	Domestic	↑
			Phoenix sylvestris				
12	Chair	Chair	*Calamus* spp.	200–1250 Tk	07 (28)	Domestic (luxurious good!)	↑
			Daemonorops jenkensianus				
13	Corner	Corner	*Calamus* spp.	350–1000 Tk	06 (24)	Domestic (luxurious good!)	↑
			Daemonorops jenkensianus				
14	Cradle	Dolna	*Calamus* spp.	1000–2500 Tk	06 (24)	Domestic	↓, √
			Daemonorops jenkensianus				
15	Doormat	Paposh	*Cocos nucifera*	50–100 Tk	12 (48)	Domestic utensil	↓, √
16	Easy chair	Easy chair	*Calamus* spp.	850–2000 Tk	08 (32)	Domestic (luxurious good!)	↑
			Daemonorops jenkensianus				

(continued)

Table 9.1 (continued)

S. No.	Article(s)		Raw material(s)	Price range (Tk)[a]	Availability[b]	Major use(s)	Remarks[c]
	Common name	Local/trade name					
17	False wall	False wall	*Calamus* spp.	750–1500 Tk	05 (20)	Domestic (luxurious good!)	↑
			Daemonorops jenkensianus				
18	Fence	Bera	*Bambusa* spp.	50–100 Tk	07 (28)	Construction, domestic use	↑
			Melocanna baccifera				
19	Fishing cage	Anta	*Bambusa* spp.	75–100 Tk	03 (12)	Domestic	↓
20	Flower vessel	–	*Calamus* spp.	300–750 Tk	06 (24)	Domestic (luxurious good!)	↑
	holder		*Daemonorops jenkensianus*				
21	Hand fan	Hat phakha	*Bambusa* spp.	20–40 Tk	09 (36)	Domestic	↓, √
22	Hand fan	Hat phakha	*Borassis flabellifer*	20–35 Tk	06 (24)	Domestic	↓, √
23	Mat	Sital pati	*Schumannianthus dichotoma*	250–1000 Tk	11 (44)	Domestic	↑
24	Mat	Madur	–	100–200 Tk	10 (40)	Domestic	↓, √
25	Mat	Dari	*Typha elephantina*	50–85 Tk	13 (52)	Construction, domestic	↑
26	Mat	Chatai	*Bambusa* spp.	35–100 Tk	10 (40)	Construction	↑

(continued)

Table 9.1 (continued)

S. No.	Article(s)		Raw material(s)	Price range (Tk)[a]	Availability[b]	Major use(s)	Remarks[c]
	Common name	Local/trade name					
27	Mirror holder	Mirror holder	*Calamus* spp.	150–450 Tk	05 (20)	Domestic (luxurious good!)	↑
28	Rickshaw hood	Rickshaw hood	*Bambusa* spp.	450–1000 Tk	04 (16)	Industrial (!)	↑
29	Show pieces/handicrafts (various)	Show pieces	*Bambusa* spp.	50–2000 Tk	11 (44)	Domestic (luxurious good!)	↑
			Calamus spp.				
			Daemonorops jenkensianus				
30	Sieve	Chaluni	*Bambusa* spp.	50–150 Tk	12 (48)	Domestic utensil	– , √
31	Sofa set	Sofa set	*Calamus* spp.	2000–7500 Tk	08 (32)	Domestic (luxurious good!)	↑
			Daemonorops jenkensianus			corporate use	
32	Tea/side table	Tea table	*Calamus* spp.	1000–1750 Tk	09 (36)	Domestic (luxurious good!)	↑
			Daemonorops jenkensianus				
33	Table lamp	Table lamp	*Calamus* spp.	500–1500 Tk	09 (36)	Domestic	↑
			Daemonorops jenkensianus				

(continued)

Table 9.1 (continued)

S. No.	Article(s)		Raw material(s)	Price range (Tk)[a]	Availability[b]	Major use(s)	Remarks[c]
	Common name	Local/trade name					
34	Walking stick	Hat lathi	*Daemonorops jenkensianus*	100–250 Tk	08 (32)	Domestic	–
35	–	Mora	*Calamus* spp.	250–700 Tk	10 (40)	Domestic	–
36	–	Mora	*Bambusa* spp.	100–250 Tk	07 (28)	Domestic	↓, √
37	–	Kula	*Bambusa* spp.	75–125 Tk	07 (28)	Domestic utensil	↓
38	–	Bhar	*Bambusa* spp.	75–150 Tk	02 (08)	–	–

[a] *Source* Market survey 2007–08

[b] The availability of the product in no. of shops in relation to total no. of shops surveyed; number in the parentheses indicates the percentage

[c] Trend of utilization (based on market demand/sell; ↑—increased; ↓—decreased; – unchanged) and presence of substitute (√—substitute present)

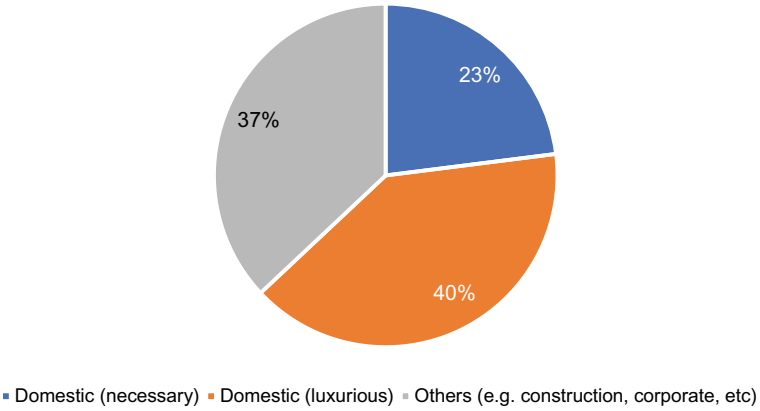

Fig. 9.3 Share of income from various NTFPs in the area

presents a brief about the products, their origin, uses, prices, availability, and demand trends. NTFPs in the area were into three broad categories: viz, domestic utensils (necessary), domestic decorative articles (luxurious), and others (e.g. construction, corporate, etc.). According to this classification, 23 articles were domestic (necessary), 11 were (luxurious) goods, and the rest were used for construction or other corporate purposes. The house broom (manufactured from *Thysanolaena maxima*) was the most common article (92% shops) across the surveyed shops. The prices of the NTFPs and associated products were found to be ranges between Tk 20 and Tk 7,500. The share of three diverse kinds of NTFPs to traders total NTFPs based income is given in Fig. 9.3, being highest (40%) in the case of decorative or luxurious goods.

9.3.3 Changing Consumption and Trade Pattern in a Competitive World

A comparison of income from selling NTFPs and associated products in the surveyed shops is shown in Fig. 9.4. A dramatical increase in sales from 96,000 Tk/year during 1997–98–288,000 Tk/year during 2007–08 was evident in the permanent shops. Those shops were found to sell mainly luxurious or decorative goods. In the case of semi-permanent (or temporary) shops, the income in 2007–08 is nearly doubled compared to their income reported for 197–98 (108,000 Tk/year during 1997–98–192,000 Tk/year during 2007–08). It was impossible to obtain the previous income of mobile shops since it was a relatively new adaptation to cope with the changing market of NTFPs. The changes in these values could be attributed to differences in consumption (based on quantity sold or demanded), value change of the products, and changes in local currency price.

Fig. 9.4 Comparison of income from sales of NTFPs during 1997–98 and 2007–08 in the area

In the market, alternatives or substitutes for about 12 products (i.e. 32% of total recorded products) were found. Most of the substitute products were made from either plastic or steel, making them more durable and attractive. Interestingly, it was found that most of the traders keep both NTFPs and their substitutes in their shops. Other major adaptations and strategy included, arranging mobile shops in public places or door to door service at more reasonable price; addition of products aesthetic and use value with more attention and finishing while manufacturing, more publicity of shops and greater user compatibility of products.

9.4 Major Problems, Challenges, and Future Potentials

Table 9.2 lists the major constraints in the development and trading of NTFPs and associated products according to the traders in the locality. Most of the traders (84%) identified competition with substitute goods as a significant challenge to the NTFPs market nowadays. Other challenges include scarcity of raw materials (72%), high production and processing cost of products (72%), and changes in consumer's preference (64%). Again, it was found that (in Table 9.3) consumers' expectations on various NTFPs and associated goods were mainly concentrated on their visual value (83%) followed by user compatibility (75%) and durability (67%) of products (Fig. 9.5).

Table 9.2 Major problems and challenges (as per traders) in NTFPs trading in the study are in northern Bangladesh

Challenges/issues	No. of sellers opined (sellers)
Competition among the sellers	09 (36)
Competition with other substitute goods (mainly made of plastic)	21 (84)
Consumers attitudinal change (in preference)	16 (64)
Increased cost in production and processing	18 (72)
Increased shop rent, and other cost	08 (32)
Lack of institution to encourage or trained local crafters/*karigar*	07 (28)
Market insecurity (seasonal demand fluctuation)	11 (44)
Poor government and NGO support	09 (36)
Scarcity of raw materials	18 (72)
Unwillingness of future generations to come in this profession	06 (24)

Note Number in the parentheses indicates the percentage

Table 9.3 Consumers' expectations on NTFPs in the study are in northern Bangladesh

Expectations/issues	No. of respondent opined (consumers)
Should be chiefly available	06 (50)
Products should be attractive (aesthetic value)	10 (83)
Should be cheap	07 (58)
Should be durable	08 (67)
Should have multipurpose use	05 (42)
User friendly/compatibility with user	09 (75)

Note Number in the parentheses indicates the percentage

9.5 Conclusion

Although a changing and challenging situation in the NTFPs market was evident in northern Bangladesh from this study, it was also apparent that NTFPs traders developed some innovative approaches that helped them minimize the adversity of changing the NTFPs market situation. For a successful business, all elements of the value chain, however, need to be work together (Belcher and Schreckenberg 2007). Government and non-government development organizations (NGOs) need to play a crucial role to strengthen the existing market that will ultimately improve the quality of livings of peoples who are directly or indirectly dependent on this sector/profession. Government and NGOs should also support research on NTFPs development, domestication, and promotion; provide small loans to the small-scale entrepreneurs; helps in the technical advancement of the processing units and storage. They could also play an essential role in maintaining effective coordination among

Fig. 9.5 Diversification of NTFPs-based (here using reeds) products in a rapidly changing world. *Photo credit* S. A. Mukul

producers and consumers and could offer some skill development programs to the workers involved in manufacturing NTFPs and associated products in the area.

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Chapter 10
The Role of Livelihood Initiatives in Reducing Non-wood Forest Product Reliance in Protected Areas of Southern Vietnam: Opportunities and Challenges

Lisa Lobry de Bruyn, Thi Minh Phuong Duong, Paul Kristiansen, Graham R. Marshall, and Janelle Wilkes

Abstract As an alternative livelihood approach to improve forest conservation and reduce dependency on non-wood forest products (NWFPs), the government of Vietnam has implemented community-based ecotourism (CBE) in the relation to protected area management. One such initiative is the Talai Ecotourism Venture for the ethnic groups living in the buffer zone of the Cat Tien National Park. This study through household survey (n = 150), and key informant interviews (n = 23), identified the impacts of the ecotourism venture on local people's livelihood and explored whether these impacts have reduced economic livelihood reliance on NWFPs, and increased awareness of forest conservation importance. Among households participating in the initiative, their level of NWFP dependency was 66% lower than those households not employed. In addition to the reduced dependency on NWFPs, the beneficiaries of the initiative also taking advantages of other benefits namely higher household income, access to benefit sharing mechanism, and heightened awareness of forest conservation. To scale out these benefits to similar livelihood interventions for forest conservation and community development goals, they need to be implemented equitably, and to attain an understanding of social-cultural norms in the area of the intervention, particularly local institutions, power structures, and differentiation of ethnic groups.

Keywords Protected area management · NWFP reliance · Ethnic minorities · Ecotourism · Benefit sharing

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10.1 Introduction

Protected forest areas worldwide are often located close to forest dependent communities that continue to use forest resources for their livelihoods to varying extents. Once these areas are designated as protected areas, it prevents local people from practising their traditional income-generating or subsistence activities that rely on access to forest areas. Although governments view protected areas as a measure for forest conservation, they pose a number of key challenges to local people's livelihoods. In a number of developing countries, including Vietnam, the use of forest resources in protected areas has presented a threat to forest conservation outcomes. A satisfactory resolution to the tension between livelihoods and biodiversity conservation objectives in protected areas is an on-going challenge for governments and local people living near protected areas.

Cat Tien National Park, a protected area in Dong Nai Province, Vietnam is well-known for its diversity of flora and fauna (Sudron 2018) and offers a noteworthy case study. The practice of collecting non-wood forest products is considered widespread in Cat Tien National Park (Duong et al.2021), despite it being illegal under the protected status of the Park (Vietnam Government 2001).

Achieving forest conservation goals under these circumstances, even if extraction levels are low, appears to be a challenging task. To address shortcomings in government efforts to improve forest conservation outcomes in a manner consistent with local community needs and cultural norms, the engagement of local people in buffer zone programs (e.g. alternative livelihood initiatives) has been endorsed by several national and international initiatives (Dhakal et al. 2020). These alternative livelihood initiatives commonly seek to provide new income sources as a substitute to income from traditional livelihood practices and thereby reduce exploitation pressures on the protected areas (Roe et al. 2015). However, it is unclear whether the intentions of such initiatives have been achieved.

The aim of this chapter is to examine the performance of an alternative livelihood initiative, the Talai Ecotourism Venture (hereafter referred to as the Venture) on local livelihoods for those ethnic groups living in close proximity to the Park. It also attempts to draw lessons that can be applied to alternative livelihood initiatives elsewhere in Vietnam and other developing countries. The structure of this chapter is organised as follows. The following section provides an overview of the case study in a protected area in Vietnam. This section includes the problem statement, followed by the research aim and objectives that will be addressed in the chapter. Section 10.2 examines the impact of community-based approach as an alternative livelihood initiative on direct livelihood outcomes. This section also analyses the stakeholder involvement of the Venture. Finally, it draws out the recommendation for designing alternative livelihood initiatives to broaden benefit-sharing and reduce forest reliance.

10.1.1 Protected Areas and Alternative Livelihood Programs

About a third of the world's land area (around 4 billion hectares) is covered with forests, with only 15% of this area is located in protected areas (Leberger et al. 2020). Threats to forests globally (percentage of forest area) include direct human activities such as land clearing, burning, and harvesting of economically important species (27% through permanent land-use change, 26% through forestry) as well as indirect threats such as shifting agriculture (24%), and wildfire (23%) (Curtis et al. 2018).

Major forested areas contain resources, including non-wood forest products (NWFPs), which are traditionally collected by local communities. It is estimated that 75–90% of the world's impoverished people depend on forests and NWFPs for at least a portion of their income (Tugume et al. 2017). The Center for International Forestry Research (CIFOR) defines NWFPs as 'any product or service other than timber that is produced in forests. NWFPs include fruits and nuts, vegetables, fish and game, medicinal plants, resins, essences, and a range of barks and fibres such as bamboo, rattan, and a host of other palms and grasses' (CIFOR 2011). Collecting NWFPs has been a major part of ethnic minority people's activities and livelihoods globally (Sunderlin et al. 2005). The role of forest resources in the livelihoods of forest-dependent households has attracted increasing interest from researchers given that NWFP harvesting has been estimated to contribute up to 70% of the annual household income of forest-dependent households (Lepcha et al. 2019).

Emerging in the United States in the mid-1960s, protected areas have become one of the main strategies for environmental protection around the world. Designated protected areas have been created under law to safeguard biodiversity and forest ecosystems (Castro et al. 2015). Protected areas have been estimated to cover 14.7% of the world's land (Jones et al. 2018). Arguments for protected areas have assumed that local people are a threat to biodiversity, so that nature can only be preserved if they are excluded (Du et al. 2015). When protected areas were designated for nature conservation, many local populations traditionally reliant on forest resources had their livelihoods disrupted.

Tensions and conflicts thus often arose between local people and the goals of forest conservation (Angelsen et al. 2014). Researchers have thus turned to investigating how local people might be still able to live alongside protected areas yet not rely so heavily on collection of NWFPs (Aziz et al. 2013). In order to address livelihood challenges, governmental agencies, and non-governmental organisations have attempted to engage local people in buffer zone programs (e.g. alternative livelihood initiatives). These initiatives commonly seek to provide new income sources as a substitute for earnings from traditional livelihood practices, thereby reducing resource extraction pressures on the protected area.

Community-based approach to forest management and governance has emerged since the 1970s to deal with this challenge. This approach seeks to simultaneously improve community livelihoods and forest conservation outcomes (Pirard et al. 2019). In particular, connecting local livelihoods to conservation in nearby forests

may be more likely to be achieved by different community based alternative livelihood approaches such as: integrated conservation and development projects (Blom et al. 2010), community-based ecotourism (Spiteri and Nepal 2008), co-management and community conservation areas (Carlsson and Berkes 2005). The authors of these case studies have demonstrated the importance of alternative livelihood in reducing conflict between local communities and national park authorities (Chhetri et al. 2003), and facilitating conservation (García-Llorente et al. 2018). The success of these approaches can be measured by their ability to reduce the multitude of pressures placed on the conservation value of protected areas by local people's activities (e.g. land use practice, grazing, timber logging) (Mukul et al. 2016). These initiatives also aimed to help local people who live near forest to be less reliant on forest resources as they become more involved in other economic activities outside the forest (Ashley and Elliott 2003). For example, in Asia (Bangladesh) and Africa (East Africa) (Persha et al. 2011; Mukul et al. 2012), researchers have found evidence that providing alternative income sources that allow local people to benefit economically from conservation while refraining from environmentally destructive practices. Important factors included compensating local people for lack of access to protected areas, improving livelihoods (employment opportunity creating) and shifting attitudes in favour of forest protection.

A recent global review of cases (n = 50) in forest conservation interventions found there were only 7 identified livelihood interventions and no cases showing a positive impact, three with mixed impacts, three with neutral impacts and one negative impacts (Pirard et al. 2019). Some studies have found that alternative livelihood initiatives can help local people who live near a forest to become less reliant on forest resources as they become more involved in non-forest-related economic activities (Ashley and Elliott 2003). However, a critical question for such initiatives concerns who benefits (Roe et al. 2015). Most authors emphasise that the fair distribution of benefits among local people is very important because it affects the processes of allocating ecotourism resources and resolution of disputes (Bayrak 2019). While some scholars query whether equitable distribution of benefits is possible in such initiatives due to the lack of local representation, and local participation in decision-making (Conning and Kevane 2002).

Attempts to understand the factors affecting the performance of alternative livelihood initiatives need to consider the influence of governance arrangements (Sikor and To 2011). A key principle of good governance, particularly for implementing alternative livelihood initiatives that are community-based, is that the lead organisation needs to have the appropriate support structures in place to facilitate effective and relevant stakeholder involvement during both implementation and operation of an initiative (Piabuo et al. 2018).

Conservationists believe that the alternative livelihood initiatives will help to reduce local people's reliance on forests for their livelihoods, thus addressing one of the main pressures on protected areas (Mukul et al. 2016). Although a number of alternative livelihood programs have been conducted to support ethnic minority people living near forests, there have been few robust evaluations of their impacts. One such evaluation was of a conservation program conducted in Posada Amazonas,

Peru. Project proponents had expected that community members who came to work at the ecotourism lodge established by the project would invest less time in shifting cultivation or hunting within the forest. The impact of ecotourism on local livelihoods in the case study area measured by household forest reliance among the same households before and after the lodge was opened was ambiguous (Stronza 2007). Another evaluation was of forest-based payments for environmental services (PES) programs conducted in Mexico. These programs also aimed to improve protected area management by promoting alternatives to forest-dependent livelihoods (Kerr et al. 2014). Such PES projects were found to benefit a select group of people rather than the whole community. Both these studies revealed that more needs to be known about the impacts of alternative livelihood programs both on biodiversity conservation and the well-being of the intended beneficiaries.

10.1.2 Protected Areas in Vietnam

Vietnam has been ranked as the sixteenth most biodiversity-rich country in the world (Le et al. 2018). In order to protect its forest and biodiversity, Vietnam's forest management system distinguishes three categories of forest. The third of these refers to 'special use forests' (SUFs), of which there are three main types: national parks, natural conservation areas (including nature reserves, species and habitat reserves, and landscape protection areas), and experimental and scientific research areas (MONRE 2011) (Table 10.1).

One of the challenges facing the management of protected areas in Vietnam is continuing collection of NWFPs by local people living near these areas. Studies by Quang and Noriko (2008) in the northern central uplands of Vietnam, Vien et al. (2006) in the north-western region of this country, and Polesny et al. (2014) in the Phong Dien Nature Reserve of central Vietnam found that local people bordering

Table 10.1 Categories and numbers of special use forests in Vietnam

Category of special-use forest in Vietnam	Total number	Total area protected (ha)	Percent of total area protected
National Parks	30	1,077,236	47.5
Nature reserves	58	1,060,959	46.8
Species and habitat reserves	11	38,777	1.7
Landscape protected areas	45	78,129	3.4
Experimental and scientific research areas	20	10,653	3.5
Total	164	2,265,754	100

Source (MONRE 2011)

forests were continuing to rely on forest resources for their livelihoods (e.g., for food, medicine and construction materials). Another study conducted near a protected natural forest area in North Central Vietnam also reveals that NWFPs contributed an average of 28% of total household income for the surrounding communities (Ngo et al. 2020). Use of NWFPs for food has been found to be particularly important in reducing local people's vulnerability during food shortages, and they have been found also to provide supplementary inputs to farming (Swinkels 2006).

10.1.3 Historical Background of Cat Tien National Park—The Case Study Area

An overview is provided here of the particular case—a project seeking to provide alternative livelihoods for people living adjacent to a protected area in Vietnam, and thereby to enhance conservation outcomes by reducing human pressure on forest resources—that was studied in the research presented in this chapter. Following this overview, the aim and objectives of the present research will be identified. The protected area studied was the Cat Tien National Park (hereafter referred to as the Park) with a total current area of 73,878 ha (Fig. 10.1). The study area for this research was Nam Cat Tien, located in Dong Nai Province, with an area of 38,302 ha.

Protected area declarations in Vietnam have historically resulted in conflict between park officials and local people (West et al. 2006). Despite the status of Nam Cat Tien as a National Park, ethnic minorities (Chau Ma and Stieng people) have been observed continuing to travel into the Park to collect NWFPs. Since the 1980s, ethnic majority Kinh people have also migrated to areas adjacent to this Park (Nguyen and Hoang 2013).

The case study documented in this chapter focused on the livelihood activities of inhabitants of Village A (name anonymised for ethical reasons) within Talai Commune of Dong Nai Province. This village is adjacent to the Park and is located within what is referred to as its buffer zone. The reason for establishing buffer zones of this kind has generally been to protect the National Park from encroachment (including collection and hunting, logging and NWFP collection) of the indigenous people who live close to the Park and from activities that take place outside the Park but that negate conservation efforts inside the National Park boundaries. The three different ethnic groups (Chau Ma, Stieng and Kinh) living in the village reside in separate parts of it. Before 1978, Chau Ma and Stieng people lived in the forest area prior to it being declared a National Park, and were resettled to Village A when the Park was created.

Fig. 10.1 Location of Cat Tien National Park. *Source* Adapted from Cat Tien National Park, 2018

Table 10.2 Percentage of households categorised according to level of total NWFP reliance (cash income and subsistence use) on NWFPs of three ethnic groups (n = 150)

Ethnic group	n	Non-reliance (%)	Low reliance (%)	Medium reliance (%)	High reliance (%)
Chau Ma	60	12	40	18	30
Stieng	50	6	58	14	22
Kinh	40	98	2	0	0

Source Adapted from Duong et al. (2021)

10.1.4 NWFP Reliance Among Ethnic Minority Groups in Southern Vietnam

The role of NWFPs in the livelihoods of rural households has received increasing attention from scientific communities and policymakers in Vietnam. Nguyen et al. (2019) found from their study in Bu Gia Map National Park, Binh Phuoc province, that income from NWFPs made up 17% of the total income of households bordering this park. In another study conducted in Lo Xo Mat National Park, Tay Ninh province, Sunderlin et al. (2005) found that NWFPs contributed, on average, 25% of forest-dependent household cash income.

For the area focused on in the present research, Duong et al. (2021) found that the total reliance of Village A households on NWFPs (for both subsistence and cash income) differed substantially between the Chau Ma, Stieng and Kinh residing in the village based on a sample of about 30% of the village population. The total NWFP reliance in this study was the proportion of average total household monthly income (on farm; off-farm, NWFPs for cash income) accounted for by the value of household NWFP collection (in terms of both subsistence and cash income). Chau Ma people had nearly a third of households with high NWFP reliance, which was the greatest of the three ethnic groups in Village A, followed by Stieng people (Table 10.2). In contrast most Kinh people did not exhibit any dependence on NWFPs for their livelihoods (Table 10.2).

This is a pattern also observed in other parts of Vietnam (Nguyen et al. 2019). Kinh people tend to have greater access to farmland and agricultural skills, education, and employment opportunities (Trædal and Vedeld 2017).

10.1.5 Role of Community-Based Ecotourism in Reducing NWFPs Reliance

To address shortcomings in government efforts to improve forest conservation outcomes in Vietnam, providing local people an alternative livelihood initiative has been promoted by several international initiatives (Nguyen and Hoang 2013). One particular initiative of this kind—a so-called community-based ecotourism (CBE)

venture—is currently operating in Village A, with the aim of providing ethnic-minority members of the village with an alternative livelihood source (i.e. from the CBE venture) and thus reducing their levels of NWFP reliance.

Community-based ecotourism involves a community caring for its natural resources in order to gain income through ecotourism and using that income to better the lives of its people (Sproule 1996). Ecotourism is distinguished from mass tourism by its lower impact on the environment, and its role in educating tourists about natural environments and cultural values (Marzouki et al. 2012). Strong arguments have been advanced in support of CBE given its focus on enhancing local livelihoods (Sakata and Prideaux 2013). CBE envisages that income from ecotourism be equitably distributed within, and managed collaboratively by, the local community (Scheyvens 1999).

Success by CBE initiatives in improving local livelihoods in CBE enterprises has nevertheless been found to be challenging in practice. Particular challenges encountered in past CBE initiatives have included ineffective benefit-sharing arrangements and unequal access to employment opportunities among local people (Lonn et al. 2018). Even so, some case studies have found income generated by CBE ventures associated with protected areas to be distributed equitably within the relevant communities (Ly et al. 2017). But overall, there is on-going debate in the literature about the importance of CBE ventures on livelihoods in particular social contexts (Reimer and Walter 2013).

10.1.6 Research Objectives

Drawing on a case study of the Talai Ecotourism Venture in the buffer zone of Cat Tien National Park, the research reported in this chapter sought to (1) assess the impact of a development initiative (i.e. Talai Ecotourism Venture) on the livelihoods of local community members, especially the ethnic minority groups, (2) examine the influence of livelihood initiatives on forest conservation outcomes, and (3) analyse the governance structures influencing the performance of the Venture in providing local people with alternative livelihoods, and thereby reducing their livelihood reliance on NWFPs.

The remainder of this chapter includes a section on the methods used in the case study approach; the key outcomes for livelihoods (income, benefit distribution) and forest conservation, and an analysis of the Venture's governance arrangements. Finally, the policy implications for livelihood initiatives to broaden benefit sharing reduce forest reliance are improve cooperation between the key stakeholders and participation by local households.

10.2 Methods

10.2.1 Case Study Approach

The case study approach (Yin 2014) was adopted as the method for addressing the research objectives identified above. Mixed method case study research can be especially useful for research on institutional arrangements for ecotourism which seeks to discover the context-specific character of ecotourism activities, including in rural areas, where people live in under particular social and environmental conditions (Molina-Azorín and Font 2016).

The case to be studied is a community-based ecotourism (CBE) project called the Talai Ecotourism Venture. Cat Tien National Park became a protected area in 1992. Before 1978, the Chau Ma and Stieng ethnic minority communities still lived in the forested area that is now part of the National Park, and harvested NWFPs for home use and sale such as bamboo shoots, traditional medicine, small animals, and other forest products. In 1978, the Stieng and Chau Ma were moved from the forest and to a resettlement area that was located within Village A. Around the same time, Tày (an ethnic minority from the north of Vietnam) and Kinh (the ethnic majority group in Vietnam) households immigrated to the area, settling in the buffer zone of the Park and commencing agricultural enterprises for their livelihoods, including cashew, rice and livestock activities.

10.2.2 The Talai Ecotourism Venture

In 2008, with the support of the Danish International Development Agency, the Worldwide Fund for Nature—Denmark and the Worldwide Fund for Nature—Vietnam (WWF—Vietnam) worked together on a venture to initiate CBE in Village A, Talai Commune. Vietnam's Ministry of Agriculture and Rural Development approved a project that would establish the ecotourism venture over 2009–2014.

The rationale for supporting the CBE initiative in Village A, Talai Commune was two-pronged. Firstly, ecotourism initiative among many buffer zone programs can offer an alternative income source to the ethnic minority people living in the village. Secondly, this venture was initiated on the assumption that the ethnic minorities involved would be willing and able to cease their current forest resource collection practices, which were considered to negatively impact forest health and therefore contributing to sustainable forest resource management.

Village A was chosen as the case to be studied because it offers a good illustration of a very widespread phenomenon of resettlement to the buffer zone of a protected area. Village A was also populated by ethnic minority people who traditionally accessed the forest.

In late 2010, the Talai Ecotourism Venture was built in the village near the ethnic Chau Ma and Stieng resettlement area. The focus of the Venture was the longhouse

and that would-be built-in Village A at that time. In 2011, WWF—Vietnam, the Park Board (established a contract for the collaboration between the private company and the Park), and Talai Commune People's Committee worked together to establish the Talai Cooperative Group (TCG) as a legal entity to support the Venture. The role of the TCG was expected to represent the interests of the community. The TCG agreement envisaged that its membership would be limited to members of Village A and particularly of its ethnic minorities. Later, in March 2011, WWF Vietnam also facilitated a three-year partnership contract under which the TCG and a private company would jointly manage the ecotourism business and share the profits (Nguyen 2014).

However, after 18 months of operation, this company withdrew from the partnership because it had not been able to attract enough tourists for the Venture to be financially viable. The decision to install a new private partner in the Venture was made by WWF Vietnam jointly with the existing and future private companies, the Talai Commune People's Committee, and the Park Board. In mid-2014, the new private partner officially entered the ecotourism business by signing a five-year contract with the TCG and the Talai Commune People's Committee (Nguyen 2014). The company's roles in the Venture include communication with tourists and the Park staff, hosting guests, organising guided tours of the Park, and organising ethnic minority cultural events in the Longhouse. The majority of visitors to the Longhouse are international rather than domestic (Nguyen 2014). Visitors typically spend one night in the Longhouse, tasting traditional food, experiencing traditional cultural activities including singing, music, and dancing and 'gong' performances—one of the traditional kinds of music of Stieng people, and touring the adjoining Park's forest ecosystems.

The Village Development Fund (VDF) was agreed to by the private company and TCG in the partnership contract as a benefit sharing mechanism. This was intended to ensure the local community benefited equitably from the Venture, by distributing the community's share of the Venture's financial benefits fairly between TCG members and the rest of the local community. The VDF was intended to support low-income villagers in meeting their livelihood needs, for instance by funding house repairs and maintenance, and providing interest-free fund loans to raise livestock or poultry. Other envisaged uses of VDF were financing provision or maintenance of public facilities (e.g., village roads), and funding local ceremonial activities and environmental protection. The benefit-sharing mechanism involved remittance by tourists of USD 7 per adult per night, and USD 4 per child per night, to the company, with these funds deposited in the VDF. Funds accumulating in the VDF were to be managed by the TCG in consultation with the Talai Commune People's Committee.

10.2.3 Data Collection and Analysis

Data were collected for the case study through key informant interviews and a survey of Village A households (n = 150). The research methods were approved by the

University of New England Human Research Ethics Committee (HE17-262), and all participants in the household survey and key informant interviews gave written informed consent.

The key informant interviews (n = 23) were conducted prior to conducting the household survey. A summary of topics covered with each category of key informant is also provided in. All of the TCG members were included in the key informant interviews (Table 10.3).

The qualitative data obtained from key informants allowed an in-depth understanding of the research context. The participants interviewed for the household survey included the 10 households of Chau Ma in Village A employed by the Venture (and also serving on the TCG), and a selected sample of those households from Village A with no household individual employed in the Venture (50 Chau Ma, 50 Stieng and 40 Kinh households who are currently living in the study village). The 'not employed' households were interviewed to determine whether they indirectly benefited, economically and/or environmentally, from the Venture activities, given that the aim of the Venture was to improve livelihoods generally within the community. The other five Tày members of the TCG were not interviewed for the household survey (or for the key informant interviews) since they are from another village and the case-study focus was on Village A.

Qualitative data from the key informant interviews were analysed using NVivo 12 Plus. The interview transcripts were translated into English and responses were coded in NVivo 12 Plus using data-driven nodes with specific themes: benefit distribution, power relationships, and the quality of stakeholder's involvement in the Venture. These themes emerged from the key informant interview analysis process.

Households provided information through the survey about their estimated household monthly income from various sources (including the income from local handicraft weaving for the ecotourism Venture) and their evaluation of the Venture as an alternative source of livelihood in the village. The impact of the Venture on local people in the village was divided into direct impacts (e.g., employment opportunities and cash income) and indirect impacts (e.g., on environmental attitudes).

MS Excel 2010 was used to tabulate and undertake descriptive statistics of categorised data. Mean and frequency metrics were used to summarise household responses and estimated monthly household income was calculated for participating and non-participating households. Cross tabulation was applied to determine significance of differences in total monthly income between these household categories. The total monthly household income was calculated by aggregating the income over a year from on-and off-farm activities and sale of collected NWFPs and dividing by 12 to obtain a value per month. Total NWFP reliance was the proportion of average total monthly household income (on farm; off-farm, NWFPs for cash income) accounted for by the value of household NWFP collection (in terms of both subsistence and cash income): 0% (no reliance); 1–29% (low reliance); 30–59% (medium reliance) and $\geq$ 60% (high reliance). The complete analysis of NWFP collection in the case study area was reported in Duong et al. (2021).

Table 10.3 Key informant categories, and topics covered with each category

Role	Topics discussed
Organisation: WWF. Key informants: site officer. Number of interviews: 2	
WWF is the facilitator of the Venture. It funded the Venture, involved relevant stakeholders, and promoted local capacity building in the period from 2009 to 2012	How the Talai Ecotourism Venture operated on the site. Evaluation of how successfully Venture improved local livelihoods
Organisation: Cat Tien National Park. Key informants: management board representatives. Number of interviews: 2	
The Cat Tien National Park established the collaboration between the WWF, the private company, and the local community in managing the Venture	(1) The context of the Venture, (2) interaction between the local villagers and the Park, (3) evaluation of how the Venture affects Park management strategies
Organisation: Talai Cooperative Group. Key informants: Talai Cooperative Group leader. Number of interviews: 1	
The TCG leader was involved in the enforcement of regulations (according to the contract) at the TCG level TCG leader has control over land tenure for the private company investment partner's venture facilities and area of operation on community lands	Determine the quality of participation mechanisms of TCG in ecotourism activities in the Venture: opportunity to participate, encouragement to participate, incorporation of views into decision making
Organisation: Talai Cooperative Group. Key informants: TCG members. Number of interviews: 11	
TCG members all belong to the Chau Ma, and the Tày minorities (another village). No Stieng members in TCG. The TCG members delivered ecotourism services on-site	The procedures of how TCG members were engaged with ecotourism issues in the area in conjunction with the other stakeholders The benefits associated with CBE activities, and the local livelihood improvement due to the ecotourism Venture
Organisation: current private company. Key informant: company representative. Number of interviews: 1	
The private company was engaged as a partner to promote, manage, and run the Venture as a tourism business, employing local staff. The company signed the partnership contract with the Talai Collaborative Group in 2013	The interviews were to discuss the relationship between TCGs and the company and the operation of the Village Development Fund
Organisation: Talai Commune. Key informant: Talai Commune representatives. Number of interviews: 2	
Talai Commune collaborated with the WWF in establishing the TCG Talai Commune was also in charge of collaboration with the TCG to develop a plan for the VDF under the original private company operating the Venture	Relationship between the Talai Commune and TCG The interview questions focused on Talai Commune efforts in developing the policies supporting relative stakeholder involvement in the Venture, and on how TCG governed the VDF

(continued)

Table 10.3 (continued)

Role	Topics discussed
Key informants: villagers. Number of interviews: 3	
The last set of key informant interviews was held with the local people in the study village (same 3 people were also interviewed for the household survey) in Talai Commune	To acquire the in-depth knowledge and experience of the local people involved in Venture, their opinions of ecotourism, and the benefits of the Venture for their livelihoods and forest conservation
Organisation: Central Venture Management Unit (CPMU), Government of Vietnam. Key informant: government official. Number of interviews: 1	
The government official interviewed plays an important role in respect of the overall strategy of the ecotourism development in the Park	To discuss general policy in terms of ecotourism development in National Park at the national level

WWF World Wildlife Fund Vietnam, *CBE* community-based ecotourism, *TCG* Talai cooperative group, *VDF* village development fund

The matrix coding query in NVivo Plus 12 was used in analysing the data collected from the household survey's open-ended questions, for instance in comparing attitudes to the Venture (e.g., impact on local livelihoods, operation of the VDF).

10.3 Results

10.3.1 Direct Livelihood Outcomes of the Talai Ecotourism Venture

There was a small proportion of households (10 out of 500 households) in the village with a family member in full-time employment in the ecotourism Venture, and they were all from the Chau Ma ethnic minority. Their responsibilities in the Venture included cooking, cleaning, maintenance, gardening, tour guiding, and security and other tasks. No one was employed in an administrative or management role. A further four Chau Ma household people from the village were appointed to part-time positions with the Venture. Also, an additional ten households from Village A were occasionally employed by the private company to participate in dancing, and 'gong' shows.

The private company decided who to employ and consulted with TCG leader. Also, the Talai People's Committee authority had little influence over who was selected to work in the Longhouse because it was not part of the authority's responsibility. Only TCG leader and members were informed of future employment opportunities (key informant interview with TCG members). Aside from the Chau Ma people employed in the Venture from Village A, 5 separate Tày households from a nearby village were also employed alongside 2 Kinh people from Ho Chi Minh City. Stieng were perceived to be uninterested in being involved in the Venture. Meanwhile,

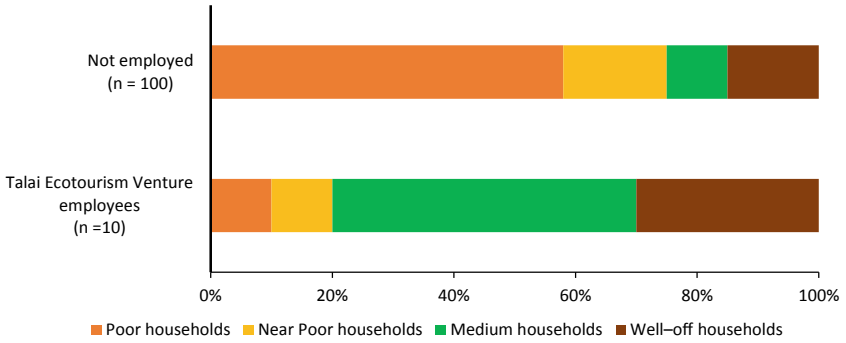

Fig. 10.2 Distribution of ethnic minority households (Chau Ma and Stieng) in Village A between household income categories, distinguished by whether they were employed by the Venture or not

Kinh people in the village were not involved in the Venture because they were not the group for which the initiative was designated for (key informant interview with WWF officers).

The pay for a full-time employee at the Venture ranged from USD 133 to USD 221 per month, which exceeded a typical income of USD 100 per month for a seasonal worker. Hence, employment by the Venture was lucrative compared with the alternative employment opportunities available to people from the village. Despite this, TCG members also received income from the VDF of around USD 50 per month (TCG members' interview). It seems the VDF payments to TCG members in this situation were not meant to happen according to the original partnership agreement.

Figure 10.2 compares two groups of households in the village—households with and without employment in the Venture—in terms of monthly income categories. The analysis reveals that households with a person employed by the Venture tended to have greater monthly income than households with no individual employed. More than 80% of the 10 Village A households with an individual employed (full-time or part-time) by the Venture belonged to the medium-income or well-off household income categories (Fig. 10.2). Around 83% of Chau Ma and Stieng households not involved in the Venture were categorised as poor or near poor household income categories. Beside the direct benefits as discussed above, little evidence of indirect benefits of the ecotourism Venture were observed in the study village.

In addition, the Longhouse remains a small guesthouse providing short-term accommodation, and consequently has not provided many income-generation opportunities for people in the village. Key informant interviews with local people and an officer of the Talai Commune People's Committee indicated furthermore that the ecotourism Venture had not made a significant impact on the local culture and lifestyle.

10.3.2 *Environmental Outcomes of the Talai Ecotourism Venture*

Views expressed by WWF officers and Government Officer key informants revealed that since the Longhouse opening, there were some positive changes in the local pro-environmental behaviours towards the surrounding environment such as it was cleaner and there was less garbage lying around in the village. However, in terms of a broader forest conservation perspective, the responses to open-ended questions in the household survey suggest that the Venture has not made a substantial difference to local people's environmental attitudes. Only 6% (n = 9) of surveyed households (all employed by the Venture) agreed that there had been an improvement in local environmental awareness after the longhouse was built. Most of the households interviewed (69%) (n = 103) agreed that 'there is no relationship between forest conservation and ecotourism in the Venture'. Approximately 25% (n = 37) of the villagers were not even aware of the existence of the Venture, and hence did not respond to questions on this topic.

The average contribution of NWFPs to overall income of members of the TCG was 9%, which was well below the average figure of 26% for Chau Ma and Stieng households (Duong et al.2021). Most households with members employed in the Venture had no livelihood reliance on NWFPs; with only two such households exhibiting a medium level of reliance on NWFP collection (Fig. 10.3).

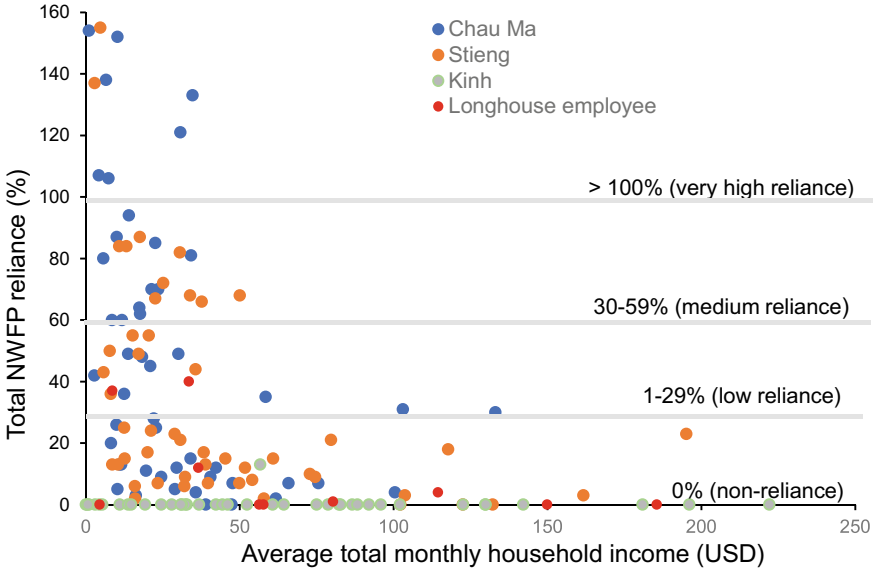

Fig. 10.3 The relationship between average total monthly household income and the total NWFP reliance (as a percentage contribution of NWFP subsistence and cash-income over total income) in the three ethnic groups (n = 150) and Longhouse employee (n = 10)

The initial expectation of the ecotourism Venture was that it would provide ethnic minorities with alternative livelihoods, through employment in the Venture and associated business opportunities that would reduce their livelihood reliance on forest resources (Nguyen 2014). However, the evidence presented above suggests that the alternative livelihood benefits of the Venture were limited and restricted only to those households employed by the Venture in a full-time capacity. It seems also those households involved in the ecotourism Venture had reduced their extraction of forest resources, but due to the small number of households involved would be unlikely to have a significant impact on forest conservation, unless similar activities could be scaled out in the buffer zones.

10.3.3 Distribution of Benefits from the Village Development Fund

A benefit-sharing mechanism (VDF) was introduced to distribute a share of revenues from Venture activities fairly among the local people in the whole village. According to the WWF report on this venture (Nguyen 2014) the fund has been more substantial in the past (based on discussion with the private company representative who were responsible for Venture management). As set out in the contractual agreement, the TCG and the private company were to jointly manage the Venture and share its profits with the funds that had been deposited into the VDF under the control of the TCG. Also, according to that agreement, the TCG was expected to act in the interests of all ethnic minority members of Village A by ensuring that benefits from the Venture were shared fairly between the company and the community and also between the members of the ethnic minority groups (including the Stieng population that was not represented on the TCG).

The VDF was designed to spread the benefits from the ecotourism Venture beyond those directly involved in the Venture, consistent with the principles of CBE. Households in the village were supposed to benefit from each visitor staying at the Venture, and the visitor contributions were to be deposited by the company into the VDF every three months. This money was then to be redistributed to villagers by the TCG in consultation with Talai People's Commune Committee. In practice, however, the VDF funds appeared to be distributed only to the leader and members of the TCG (including 5 other Tày members in another village). One TCG member observed:

> VDF revenue was shared amongst members of Talai Cooperative Group and contributed little to livelihood diversification in the village (TCG member 1 interview).

Hence, the study revealed that the impact of the Venture on the livelihoods of most households in the study village was very limited, with nearly all the VDF funds being captured by TCG members, i.e. around six members of the TCG. The majority of households (67%) (n = 100) opinion of VDF was consistent with the following key informant observation from a villager:

> Most of us did not know in great detail how the fund from the venture was allocated to the whole village through a benefit-sharing mechanism (Local person 1 interview).

Of the remaining households surveyed (33%) (n = 50), less than half (14%) (n = 21) agreed with a statement in the household survey that 'the Venture is beneficial for the village, especially those who participate in the Venture activities'. While 19% (n = 29) of households in this group showed minimal interest in the activities of the ecotourism Venture, a typical comment being that 'we had own jobs with farming, so we don't care'.

10.3.4 Stakeholder Involvement in the Talai Ecotourism Venture

This section presents a diagram of stakeholder power relations and involvement, which explores the stakeholder's interactions with other stakeholders, local government, and NGOs in the Talai Ecotourism Venture.

According to Fig. 10.4, the internal stakeholders were: Talai Ecotourism Venture, the TCG leaders and members, and the private company. The external stakeholders were based outside the village including: WWF officer (NGOs), Cat Tien National Park Management Board, Talai Commune People's Committee, villagers in Village A.

The complex interaction among the stakeholders involving the Talai Ecotourism Venture was analysed based on field data. This analysis highlighted the relationships between stakeholders in the Venture (Fig. 10.4). The darker the colour and the larger the circle relates to increasing importance of current stakeholder power and positioning of circle relates to closeness of relationship between stakeholders. This highlights the ongoing dynamic interplay among key stakeholders, and of internal and external relationships that occur with stakeholders, both inside and outside the Venture.

10.3.4.1 Internal Stakeholders

The focus of Fig. 10.4 is Talai Cooperative Group (TCG) which is managed by one Chau Ma leader from the village, plus ten other ethnic minority members (Chau Ma, and minority Tày people). The elected leader was the person who was responsible for the internal and external communication locally (e.g. with Talai Commune People's Committee). The leader was selected by the villagers based on status, experience and enthusiasm: 'The leader is well-respected in the village. He is a well-spoken person and thus has more influence' (TCG member interview).

Although the private company took over the role of recruiting TCG members after the establishment of TCG in 2011, the TCG members were actually appointed by the TCG leader based on the quality of their connections with the leader or leader's relatives. Stieng were initially invited by WWF but the TCG leader was

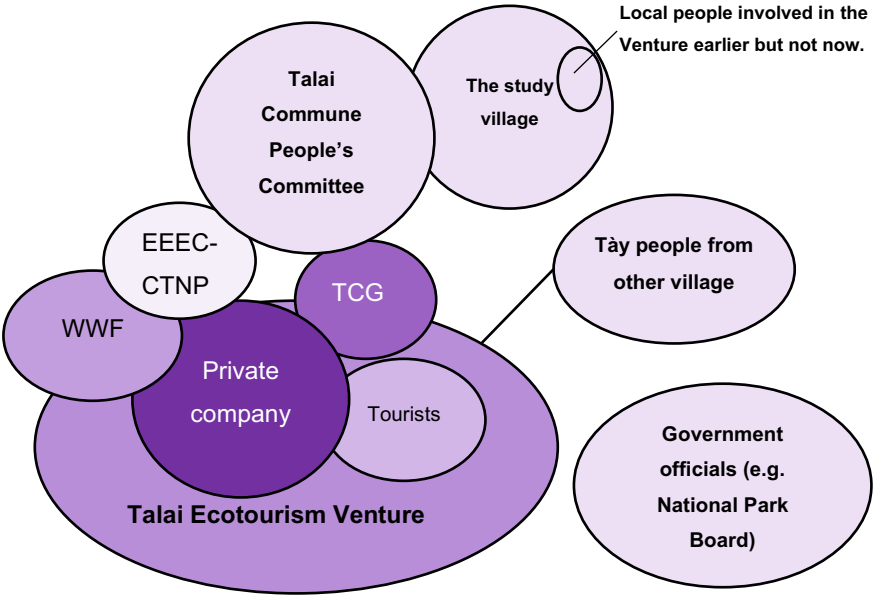

Fig. 10.4 Stakeholder groups in Talai Ecotourism Venture. *Notes* Environmental Education and Ecotourism Centre (EEC)—CTNPMB (Cat Tien National Park Management Board), TCG (Talai Cooperative Group), VDF (Village Development Fund), WWF (Non-Government Organisation World Wildlife Fund for Nature), Talai Commune People's Committee and connections to the study village. The darker the level of shading indicates greater stakeholder power in ecotourism Venture

reluctant to employ them. The TCG leader preferred to employ Chau Ma people, and Stieng people were excluded. Relationships between the private company and the TCG members were not based on equal power sharing. The TCG members although exerting an exclusive position as employees in the Venture were not as privileged as the private company, the Park, the local government, and TCG leader who were likely to exert power over them.

For example, to provide a firm legal foundation for practical cooperation between the two parties (the TCG and the private partner), a five-year contract was signed with strong support from the Park Board and the Talai Commune People's Committee authorities. One of the obligations arising from this contract was that the private company needed to help improve TCG members' capacity to assume increasing responsibility for ecotourism activities in the village. However, in reality, the private company did not provide the TCG members with the capacity to plan and develop ecotourism activities independently. The WWF officer commented on the level of involvement by the private company in terms of local capacity building that was mentioned in the contract:

> The five-year negotiation period would be a learning experience for both the community and the company. However, it seems that everything was under the management of the private company rather than that of TCG leader and group members. (WWF officer 3 interview)

TCG members found it challenging to participate during the operation of the Venture, given the inverse power relations involved in this 'participatory' process. The WWF officer also stated that the TCG played only a minor role during almost every stage of the Longhouse management. The private company representative also admitted that they were excluded from certain activities:

> TCG team members were not allowed to participate in the private company's business plan. They were not allowed to participate in any decision-making activities (in terms of marketing activities, and event organisation) (Private company representative interview)

This inherent power imbalance between the TCG members and the company could pose issues for the long-term sustainability of the partnership relationship.

10.3.4.2 External Stakeholders

The Environmental Education and Ecotourism Centre from Cat Tien National Park was the key government department that coordinated this Venture with WWF officers. Meanwhile, the Talai Commune People's Committee involvement was distant in that their role was the provision of policy guidelines for ecotourism development in this Commune. They directly organised the enforcement of laws and policies that affected local people, and in the past they have collaborated with the WWF in organising the TCG, and ecotourism Venture.

In summary, it was likely that the Venture initiative had many features of a top-down approach, with strongly centralised planning and control from WWF, Cat Tien National Park, and Talai Commune People's Committee and participation dominated by elites at various levels. For example, the results presented that although WWF initially viewed the TCG as a community-based initiative for ensuring local participation in, and ownership of, all phases of its implementation, the majority of the meetings and consultations held by the WWF and Talai Commune People's Committee were not successful in getting the local people's attendance and ideas about the Venture from the wider village community.

10.4 Discussion: Opportunities and Constraints of Livelihood Initiatives

The research presented in this chapter focussed on the livelihoods of villagers in the buffer zone of Cat Tien National Park, a high conservation value area in southern Vietnam traditionally occupied by Chau Ma and Stieng minority ethnic groups. When the Park was established in 1992, in order to protect its biodiversity, its conservation zone restricted the access of local communities' to lands from which they had traditionally earned their livelihoods from NWFPs and timber. While in theory, forest resources within protected areas in developing countries, including Vietnam, are held

as state property, in practice local indigenous people in these areas often continue using these areas as if they remain their de facto common property (Agrawal 2001).

This chapter examined the extent to which forest conservation has been improved due to the implementation of an alternative livelihood initiative in a village adjacent to the Park; the Talai Ecotourism Venture. The specific aim of this chapter was to examine the impacts of the Venture, as an attempt at CBE on local livelihoods, and the governance structure influencing the effectiveness of the initiative. Two main arguments were drawn from the literature in respect of development initiatives seeking to promote effective forest conservation by offering alternative livelihoods. Firstly, improving the livelihoods of those living near forest resources will improve conservation of those resources by reducing their forest reliance (Tacconi 2007). This requires the availability of viable alternatives for wealth creation and food security. Secondly, a community-based approach to such initiatives is important, if they are to yield improved forest conservation outcomes (Brooks et al. 2013). Reducing forest resource reliance requires effective governance at the local level, including promoting stakeholder cooperation, irrespective of each stakeholder group's level of power (Bramwell and Lane 2011) and participation by disempowered groups (Stone 2015). These two arguments suggest the potential of a win–win situation in which objectives for both forest conservation and improving local livelihoods can be jointly achieved if the governance settings and conditions for equitable distribution of power and benefits are also met, as discussed below.

10.4.1 The Economic Outcomes of the Talai Ecotourism Venture

At its inception, there was a clear benefit sharing mechanism conceptualised in Talai Ecotourism Venture (Nguyen 2014). The private company had a contractual agreement to set aside a share of revenue from the Venture activities according to an agreed formula in order to establish a VDF that would be shared widely among villagers in accordance with agreed principles. However, we observed that the VDF mechanism was not executed effectively during the Venture.

For community-based ecotourism initiatives to be effective, they should address the needs of the local people. The emphasis on local scale of CBE can provide an opportunity to create job opportunities (e.g. ecotourism guiding), broaden entrepreneurial capacity and offer stable incomes at the village level (Eshetu 2014), and promote environmental awareness (Hiwasaki 2006). While the Venture generated employment opportunities and revenue for members of the Talai Cooperative Group (TCG) (which was supposed to represent the interests of the village as a whole), it was also shown that few opportunities arose more broadly for ethnic minority people in the village.

From interviews with villagers, the VDF appeared not to be distributed by the TCG to the households in the village beyond those of the leader and members of the TCG.

Local participation in the livelihood benefits of the Venture should not be limited to TCG members who appeared to have captured all employment opportunities and most of the benefits from the VDF. The issue of dominance by a narrow group of people in an ecotourism venture has also been experienced in other ecotourism ventures in developing countries such as Zambia and Tanzania (Mensah 2017). For example, in the study of Tanzania conducted by Benjaminsen and Bryceson (2012), the benefits of community-based safari ecotourism development often accrued to a few local people and rarely reached the whole community. Based on the discussion with key informants in the current study, the Chau Ma people who held positions on the TCG, despite not being granted greater autonomy in the Venture operations, were still a more powerful group compared to other Chau Ma in the village who benefited little from VDF or ecotourism activities of the Venture.

Reflecting the principle of community-based ecotourism through benefit sharing mechanisms (Stone 2015), the VDF was intended to help villagers develop alternative livelihoods, including supporting reinvestment activities (the Longhouse reinvestment; road building, schools and local houses maintenance), providing interest-free loans for local households to raise livestock or poultry, and by supporting public facilities in the village (Nguyen 2014). The intention was that a substantial proportion of the village households would benefit from visitors paying to stay at the Longhouse and its ecotourism activities. However, the results presented in the previous section reveal that initiative to equitably improve villagers' livelihoods has appear to be fallen well short of its goal. The funds allocated by the private company to the VDF were to be transferred every three months to TCG, who, in turn, would distribute those funds. Ultimately, based on the discussion with key informants, although the Venture intended to share benefits to all villagers, it appears only two households outside the TCG members received support from VDF.

Community-based ecotourism can encourage local residents to carry out pro-environmental behaviours (Liu et al. 2014), and alter villagers' habits towards more environmentally responsible practices (Wang et al. 2020). The results of the present study reveal that to some extent the Venture could help shift the current behaviour of these ethnic minorities towards a pro-environmental behaviour. Tourists' behaviour, for example, collecting and properly disposing of trash in designated places, had positively influenced the villagers' behaviour.

10.4.2 Stakeholder Involvement in CBE

Several requirements for good governance in community-based ecotourism were identified from the literature review, including promoting stakeholder interactions irrespective of each stakeholder group's level of power (Bramwell and Lane 2011). Likewise, according to Pasape et al. (2015), good governance in CBE needs to start at the community level, where local people can jointly develop transparent and accountable institutions. These institutions can help facilitate equitable benefit-sharing, and

community empowerment thereby having a key influence on how involvement in ecotourism occurs at a local level (Palmer and Chuamuangphan 2018).

Previous studies have shown the domination of development initiatives by an 'elite' subset of the local population indicates that governance arrangements were not suited to the goals of CBE and failed to systematically address pre-existing power imbalances (Stone 2015). A review of several CBE schemes in Kenya found that the private partners in CBE can be expected to pursue their narrow private interests if the governance structure and processes could not provide adequate incentives for them to broaden their interests to encompass those of the community (Manyara and Jones 2007).

In this case study, the private company in particular appeared to exercise dominant control over the Venture, in contrast to the original intention that management of the Venture would be shared between the company and the TCG, with the latter expected to represent the overall interests of ethnic minority people in the village. Unwillingness to transfer power and/or ownership in CBE cases has been cited in previous studies, especially in the developing countries context. In Botswana, where wildlife tourism and hunting are primary sources of income, it is considered risky for the higher authorities and businesses to share the power with the community (Songorwa et al. 2000). The study revealed that despite its intended origins as a CBE initiative, the Venture structure was executed in a top-down manner, with power and benefits concentrated in the hands of few people. This suggests that the governance mechanisms, especially equitable sharing of power and benefits need to be considered in order to develop and support local ownership and participation (Ramón-Hidalgo and Harris 2018).

10.4.3 Likelihood of Ecotourism Being a Successful Model to Reduce NWFP Reliance

While economic benefits for communities and households can be an important aim of CBE schemes, other goals such as sustainable natural resource management are also important (Cobbinah 2015). CBE involving local people often increases environmental awareness and adoption of conservation practices among residents (Masud et al. 2017). According to Boley and Green (2016), the income from ecotourism activities can provide a strong incentive for conservation by replacing many traditional livelihood activities that damaged the environment such as hunting, food and fuel gathering, and livestock grazing. Also, evidence from Ethiopia indicates that high local participation in ecotourism has changed local attitudes away from exploiting natural resources and thereby contributed to conserving a national park and preventing conflicts between local communities and the national park authority (Kala and Maikhuri 2011).

The initial expectation was that the Venture would provide villagers with alternative livelihoods—through employment in the Venture and associated business opportunities—that would reduce their livelihood reliance on forest resources (Nguyen 2014). However, there was evidence that the alternative livelihood benefits of the Venture did not have a wider impact as planned and was restricted to those village households directly employed by the Venture. This suggests that few villagers would have reduced motivation to extract forest resources as a result of the initiative and this response was also observed in Ethiopia (Eshetu 2014) and in Vietnam (Yamanoshita and Amano 2012). The benefits of the Venture in helping to raise local people's awareness of environmental protection was also challenging, because the awareness raising meetings were not conducted as planned. The limited impact of the Venture in scaling out of benefits to broader village community also meant that the livelihood reliance of ethnic minority people in the village on harvesting resources from the Park is unlikely to have been affected (Kerr et al. 2014; Duong et al.2021).

Ecotourism is believed to help mitigate the negative environmental impacts of tourism, and to build an educated and motivated constituency that supports environmental conservation and social improvements (Powell and Ham 2008). The benefits to the local communities were expected to create incentives for conservation of the natural environment (Butcher 2011). The findings demonstrated a range of challenges to achieving forest conservation through an initiative designed to provide traditional users of forest resources with alternative livelihoods. Despite the positive impact on NWFP dependency of those employed by the Venture who had about 66% lower dependence on NWFPs compared with non-participating households there was little evidence from case study that the Venture itself had affected the level of forest reliance for ethnic minorities who live adjacent to the Park.

The private company employed all TCG members which meant that the TCG appeared to become more inclined to serve the interests of the private company. This can lead to possible conflicts of interest, since disagreeing with the company, rather than supporting the interests of the wider community, could potentially jeopardise their ongoing access to salary from the company and to revenues from the VDF. In regard to the Venture, wider local participation by the village households in the initiative's livelihood benefits were greatly limited by TCG members having captured all employment opportunities and most of the benefits from the VDF. Partnerships between the community and/or private organisations were not capable of stimulating genuine community participation (Manyara and Jones 2007). Therefore, in this case, the private company contracted to lead the Venture appeared to lack motivation to act in the interests of the village because it was unlikely to be held accountable for failures in developing these skills. Achieving increased community participation requires a focus on improving governance arrangements such as strengthening local institutions and government support at the local level (Beaumont and Dredge 2010).

10.4.4 Strategies to Improve the Effectiveness of Livelihood Initiatives and Stakeholder Involvement

Two concerns for development initiatives seeking to promote effective forest conservation by offering alternative livelihoods are (1) improving livelihoods of those living near forest resources will improve conservation of those resources by reducing forest reliance (Wolf et al. 2021) and (2) a community-based approach is necessary to yield improved forest conservation outcomes (Brooks et al. 2013). The first requires the availability of viable alternatives for wealth creation and food security, and the second requires effective governance at the local level, and, ideally, effective engagement of relevant stakeholders (Baggio et al. 2016). Good governance in community-based ecotourism similarly requires improving local participation in the management (Jamal and Getz 1995), and the promotion of stakeholder interactions (Baggio et al. 2016). Interviews with stakeholders in the Talai Ecotourism Venture indicated that the governance arrangements of this initiative needed to be more aligned to these principles for CBE, particularly the form of interaction between local stakeholders, local government, and third-party NGOs. The low level of alignment to CBE principles may have been inevitable due to not addressing pre-existing power imbalances (Ramón-Hidalgo and Harris 2018).

Leading stakeholders need to demonstrate that they can understand their allocated responsibilities (Riggs et al. 2018). In order to ensure greater community or relevant stakeholder engagement, formal communication strategies from the Talai Commune People's Committee, TCG, Park Board were needed to enable the stakeholder to execute their roles in working in TCG (Armitage et al. 2009). Particularly, the Talai Commune People's Committee and TCG need to have a better understanding of the decision-making processes, benefit-sharing mechanisms, and their relationship with local people and the private sector (Hughey et al. 2017). Procedures are needed to ensure that the power of the dominant groups is managed and that negative prejudices are prevented (Mompati and Prinsen 2000).

Initiatives and activities closely related to local cultures and the social context of the local community are more likely to be successful in engaging and supporting local people (Pagdee et al. 2006). The results of the case study showed that there was a lack of understanding of ethnic groups and their social status among those in key roles such as the TCG, private company and Park Board. The lack of participation by members of the Stieng community in the Talai Ecotourism Venture may have been remedied if there had been greater understanding of, and empathy towards Stieng cultural norms and the creation of a more culturally inclusive plan for engaging local ethnic minority peoples in the venture (Waylen et al. 2010). Alternative livelihood initiatives that do not take the cultural context into account are therefore unlikely to be successful (Dahlberg et al. 2010).

10.4.5 Epilogue: Disruption to CBE Initiatives

A major disruption to CBE and its potential for improved forest conservation and reduction in NWFP reliance by local people in southern Vietnam has been the global pandemic of COVID-19. Vietnam recognised COVID-19 as a serious threat in January 2020. Soon after the national emergency plan was enacted, including closing borders, imposing travel restrictions and suspending all international flights into and out of the country. When there were about 200 confirmed cases, a nationwide lockdown was implemented on 1 April, 2020 (BBC 2020). Although the number of COVID-19 cases has remained low, the impact on tourism in Vietnam has been severe. There was a 99.3% decrease in tourists recorded in June 2020 compared to the same period in 2019. Vietnam National Administration of Tourism also recorded a loss of around US$5.9–7.7 billion in tourism revenue during the three months from February to April 2020 (Reuters 2020).

Prior to COVID-19, the majority of visitors to the Talai Ecotourism Venture were international such as tourists, students from international schools in larger Vietnamese cities, and low budget travellers (Nguyen 2014). The COVID-19 pandemic has therefore affected all aspects of Talai Longhouse operations due to a large decrease in visitors. The nature of the on-going impact of the pandemic on local people's participation in and benefits from the Venture is uncertain, as is the impact on NWFP reliance and whether it will increase due to lack of viable livelihood options. The impacts of COVID-19 will be unevenly felt, and global reports clearly indicate that women and ethnic minorities more likely to be adversely affected (UNWTO 2020).

10.5 Conclusion

This study assessed the performance of CBE for two forest-dependent ethnic groups (Chau Ma, Stieng) in the buffer zone of Cat Tien National Park in southern Vietnam, and the impacts on their livelihoods, dependency on NWFPs, and broader community awareness of forest conservation. The CBE program had created positive impacts for those employed in the Venture, with reduced dependency on NWFPs and heightened awareness of forest conservation. To scale out these outcomes to the broader community would require other mechanisms such as VDF to become more effective, and initiation of similar livelihood interventions in the buffer zone. Results from the study on the livelihood intervention could be improved if governance arrangements were more community-based such as improvements in benefit sharing, greater engagement of relevant stakeholders, more equal power sharing in management of Venture, and improvement in capacity building for those involved. Another area that would assist in greater engagement and scaling out of such livelihood interventions is a well-developed understanding of existing social-cultural norms. To scale out these benefits to similar livelihood interventions for forest conservation and community

development goals they need to be implemented equitably, and to attain an understanding of social-cultural norms in the area of the intervention, particularly local institutions, power structures, and differentiation of ethnic groups.

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Chapter 11
Non-timber Forest Products for Poverty Allevation and Environment: The Development and Drive Forces of Hickory Production in China

Zhen Zhu, Yueqin Shen, Ke Ning, Zheyi Zhu, Bowei Li, and Zhang Yaoqi

Abstract This study overviewed the development of non-timber forest products (NTFPs) with four stages and its contribution to poverty allevation and environment based on hickory production practices in Lin'an, China. The study analyzed the driving forces of hickory production including policies, technologies and market. Finally, it outlined the experience of hickory industry development in China, including cooperation between local governments, universities and farmers' organizations to impel technologies innovation; popularize the ecological and sustainable management of NTFPs and collaborate those small holders through the foundation of farmers' cooperation organizations and encourage the popularization of internet based e-commerce in rural areas.

Keywords NTFPs · Forest tenure reform · Ecological management · Farmers' collaboration · Hickory

11.1 Introduction

Non-timber forest products (NTFPs) have long been an important component of the livelihood strategies of people living in or adjacent to forest areas. Several million households worldwide depend heavily on these renewable resources for subsistence and/or cash income, and the FAO estimated that 80% of the population of the developing world use NTFPs to meet some of their health and nutritional needs (Stark et al. 2008).

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The roles of forestry in the livelihoods of rural population and the poor are particularly reflected in non-wood forest products (NTFPs) in many developing countries. While a significant amount of NTFPs is for own uses, an increasing share is sold on markets. The resources of NTFPs include leaves, bark, fruit, seed and flowers, and edible fungus, etc. They can be used for food and oil, perfume products, drinks, medicinal materials, and others. For the poor families, NTFPs can account for over 50% of the household's diet (FAO 2007).

Over the past two decades, NTFPs have become increasingly valuable resources for the income and employment of rural households in China (Liu and Xu 2019; Zhu et al. 2019, 2020), where the resources are estimated to take up at least 10 million ha of forestland (State Forestry Administration 2017). After the two rounds of forest tenure reform, millions of rural households have the use rights of forestlands to make forest management with their own decision. With the high economic value and shorter life-cycle, NTFPs from natural and planted forests play an important role in the household economy in China. In 2020, the total planting area of NTFPs arrived at 40 million ha, the total output value of NTFPs industries is about 150 billion USD, and about 340 million labors have been employed in the departments which are relative with NTFPs (State Forestry Administration 2020).

The importance of NTFPs for development has drawn wide attention by academia since 1980s. NTFPs have been considered as an alternative approach for income generation and economic development in rural area (WCED 1987; Peters et al. 1989; Sayer 1995; Belcher and Schreckenberg 2007; Ahenkan and Boon 2010). However, past studies are primarily focused on its importance to rural household income, but what are path of the development and the driving forces are not well addressed. More importantly, how the small products (they were often called minor products) develop in a significant business is hardly addressed, and environmental implications are usually not being paid with enough attention.

With the case of hickory (*Carya cathayensis*), one of the most famous NTFPs in China, the objective of this study is to review the stages of development in the hickory production in Lin'an county, also it analyzed the influencing factors which drive the development of local hickory industry including polices, technologies and market. We expect the study will provide valuable lessons and insights to other products in other developing countries on how to use NTFPs for poverty alleviation and sustainable development.

11.2 The Development of Hickory Production in Lin'an

Hickory, an endemic plant in China, is in the walnut family and has been planted and managed for its nut production for half millennium (See the Figs. 11.1 and 11.2). The trees produce catkins in the spring, which will mature into hickory nuts if they are properly fertilized. Like other nuts in the walnut family, the hickory nut is hard shelled and covered in a woody outer layer. Its central production zone covers several counties in Zhejiang, particularly in Lin'an.

Fig. 11.1 The hickory trees

Fig. 11.2 The hickory nuts

As a typical collective forest area in southern China, Lin'an district of Hangzhou in Zhejiang Province is the earliest "Forest City" at the county level. Lin'an located on the northwest of Zhejiang province (Figs. 11.3 and 11.4), its forest coverage rate ups to 81.97%, and the total area of forestland nearly reaches 270,000 ha. In addition, Lin'an is an important member of the Asia–Pacific Forest Restoration Network (APFRN) and Chinese Model Forest Partnership Network (CMFPN). The forest cover ratio is 80% and the per capita income of farmers is about 5,800 USD in 2020 (Lin'an Statistics Bureau 2021). Besides, as the origin of China's hickory, Lin'an District has more than 500 years of hickory cultivation history. On China (Lin'an) Hickory Cultural Festival, Lin'an was officially awarded the title of "hickory Capital of China" by China Economic Forest Association in 2009. Now the whole area of hickory is more than 38,000 ha, accounting for 31% of the total area of China. The

Fig. 11.3 The location of Lin'an in Zhejiang province

Fig. 11.4 The location of Zhejiang province in China

stable annual output of hickory is more than 10,000 tons, accounting for 37% of the national output. In 2019, the total output arrived at 15,109.5 tons. There are 258 hickory enterprises, including 28 large-scale enterprises, and the processing volumes account for 80% of China. Meanwhile, the hickory industry helped local rural households to improve their incomes and livelihoods, there are 76 villages with an annual income of more than USD 166,666 from hickory, 23,949 households with an annual income of more than USD 1600 from hickory (Lin'an Forest Bureau 2019).

From the initial wild state to the present ecological standardized management, the hickory industry has undergone great changes. Figure 11.5 depicts the change of hickory yield from 1982 to 2019, and Fig. 11.6 depicts the change of hickory planting area from 2004 to 2018. Based on the yield changes of each sample county, the development process of hickory can be divided into four stages: before 1988, 1989–2002, 2003–2009, after 2010.

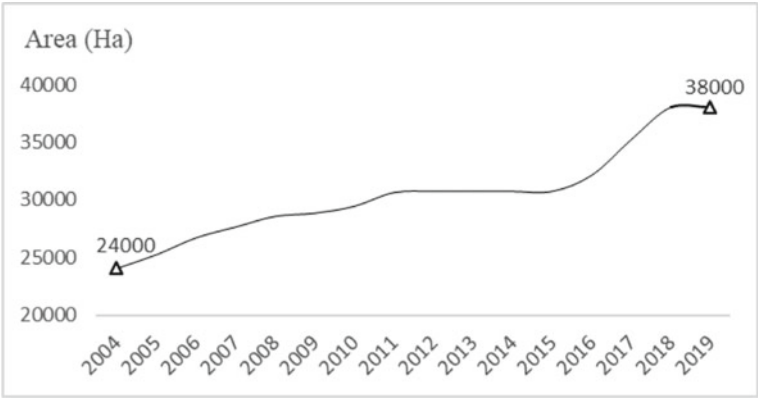

Fig. 11.5 Hickory area change in Lin'an from 1982 to 2019 (ha). *Source* Second-hand data collection

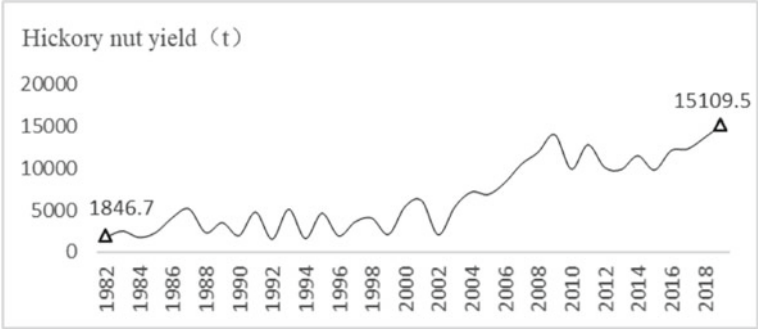

Fig. 11.6 Hickory nut yield change in Lin'an from 1982 to 2019 (t). *Source* Second-hand data collection

(1) **Stage I: Mostly wild hickory and slow development of hickory industry (before 1988)**
At that time, due to forestlands owned by the village have just been assigned to individual households, farmers can not accurately grasp the central collective forest rights system policy, and they worried about policy changes. Also, they neglected the management of wild hickory, the growth of hickory production was slow in this stage. At the same time, the development of hickory processing enterprises was obviously insufficient at this stage. At first, the hickory is mainly pressed with edible oil. In the early 1970s, hickory has begun to be processed into salt and pepper pecans. In the late 1970s, hickory flavors were getting richer, not merely monotonous, salt-flavored dried fruit, but also a variety of flavors, including creamy and five-flavored. Generally speaking, the hickory processing enterprises were small in scale and product types were few. As a result of national regulation, hickory was mainly purchased by Chinese government with planned price.

(2) **Stage II: Fluctuation of alternating high-yield and low-yield years, and hickory market began to develop (1989–2002)**
This stage was a significant fluctuation of alternating high-yield and low-yield years of hickory. As the different local situation of each place, this stage is roughly in the last century from 1989 to 2002. Due to the continuous improvement of the central collective forest rights system and the stability of government policy, forest farmers had been encouraged to plant hickory and develop hickory industry. However, due to the laws of nature, the fluctuation of alternating high-yield and low-yield years was still apparent in Lin'an.

The hickory market continued to improve, the scale of processing enterprises expand, and the number was constantly increasing in 2000, more than 90% Lin'an hickory were sold to the consumers after processing. With the new processing products of "hand peeling hickory" entering into the market which made the consumers more convenient for eating in 2001, hickory market price rose and the income of forest farmers increased, which greatly stimulated the investment of forest farmers to plant hickory. The average output value at this stage kept more than 20 million USD steadily in this stage.

(3) **Stage III: Rapid Industrial Development (2003–2009)**
In this stage, the production of hickory increased steadily and rapidly. As the economic benefit of hickory was becoming more and more obvious, it had gradually became the main source of income for farmers in mountainous areas, per capital income of farmers from hickory in Lin'an is about 1200 USD in 2009, and it alleviated the poverty of households effectively. At this stage, with the continuous breakthrough of science and technology, the fluctuation of alternating high-yield and low-yield years of hickory gradually disappeared, and the area of hickory was continuously expanded (Fig. 11.7). The farmers' cooperative organizations which improve the competitiveness in market trade for small-size hickory planters developed rapidly to ensure the benefit of farmers in hickory sales. Also, the hickory processing enterprises in Lin'an began to

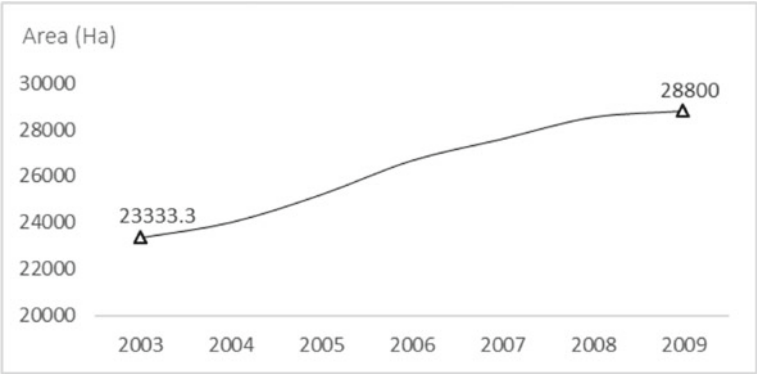

Fig. 11.7 Hickory area from 2003–2009 in Lin'an. *Source* Statistical yearbook of Lin'an City (2003–2009)

focus on the brand building and marketing promotion, some enterprises built their brand famously in national and provincial level for their hickory products.

(4) **Stage IV: Ecological and standardized management (2010–present)**
This stage focused on the stage of standardized and ecological management for hickory. From 2010 to 2015, the production of hickory showed a trend of decreasing year after year in Lin'an, one important reason is that farmers had been using chemical fertilizers and pesticides in large quantities for a long time from the beginning of 1990s in order to maximize economic benefits from hickory production, which lead to the decline of soil fertility, land hardening, and the frequent occurrence of dry rot and root rot diseases for hickory. It ultimately affected the growth of hickory yield. In order to achieve sustainable management of Lin'an hickory industry, the government of Lin'an District had vigorously built and promoted the ecological and standardized business model. Meanwhile, as the policy system and key applicable technologies continued to improve, the production of Lin'an hickory began to recover, and showed a rising trend in recent years. The average output value at this stage increased 8% annually, and kept more than 20 million USD steadily in this stage.

11.3 Driving Forces of Hickory Industry Development in Lin'an

With the continuous growth of hickory industry, it has gradually developed into an industry integrating planting, processing and sales from the original single farming industry. However, it's important to discuss that what are the driving forces for the development of local hickory industry? It's argued that there are four driving forces including policies, technologies and market which motivated the development of hickory industry.

11.3.1 Policies

From the above analysis, it' has been shown that the development of hickory industry has gone through four stages. As one of the most important NTFPs in Lin'an, the local government has paid more attention on the hickory industry. The supporting policies of industrial development were designed and introduced to improve the sustainable development of the hickory industry. The policies evolution of hickory industrial plays an important role in the development of hickory industry.

(1) **Stage I: Forest tenure reforms and policies which gave individual households access to delineated forest areas (1980s–2000)**
Following the effective implementation of the Household Responsibility System (HRS) in rural of China from 1978, the State Council issued the Resolution on Several Issues Concerning Forest Protection and Development in 1981 in an effort to stabilize forest use rights, delineate self-retained mountainous land for villagers and formalize both family forest management and the HRS within the collectives (Hyde 2019). Marginal forestland was allocated to individual households under a system known as family forestland. Compared with other provinces in China, Zhejiang government began to assign the tenure right of forestland to thousands of households in the early of 1980s. Given a more clear and security forestland tenure right, rural households have more incentives to make forest production in Zhejiang and many local households began to operate the natural hickory in Lin'an. In 1985, as the CPC Central Committee and the State Council implemented the Ten Policies on further activating the rural economy, the hickory could be traded in the market by the circulation system construction of agricultural products, and the traditional monopoly purchase and distribution system by government had been abolished. However, due to the long cycle and high risk in hickory management, smallholders with less endowment did not have more incentives to invest the hickory management.

(2) **Stage II: Policies mainly oriented on marketization and industrialization (2000–2005)**
During the 14th National Congress of CCP, the market prices of mostly agricultural and forestry products had been liberalized, which greatly promoted the development of market economy [8]. In hickory management, the price of hickory trade was basically adjusted by the market. In 2001, Zhejiang Provincial Committee of the CCP issued the "*Policies on Forestry for Ecological Environment Development*", pointing out to strengthen the development of NTFPs including hickory. In the same year, Lin'an and Chun'an in Zhejiang provinces built the special forestry base at provincial level for hickory with the financial support from provincial government. Local hickory industry in Lin'an also established the technologies extension supporting system and passed the forest food certification at provincial level. In July of 2002, "*Reform of Rural Taxes and Fees*" *(Zhejiang Committee* (2002 [4]) cancelled or adjusted different kinds of agriculture and gradually lightening the tax burden for farmers. The

enthusiasm of farmers to manage hickory was further improved, and the area of hickory was continuously expanded, however, there was still a fluctuation of alternating high-yield and low-yield years in hickory harvesting.

(3) **Stage III: Policies emphasized the improvement of industrial organization for small holders (2006–2010)**
On the basis of stabilizing contract with small-size forestlands for households, with the implementation of the "*Law of the People's Republic of China on Farmers' Cooperatives*" in 2006 as the symbol, the state gradually paid attention to the construction of farmers' industrial organizations, and many hickory specialized cooperatives were established in major hickory production areas to improve the competitiveness of smallholders. Governments at all levels have issued policies to support the development of the hickory industries and promote the standardized construction of farmers' professional cooperatives. Document No.17 which issued by general office of Zhejiang provincial people's government (2007 [17]) put forward to vigorously promote the standardized construction of farmers' cooperatives, and built the provincial financial special funds to support about 300 specialized farmers' cooperatives at provincial-levels. Document No. 51 of Zhejiang Forest Industry (2007 [51]) focused on accelerating the development of professional forestry cooperatives which focused on the local special forestry industries. In February 2008, Government in Lin'an issued the *Three-Year Action Plan of Strengthening Rural Industries and Promoting Rural Development* (2008 [2]), In March, the government issued the plans of "*Accelerating the Development of the Hickory Industry*" in order to further optimize the structure of hickory industry in Lin'an and improve ecological environment of the hickory production area.

(4) **Stage IV: Ecological and standardized management policies to promote the sustainable development**
In order to solve the urgent problems such as the deterioration of ecological environment of hickory production, Lin'an government actively guided the farmers to carry out the ecological standardized management for hickory production. For example, Lin'an government designed the plan for accelerating the ecological management of hickory" in September 2019. More than 1400 ha degraded forestland which over managed for hickory had been restoration. The prohibition of using herbicides in hickory forest had been implemented strictly which reduce the soil pollution and deterioration.

11.3.2 Technologies

For a long time, hickory was mainly cultivated in wild and long growth cycle, so it did little contribution for increasing income for local households in mountainous areas. One of the important reasons is the extensive management and significant alternating high-yield and low-yield years for hickory. Therefore, technologies are one of the most critical determinants in the development of hickory industry. The technology

of hickory has undergone a long process of change in Lin'an which can be divided into the following three stages.

(1) **Stage I: Artificial cultivation and management technologies for wild low-yield forests**
After the given forest tenure right to local households by forest tenure reform from 1980s, households were willing to improve investment in their own hickory forest. At first, some field conservation, improving-yield technologies for wild forests management had been applied by a great number of households. However, the processing and manufacture technologies were insufficient for households. In this period, the scientific researches on hickory mainly focused on the cultivation and nursing of wild hickory, but few technical achievements could be extension.

(2) **Stage II: Transformation from high-yield technologies to comprehensive R&D technologies**
From the end of 1990s, local households adopted the extensive forest management which imitated from field farming in agriculture. However, due to the excessive reliance on fertilizers, pesticides and herbicide in the management, it brought serious ecological and soil damage in hickory production. Therefore, the staffs and experts from government and universities adjusted the objectives of researches from purely pursuit of high yield to compatible development between yield, quality of products and environment improvement. In addition, some marketing strategies such as branding of hickory had been developed.

(3) **Stage III: Ecological and standardization technologies for connecting the international demands**
After China's accession to the WTO from 2001, facing fierce competition in international trade of forest products with other countries, the quality monitoring system and standardization for connecting the international demands have been built.

Several ecological technologies such as interplant, formulating fertilization and pest control have been applied in hickory production. Among those technologies, the most important technology is the emergence of natural fruit harvesting technology (Fig. 11.8). It referred to lay big net around the trunks of the hickory trees, the hickory fall naturally on the ground net and then can be collected in the container bucket which fixed at the bottom of the ground net. The innovation of the harvesting technology greatly reduces the labors and time cost of the traditional harvesting, avoids the high-risk behavior of climbing tree for harvesting, reduces the soil erosion for forestland.

11.3.3 Market

The fast growing hickory nut production has been driven by market. Before the 1950s, hickory nut was only consumed locally in the production region. The economic

Fig. 11.8 Natural fruit harvesting technology

growth created the demand and increased the price to attract farmers to plant and manage hickory nut. Moreover, marketing has also played an important role, extending from the few southern cities such as Shanghai, Hangzhou to other cities such as Beijing, Guangzhou. In recent years, Lin'an has been focused brand establishment and standard development of the product and industry. The decentralization of collective forestland ownership in the early of 1980s and following-up government (such as subsidies and tax relief) accelerate the progress. Prices and market expansion are important forces. The price has increased from 2.2 USD/kg in the 1990 to 12 USD/kg in 2019 (Fig. 11.9).

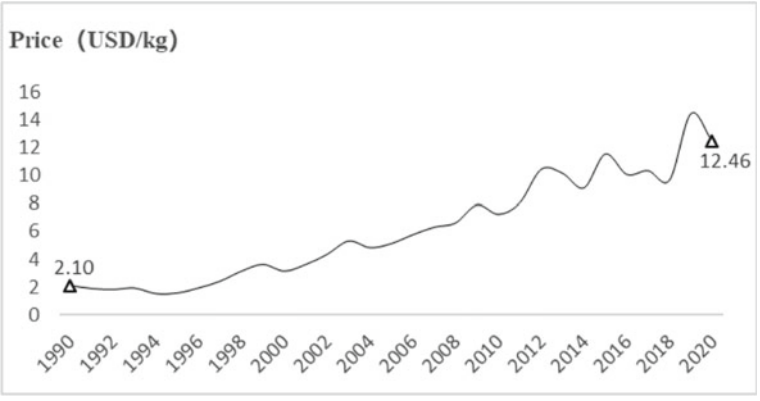

Fig. 11.9 Hickory price change in Lin'an from 1990 to 2020. *Source* Second-hand data collection

The good price makes the cultivation and investment attractive. The processing and market expansion have also play an important role. The coordination of cultivation, production, processing and sale has developed into an efficient chain. The market has extended from the few southern cities such as Shanghai, Hangzhou to other cities such as Beijing in the north, Guangzhou in the south.

To promote the products, various market strategies were used. Current consumers would like to know the origins of the production sources, and prefer to buy the product produced from the native produce region. Therefore, various brand names were reserved to protect the producers from a certain regions. The most famous one is "Lin'an" which was assessed with 0.364 billion Yuan of market value.

11.4 Conclusions

China has the long tradition of NTFPs utilization, given the enforcement of a strict logging and the low return of timber plantation, NTFPs made significant contribution to poverty alleviation, especially in the remote mountain area that lacks other business opportunities. Based on our analysis and findings, with the forest tenure reform and open market for rural agriculture products from the 1980s, hickory industry developed gradually following three stages and it was droved by various forces including technologies, processing, and market access of the industry. Many Hickory tree as a China's endemic plant in the walnut family has been planted and managed for its nut production for half millennium. Currently the managed area had increased to nearly 100 thousand ha and produces more than 10,000 ton/year. The value of hickory nut product in 2019 amounted to more than 125 million USD in Lin'an County alone. For some villages, the revenue accounted for 60–70% of the farmers' total income (Shen et al. 2010).

The rapid development of NTFP based industries in China is due to the constant and dynamic policy support of the governments both central and local level. Concerning with the rapid development of NTFPs, the growth can be attributed to the drives including policies, the technological innovation, increasing price and market expansion. The cooperation between local governments, the universities and academies and farmers' organizations prompted the technologies innovation and extension for NTFPs.

The biggest challenges for NTFPs in China are the over-exploitation and management practices by the smallholders. The ecological and sustainable management of NTFPs should be the most important objectives for developing and expanding NTFPs in other developing countries. After the two rounds of forest tenure reform from 1980s, smallholders have the user rights of their forestlands to have the NTFPs management, however considering the high and quick return from NTFPs, a substantial number of local small-scale households in China apply excessive fertilizer, herbicide or pesticide to boost the production which in turn posing threat to biodiversity, soil conservation and, also the sustained supply of NTFPs as a source of cash income (Dai et al.2020; Shen et al.2010). Peoples in other developing countries still face

the same situation which happened in China. The ecological management and standardized technologies should be applied by households whose livelihoods depended on NTFPs management to keep the sustainable forest management in all over the countries.

Considering the high proportion of smallholders in NTFPs management, another important recommendation is that to collaborate those smallholders by the foundation of farmers' cooperation organizations and encourage the popularization of internet e-commerce in rural. It can improve the organizational level and negotiation abilities for smallholders and reduce their constraints to maximizing income benefits from NTFPs. Also, producers and collectors in mountain area do not have access to market knowledge (such as demand and price) and sell their produce individually to outside traders, so it's important to give the trainings for e-commerce application for local rural households, which can make the NTFPs sales more conveniently and timely.

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Index

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