Wild flora for improved rural livelihoods

Case studies from Brazil, China, India and Mexico

BGCI
Plants for the Planet

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September 2012

Recommended citation: Oldfield, S. & Jenkins, M. 2012. Wild flora for improved rural livelihoods. Case studies from Brazil, China, India and Mexico. Botanic Gardens Conservation International, Richmond, U.K.

ISBN: 978-1-905164-41-7

Published by: Botanic Gardens Conservation International
Descanso House, 199 Kew Road, Richmond, Surrey, TW9 3BW, UK

Design: John Morgan, www.seascapedesign.co.uk
Cover image: Brent Stirton/Getty Images/WWF-UK

Executive summary

Left: Fritillaria cirrhosa - *an important species in Chinese traditional medicine (C. Leon, RBG Kew)*
Right: Tillandsia guatemalensis – *a traditionally utilized species in Mexico (Isauro Vidal Rodríguez)*

Wild plants provide a huge diversity of products of livelihood value. Millions of people around the world depend directly on wild plant resources for at least part of their livelihoods, be it for food, medicine, building materials, fuelwood or financial income. Documentation on the use, values and impact of wild plant utilisation is scattered, fragmented and particularly scant in the scientific literature. This report summarises the findings of a short study on wild flora for improved rural livelihoods in four countries that have extremely rich and diverse floras - Brazil, China, India and Mexico.
The study considered a series of around 80 case studies drawn from the literature and compiled by experts in a standard questionnaire on plants that enter local, national or international trade. Timber species have been excluded from the study, focussing instead on products that have a greater potential to be sustainable. In each case information was sought on livelihood values and indications of sustainability relating to the plant species.

The study has confirmed the value of wild plants as livelihood resources, many of which are apparently used sustainably. Further work is however required to confirm the findings for individual species. Examples of integrated management and monitoring of wild plant species with livelihood values are hard to find. The study has generated considerable interest and debate about policy implications particularly in relation to the sustainable use objective of the Global Strategy for Plant Conservation (GSPC). This Strategy has been agreed by governments worldwide and is one of the mechanisms for implementing the Aichi Targets of the Strategic Plan for Biodiversity for delivery of the Convention on Biological Diversity. It is imperative that more action is taken to meet the GSPC and Aichi targets on sustainable plant use, taking into account ecological, economic and social considerations by 2020. Prioritising resource species for further attention is an important next step. At an international level plant species that enter global commerce should be a particular focus of attention to ensure sustainability and equitable sharing of trade benefits. Voluntary certification schemes and regulatory approaches exist to enhance sustainability and to an extent improve livelihoods and these should be promoted and utilised to the full.

BGCI is grateful to all the experts and organisations involved in the study and to the UK Government for funding the initiative. The subject matter we have attempted to research is complex, thought-provoking and poorly documented. It is certainly an issue that warrants far greater attention in biodiversity debate, policy formulation and practical action. Working with botanic gardens, members of the Global Partnership for Plant Conservation and other partners BGCI will strive to build on the initial findings presented in this report.

Gastrodia elata *products on sale (Ding Zimian)*

Euterpe precatoria *(W. Baker, RBG Kew)*

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Acknowledgements

This study has involved input from many organisations and individuals to whom we are most grateful. At BGCI, Chrissie Stanley undertook a review of the literature, processed a lot of information in a short space of time and prepared case studies for selected species. Joachim Gratzfeld designed the species questionnaire. With Xiangying Wen, he led the Chinese component of the study and held an in-county consultation meeting. Suzanne Sharrock participated in the Brazilian workshop, advised on the final project outputs and the selection of the species case studies for inclusion in the GSPC Toolkit.

Specific technical input was provided by the in-country project consultants Miguel Moraes, CNCFlora; Dr Maite Lascurain Rangel; Professor Ding Zimian, Professor Long Chunlin, Professor Luo Peng and Professor Li Zhijun and by Sudipto Chatterjee.

The support provided by CNCFlora at the Rio de Janeiro Botanical Garden in hosting and co-funding the project workshop held in January 2012 is gratefully acknowledged. Participants in the workshop are thanked for their valuable contributions: Ana Lucia Camphora, Detzel Consulting; Ananda Virginia de Aguiar, Embrapa Florestas/MAPA; Arthur S. Mouço Valente, CNCFlora; Claudine Mynssen, JBRJ; Daniel Maurenza de Oliveira, CNCFlora; Danielli C. Kutschenko, CNCFlora; Denise Pinheiro da Costa, JBRJ; Eleanor Mitch, JBRJ; Flavio Valente, INEA; Gustavo Martinelli, CNCFlora/JBRJ; Iona'i Ossomi de Moura, MMA; Joberto Veloso de Freitas, MMA/SFB; José F. Montenegro Valls, Embrapa – CENARGEN; Lidia Vales, JBRJ; Liszt Benjamin Vieira, President/JBRJ; Ludmila Pugliese, SOS Mata Atlântica; Mara Zélia de Almeida, JBRJ; Maria do Rosário de A. Braga, Maria do Rosário de A. Braga, OrquidaRio; Maria Franco T. Medeiros, UFRPE; Maristerra Lemes, JBRJ; Rejan R. Guedes-Bruni, JBRJ; Renato Lorza, Fund. Florestal-AT/GPRA; Roberto L. Romão, JBRJ; Rodrigo Bacellar Mello, INEA; Rodrigo Guardatti, JBRJ; Rogério Gribel, JBRJ; Sandra Faillace, JBRJ; Sérgio Gallucci, Natura; Sueli Matiko Sano, Embrapa cerrados/ MAPA; Tainan Messina, CNCFlora and Thais Pacheco Kasecker, CI Brasil.

The support provided by CONABIO in hosting and co-funding the project workshop in Mexico City, in March 2012 is gratefully acknowledged. Participants are thanked for their valuable contributions: Hesiquio Benítez, CONABIO; David Espinosa, Facultad de Estudios Superiores Zaragoza, Universidad Nacional Autónoma de México; Juana Flores, Sanzekan Tinemi; Edelmira Linares, Jardín Botánico del Instituto de Biología, Universidad Nacional; Andrés Vovides, INECOL; Rosa Ma. Vidal, PRONATURA Chiapas; Guillermo Dahringer, PRONATURA Chiapas; Javier Caballero, Jardín Botánico del Instituto de Biología, Universidad Nacional; Andrea Martínez, INE; and Francisca Acevedo, CONABIO.

Advice and sources of information for the study have been provided by Chris Leon and Noel McGough of the Royal Botanic Gardens, Kew; Bryony Gordon and Thomasina Oldfield of TRAFFIC International; Harriet Gillett; and Danna Leaman, Chair of the IUCN/SSC Medicinal Plant Specialist Group. Their support is acknowledged with special thanks. Hesiquio Benítez has provided advice throughout the project and we are grateful for his support.

A special thank you is due to the Department of Environment, Food and Rural Affairs (Defra), United Kingdom, for funding this initiative.

Introduction

Chinese medicinal plant, Schisandra spenanthera *in flower (C. Leon, RBG Kew)*

Wild plants provide a huge diversity of products of livelihood value. Millions of people around the world depend directly on wild plant resources for at least part of their livelihoods, be it for food, medicine, building materials, fuelwood or financial income. With the continuing global loss of biodiversity the availability of the range and abundance of plant resources of livelihood value is under threat. The magnitude of loss and impact on livelihoods are still scarcely understood.

There is however general recognition that conservation of plant diversity and maintenance of livelihoods are inextricably linked. There is also an expectation that managing wild plants sustainably at the species level can contribute to the long term survival of the species involved, in some cases also to maintaining the ecosystem of which it forms part, and improve livelihoods. The interlinked biological, social and economic issues are extremely complex given the diversity of species and their uses under different circumstances and in different parts of the world. Brazil, China, India and Mexico each have exceptionally rich floras providing a wide variety of plant resources for subsistence and raw materials for trade. Each country has a long tradition of plant use, faces current issues of conservation and sustainable use and, to a varying extent, views wild plant resources as a source of increasing wealth in the future. The UK Government has promoted a Sustainable Development Dialogue with the four countries to foster collaboration and good practice in sustainable development. The emphasis has been on fostering new alliances to promote mutual learning and understanding, and joint innovation and action on sustainable development involving civil society, the scientific community, business, and government.

In this study we have undertaken a rapid review of wild flora for rural livelihoods in the four countries. In doing so we have attempted to consider and bring together strands of research and policy relating to:

- Biodiversity and poverty alleviation
- Production and trade in non-timber forest products
- Sustainable plant production and certification
- Implementation of the Convention on International Trade in Endangered Species (CITES)
- Implementation of the Global Strategy for Plant Conservation (GSPC)

The study has drawn on a set of case studies for individual species that have been compiled through a comprehensive review of published literature, by local experts and through participatory workshops. The case studies, compiled in a common format linking biological, social and economic information, have been reviewed to identify factors that influence success in sustainable use of wild plants and improvement of rural livelihoods. Participatory workshops and in-country discussions have brought together a wide range of interested parties to discuss the broad issues of wild flora for rural livelihoods. From these broad discussions we have identified some common themes that can contribute to further discussions and policy relating to sustainable use particularly in relation to the implementation of the Sustainable Use objective of the GSPC.

Background

Wild plants have direct and indirect values for local livelihoods through the ecological goods and services they provide. An estimated 50,000 plant species are used medicinally around the world (Schippmann *et al*, 2002) relatively few of which are in cultivation. In China, 8000 native plant species have been identified as of medicinal value, in India around 7500 medicinal plant species are recorded and the figure is approximately 2000 each for Brazil and for Mexico. It is thought that 70-90 percent of the market demand for medicinal and aromatic plants is met by wild or "natural" resources (Bhattacharya *et al*, 2008). Around 7000 edible plant species are cultivated for food or collected from the wild. Minor or lesser known crops may be of considerable national and local importance and there is increasing recognition of the importance of wild plant diversity in ensuring food security.

Medicinal plant market (BGCI)

Box 1 Biodiversity conservation and poverty alleviation

A statement by the heads of the five biodiversity conventions, "Life insurance for our changing world" September 2005, notes: *Biodiversity can indeed help alleviate hunger and poverty, can promote human health, and be the basis for ensuring freedom and equity for all.*

A recent review of biodiversity conservation and poverty alleviation conducted under the auspices or the Convention on Biological Diversity has shown that there is a general paucity of empirical information about the ways in which people (especially the poor) use and benefit from the existence of biological diversity. Resources derived from species components of biodiversity are more readily, but generally poorly, quantified. There is considerable reported variation in the extent to which biodiversity-based resources contributes to household income. The poor typically show higher levels of dependence with evidence suggesting that they tend to depend disproportionately on relatively low value subsistence or 'inferior' goods and services from biodiversity. More affluent groups may get interested in such resources if they have higher commercial values (often crowding out the poor in the process). This suggests that there is some evidence of a possible 'poverty trap', with poorer users stuck in low value extractive uses but unable to make the transition out of this resource dependent mode. Interventions that increase the value of wild plant resources through improved negotiating, processing or marketing may be required.

The review suggests that biodiversity provides the poor with an insurance against risk, particularly food security risks, risks from environmental hazards, and health risks. In general the evidence that is available in the reviewed literature suggests that the poor benefit from the existence of, and access to, natural resources (such as plant products), rather than biodiversity in its strict sense. There seems to be inadequate published evidence that supports the conjecture that the diversity of biological systems themselves is significant for the livelihood strategies of the poor. It is considered important to carry out research which looks more closely at the ways in which biodiversity affects poor people's dynamic livelihoods, and their trajectories over time and across different spatial scales.

Source: Secretariat of the Convention on Biological Diversity, 2010

Dua Busé, healer at Ika Nai Bai Park, a Huni Kuin indigenous botanic garden used for cultivation of medicinal plants in Acre state, Brazil (Camila Coutinho)

Trade in wild plants can provide an important source of income for rural communities. The supply chain may be for local, national or international markets, in some cases passing through many intermediaries. The total reported value of non-wood forest products (NWFPs), most of which are plant-based, amounted to about US$18.5 billion in 2005 with food products accounting for the greatest share (FAO, 2010). Much harvest and trade in NWFPs goes unrecorded and this figure, which is based on a limited number of countries, is certainly a considerable underestimate (FAO, 2010).

Wild plants are traded internationally for a wide range of uses. Food and medicinal products are of major importance as are plant oils, gums, dyes, resins, latex and rattan and bamboo for use in furniture making. Wild plants including orchids, bromeliads, cycads, palms and cacti are also traded for ornamental purposes. China followed by India dominated the world export market in NWFPs as reported by FAO, 2000 and continues to do so. The value chains for wild plants traded internationally are complex and the direct livelihood values to rural communities vary widely. As noted in Box 1 the poorest of the rural people may not benefit fully from the extractive value of wild plant resources.

The impact of harvesting of wild plant resources, whether for subsistence use or trade, may be detrimental to the species or its habitat, or both, if the extraction exceeds the capacity of the species to recover or if the habitat is badly damaged in the process. The Millennium Ecosystem Assessment highlighted over-exploitation as one of the five main drivers of biodiversity loss impacting on the conservation status of species. It is generally accepted that use of and trade in wild plants may threaten the survival of species particularly when combined with other factors such as habitat loss, the impact of invasive species and climate change. However, knowledge of the conservation status of wild plants including important resource species remains inadequate globally. It has been estimated that 15,000 medicinal plant species may be threatened with extinction (IUCN/SSC MPSG, 2007); equivalent information is not available for nutritional plant species. In only a small number of threatened plants has the impact of specific threats such as over-exploitation been assessed.

BOX 2 Bringing wild vegetables to market in China

In the Xiangxi region of Western Hunnan Province – 335 taxa are used as vegetables of which 228 are sourced from wild or semi-wild habitats. Local ethnic groups in the area (including Miaozu, Tujianzu, Yaozu and Dongzu) have developed knowledge systems relating to the use and conservation of these plants which are an important subsistence resource. Collection from the wild supplements mixed crop and livestock farming. Medicinal plants including Clerodendrum crytophyllum, Gastrodia elata and Iris lactea are also collected. Surveys of local vegetable markets have shown that over 80 wild vegetables are sold, accounting for around one third of total vegetable sales at the markets. There are now 80 restaurants in Fengfang city that serve wild vegetables to tourists, thus creating a higher demand, resulting in an increase in wild collection. The use of wild vegetables is considered to be of great benefit to local people particularly for poorer communities in mountainous areas with limited land for cultivation. Documentation of local knowledge, detailed research and improved marketing are needed to maximise the benefits from wild vegetables. An increase in reliable income may also increase the perceived value of natural forests.

Source: Zou, X. et al*., 2010*

Sustainability – the rhetoric and reality

The idea of sustainability – a balance between ecological, social and economic factors – has been predominant in environmental discourse for the past 25 years whether at the broad level of development, at the ecosystem level or level of species use. The Brundtland Report published in 1987 defined sustainable development as:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and

the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."

During this period, sustainable forest management has become a major goal of international environmental policy, exemplified by the development of the Forest Principles and Chapter 11 of Agenda 21 at UNCED in 1992. The production and trade in alternative forest products (to timber) has been widely promoted as a means of enhancing sustainability by improving livelihoods and achieving ecosystem and species conservation. Use of NWFPs has been seen as a less destructive use of forests than commercial logging in that harvesting NWFPs often does not involve harvesting whole plants or damaging the ecosystem to the same extent. In 1992 Prance suggested that a desirable future pathway for forests is "the use of many products from the forest without destroying any of the species that produce them". He noted that issues to be addressed in meeting this goal include:

- Maintaining a reliable supply of raw material from the wild to meet demand generated by potential new markets
- The need for research on methods of harvesting and the effects of harvesting on local forests and local communities
- Dealing with the results of success – with the potential replacement of forest product by plantation crop reducing the incentive to conserve the forest resource (Prance, 1992).

Since then there has been increasing recognition that NWFPs can support improved rural livelihoods, household food security and nutrition and make an important contribution to national economic development and international trade. Ensuring that wild resources are used sustainably can however be a complex process. As observed by Belcher and Schreckenberg (2007), intervening in NWFP commercialisation requires a long-term and multidisciplinary approach that ranges from providing support to both the technical and social aspects of natural resource management to understanding how markets function from local to international level.

Rural poor depend on wild plant resources (BGCI)

The international policy and regulatory framework

The policy framework for sustainable use of wild resources encompasses instruments that are primarily focussed on development as well as those focussed on biodiversity. The Millennium Development Goals (MDGs) agreed in 2000 and the Millennium Ecosystem Assessment (MA) published in 2005 emphasise clear links between environmental issues and poverty alleviation.

The Convention on Biological Diversity (CBD): as the main mechanism by which biodiversity policy is delivered internationally, the CBD embraces sustainable use as one of its core objectives. The preamble to the Convention recognises that "economic and social development and poverty eradication are the first and overriding priorities of developing countries". In 2002, the CBD adopted a target "to achieve by 2010 a

Workshop to discuss GSPC sustainable use objective in Brazil (Eduardo Fernandez)

significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth". In 2006 the CBD so-called "2010 Target" was included as a new target within Goal 7 of the MDGs. In 2010 the CBD adopted a new overall target for biodiversity and Strategic Plan to achieve this by 2020. The mission of the Strategic Plan is "*to take effective and urgent action to halt the loss of biodiversity in order to ensure that by 2020 ecosystems are resilient and continue to provide essential services, thereby securing the planet's variety of life, and contributing to human well-being, and poverty eradication….*" A set of 20 targets, known as the Aichi Targets, was also adopted in 2010 including the following that relate to biodiversity and poverty reduction:

Target 2: By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.

Target 4: By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Target 13: By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

Target 18: By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.

The Global Strategy for Plant Conservation (GSPC) of the CBD focuses attention on the conservation of plant diversity. First adopted in 2002 and revised in 2010, the GSPC has been effective in galvanising the botanical community into taking coordinated action. The GSPC is fully aligned with the Strategic Plan of the CBD and in its preamble recognises the fundamental links between maintaining plant diversity and human livelihoods. Objective III of the GSPC relates to the equitable and sustainable use of plant diversity with three targets:

GSPC Target 11: No species of wild flora endangered by international trade.

GSPC Target 12: All wild-harvested plant-based products sourced sustainably.

GSPC Target 13: Indigenous and local knowledge, innovations and practices associated with plant resources, maintained or increased, as appropriate, to support customary use, sustainable livelihoods, local food security and healthcare.

National Biodiversity Strategies and Action Plans (NBSAPs) are the principal instruments for implementing the CBD at the national level. Article 6 of the Convention requires countries to prepare a national biodiversity strategy (or equivalent instrument) and to ensure that this strategy is mainstreamed into the planning and activities of all those sectors whose activities can have an impact (positive and negative) on biodiversity. These national plans are now being redeveloped in line with the CBD's current Strategic Plan and the 2020 Aichi Targets. In turn national responses to the GSPC are being revised.

The Convention on International Trade in Endangered Species (CITES): The fundamental goal of CITES is to ensure that international trade in specimens of wild animal and plant species does not threaten the survival of those species. Implementation of CITES is therefore directly linked to meeting Target 11 of the Global Strategy for Plant Conservation. CITES operates primarily through its appendices – lists of species covered by the provisions of the Convention.

Rural nursery production of Dioon edule*, an ornamental cycad (Andrew Vovides)*

Over 30,000 plant species are included in the appendices, the vast majority of these orchids, of which the entire family is listed. Listed plants include many species that are of medicinal value and a wide range of ornamental species as well as some timber species. A relatively small number of plant species is included in Appendix I. These are species regarded as highly threatened with extinction and for which no commercial international trade of wild specimens is permitted. Virtually all remaining species are included in Appendix II. Commercial international trade in wild specimens of these is permitted, provided that harvest for trade can be shown not to have a detrimental impact on the conservation status of the species. That is, before allowing export, a so-called non-detriment finding (NDF) is required based on knowledge of the distribution, abundance and management of the species. Listing of a species in Appendix II of CITES provides, at least in theory, a basis for sustainable management of stocks for export, a form of certification through licensing, and monitoring of trade through regular reporting.

Given the very wide range of conditions under which CITES-listed species are harvested, and the lack of a precise definition of what constitutes an acceptable NDF, it has proven difficult to develop anything other than very general guidelines for the making of NDFs. Rosser and Haywood (2002) provide a checklist of factors to be considered. Resilience of the species to collection, taking into account biological and harvest characteristics, and management of the collection process are the main factors to be made in developing NDFs. The biological and harvest characteristics suggested for NDFs are based on guidelines for sustainable harvest of NTFPs by Cunningham (2001) and Peters (1994). Principles, criteria and indicators for making NDFs for plant species are given in CITES, 2010.

In the preamble to the Convention text, CITES recognizes that people and States are and should be the best protectors of their wild fauna and flora, but the Convention itself does not directly address livelihood issues. Although CITES listing should enhance sustainable trade and thus benefit livelihoods, there have been concerns that listing species might send negative messages to consumers, reducing demand and in consequence having a negative impact on rural livelihoods (see for example Dickson, 2008). There have also been concerns that if inappropriately applied, CITES implementation may impose a heavy burden on producers without necessarily delivering conservation benefits. In 2004 the Parties to the Convention agreed in a Resolution that "implementation of CITES-listing decisions should take into account potential impacts on the livelihoods of the poor" (Resolution Conf. 8.3). In 2006 a workshop was held on CITES and livelihoods to identify practical measures for the implementation of this resolution. As a result, the Parties have agreed to prepare:

a) tools for voluntary use by the Parties for the rapid assessment at the national level of the positive and negative impacts of implementing CITES listing decisions on the livelihoods of the poor

b) draft voluntary guidelines for Parties to address these impacts, particularly in developing countries. The guidelines should, where possible, assist Parties to develop local, national and regional initiatives that take account of the impacts of implementing CITES listing decisions on the livelihoods of the poor.

Work on these is continuing, and it is hoped that they will be completed by the next meeting of the Conference of the Parties in 2013. Much of the focus of this work has been on animals and as yet relatively little work has been undertaken to assess whether CITES listing decisions relating to plant species have an impact on rural livelihoods. One exception to this is a study of the trade in Galanthus (snowdrop) bulbs harvested in the wild in Turkey for international markets. This study showed that collaboration between scientists and government agencies in Turkey has resulted in a management system that provides a more sustainable and higher income for wild bulb collectors. The study was unable to clearly demonstrate whether CITES-listing was an important factor in leading to the observed livelihood changes. The authors of the study report concluded that "a more detailed analysis of the policy development process would have been necessary to unpick at which point different stakeholders (from Turkish botanists to export companies, import companies, retailers, environmental NGOs and

CITES Committees) had most influence on regulating the trade in Turkey. The existence of a baseline of information relating to livelihoods and the role of bulbs in them before the Turkish and CITES regulations came into force would have allowed us to collect data more rigorously than through the use of recall." (Osborne *et al* 2011).

Non-regulatory approaches to sustainability

In addition to regulatory approaches to sustainable resource use, voluntary certification schemes have been developed aimed primarily at species whose products are in international trade. Certification of timber from sustainably managed forest is now well-established. Certification takes into account social, economic and ecological aspects of sustainability. Forest certification has also increasingly addressed NWFPs as they have gained economic importance. The Forest Stewardship Council developed an NWFP Working Group in 1996. Certification is undertaken using guidelines for general forest management rather than through a specific process for goods other than timber. Chicle, the natural gum used in chewing gum derived principally from the Central American tree Manilkara chicle, was the first NWFP certified and brazil nuts and palm products – both discussed in more detail below – have been certified in Brazil (Shanley *et al*, 2008).

The Fairwild Foundation was established in 2008 with the aim of providing a worldwide framework for implementing a sustainable, fair and value-added management and trading system for wild-collected natural ingredients and products. The Foundation operates a certification system based on a set of principles and criteria providing guidance on ecological aspects of sustainable sourcing

Fruits of Oecopetalum mexicanum *Cachichín on sale. Around 100,000 inhabitants of the Sierra de Misantla are involved directly and indirectly in its collection, processing, consumption and trade (Sergio Avendaño/ Maite Lascurain)*

Annatto, produced from the fruit of Bixa orellana *(BGCI)*

of plants from the wild. Principles and criteria, known as the International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP) were developed during the period 2004-2007 by an international and interdisciplinary advisory group and have subsequently formed the Fairwild Standard. Requirements for certification include resource assessment, development of a management plan, sustainable collecting practices, cost calculation along the supply chain and practices of fair trade. Pilot implementation projects have been undertaken for a range of plant species in various countries including Brazil, China and India. The certification system is considered to have application to the development of NDFs for CITES-listed species (Leaman, 2008).
The Fairwild Standard aims to bridge the gap between existing broad conservation guidelines and management plans developed for specific local conditions.

Currently the Fairwild Foundation is working with the IUCN/SSC Medicinal Plant Specialist Group to develop a robust method for assessing the resilience of plant species to harvesting pressures. The method uses functional ecological attributes such as distribution, regeneration and reproduction to determine how resilient a given species is to collection pressure. It is, for example, obvious that a slow-growing species with limited dispersal is likely to be more susceptible to over-collection than a fast-growing one whose propagules are widely dispersed. At present nine factors are used in the analysis, which is designed to be robust and easy to apply, the intention being that most species can be analysed within the equivalent of one working day.
The proposed factors of resilience are: conservation status; plant part collected; geographic distribution; local population size; habitat specificity; regeneration capacity; reproduction methods; threat causes; and scale and trend of use and trade.

Assessing the case studies

This study has set out to identify successful case studies of sustainable use of wild flora that enhance rural livelihoods in Brazil, China, India and Mexico. In total some 80 case studies have been compiled from a review of literature and by consultants who selected species that they considered to be appropriate within the broad framework of the project. Key literature sources are listed in Annex 1 and included in the references on p.24. In Mexico, 13 case studies were compiled by individual experts and then reviewed at a workshop to formulate national recommendations. In Brazil, 11 case studies were compiled and again reviewed at an expert workshop which considered the use of wild flora for rural livelihoods broadly at a national level. Five case studies were compiled in India and reviewed by local experts. In China, more detailed case studies on five species (including one fungus) were prepared by consultants and discussions were held during a workshop to discuss implementation of the China Strategy for Plant Conservation. A brief summary of the case study species is provided in Annex 1. Further information on the case study species can be found at www.bgci.org together with a comprehensive bibliography prepared for the study.

The amount and quality of information available for each of the case studies is highly variable. This reflects the wider situation regarding the often limited availability of information on harvest and use of NWFPs. Indeed the case studies are likely to represent those species in the target countries for which most information is available – the knowledge base for the great majority of other utilised plant species is likely to be even poorer and largely undocumented. This applies particularly to those species that are used exclusively or largely for subsistence purposes and do not enter market economies to any great extent. Gathering information on this kind of use is technically difficult and expensive. Where detailed studies have been carried out, these are usually at small scale, often looking at use of a limited range of species within individual communities. Even for products that are commercialised nationally or internationally, data are often sparse.

Just as information on the socio-economic aspects of harvest and use of NWFPs is scarce, so are data on the impacts of such use on the species concerned. In very few cases are there quantitative baseline data against which to assess the impacts of harvest. Where there are indications of decline these are often anecdotal or are inferred from changes in harvest patterns or in the supply of the products concerned on the market. Where there is persuasive indication of local decline, it is often difficult to know to what extent such declines are typical of the species as a whole. Many of the harvested species are widespread and, as noted above, very different conditions may pertain in different parts of the range.

A selection of the case studies is presented below. These have been chosen as representative of the range of conditions applying and to demonstrate possible mechanisms to enhance successful outcomes.

Gastrodia elata *products on sale (Ding Zimian)*

*Tonka beans (*Dipteryx odorata*) in Brazil (Juvenal Pereira/ WWF Brazil)*

Collection and international trade in Tonka Beans from Brazil

Dipteryx odorata is a leguminous tree of great livelihood value in Amazonia. The seeds – known as tonka beans – are a rich source of coumarin, a sweet, highly aromatic compound. Known locally as cumaru, extract from the seeds is used traditionally as a medicine and has been exported for several centuries as a spice to give a vanilla-like flavour to tobacco and foods. It is used as a fixative for perfumes, paints and spray additives and in cleaning products, as well as reportedly having antibiotic properties. Coumarin can cause serious though reversible liver damage if taken at high dosage or over an extended period and has been reported to be carcinogenic in rodents. Its use as a food additive is now prohibited or severely restricted in several countries, including the USA and Germany.

From 1989 to 1996, Brazil exported approximately 700 tonnes of tonka bean seeds, generating a gross income of around USD $3 million. The major single importer was Hong Kong; European countries accounted for approximately half of all imports. Exports peaked in 1994 and the subsequent decline is attributed to substitution by synthetic coumarin. Currently, natural coumarin in international trade is reported to originate mainly in Venezuela and Nigeria (where the species is not native).

The majority of tonka bean production in Brazil comes from wild collection. Some families are entirely devoted to the collection during the harvest season with all family members involved. Each fruit has a seed that is released when the fruit is struck with an axe or machete. This step of "breaking" the tonka bean is mainly done by women and children. After breaking, the seeds are dried. This takes two to three days and can be waived if there are buyers already interested in buying the product while it is still "green." This process is done in "cumaruzais" and riverside communities. When price or production increases, men tend to take over.

The state of Pará is currently responsible for virtually all Brazilian tonka bean production. It is thought that wild populations are stable but there is rising demand for timber of the species which is less likely to be produced sustainably. Further information on levels of production and impact on wild populations would be very valuable in verifying sustainability and involvement with the private sector in ensuring a sustainable trade.

Aniba rosaeodora (Brazilian rosewood)

Aniba rosaeodora is exploited to obtain linalool-rich essential oil from its timber for use as a fragrance ingredient and as a fixative in fine perfumes. In Brazil, the species occurs in the Federal States of Amazonas, Pará and Amapá. Exploitation takes place in Pará and Amapá. At present, the species can be found relatively frequently in the interior forests of Amapá, near the border with Guyana, where access is difficult. Harvesting is carried out by teams of collectors under contract to distillery owners. The harvest of the species has been regulated by IBAMA in 2002 and by the Ministry of Sustainable Development of the State of Amazonas since 2006, when forest management was decentralized in Brazil. Since 2007, with the implementation of the 'DOF System' (Documento de Origem Florestal – document of forest origin), the control of the chain of custody of this and other species has become stricter. An estimated 85 percent of the essential oil is exported and *Aniba rosaeodora* was included in CITES Appendix II, reflecting concern that "the population is undergoing a worrying decline because it is subject to a harvest rate greater than its replacement rate". Despite its high value and international interest, the distribution and abundance of the species has never been determined in detail. Natural regeneration is poor, since it is slow-growing and seeds are intensely predated upon by birds and insects. Harvest of the best phenotypes may have led to negative selection pressure on the species, although there are no data to support this. There are indications of illegal harvest associated with the international trade in essential oil.

Tillandsia eizii *harvested for ceremonial use (Isauro Vidal Rodríguez)*

International demand for Golden Grass handicrafts from Brazil

Syngonanthus nitens, commonly known as golden grass, is a widespread plant in South America. In the region of Jalapão, Eastern Tocantins State, Brazil, local people have used the species to make handicrafts for over 70 years. The scapes (leafless flowering stems) are sewn tightly together with strips of Buruti palm (*Mauritia flexuosa*) to make jewellery and other products. Originally used locally, more recently these have been commercialized in large Brazilian cities and European countries, increasing extraction rates (Schmidt, 2005). Men, women and children from all the villages of Jalapão are involved in the collection of the plant resource and in the making of handcrafts all year around. Research in 2009 showed that in one area sampled, over 80% of the families extract golden grass and 65% of them work with its handicrafting. The Normative Instruction Naturatins Number 362/2007, regulates management and collection of golden grass. It states that harvesting can only be done by registered local producers and artisans that live in the area. It also establishes the collection period, from 20 September to 30 November, and specifies that the stems are dry and mature, in order to guarantee that the flowering season is over. Sustainable management procedures have thus in theory been established at a local level.

Indigenous use of air plants *Tillandsia* spp. for local rituals in Chiapas, Mexico

The indigenous peoples of the Altos de Chiapas in Mexico collect large quantities of inflorescences of *Tillandsia* spp. (epiphytic bromeliads) for ceremonial use. Informal payments are made to the owners of the land where the collection takes place and the flower stalks are sold at local markets. The price is per dozen and is variable, depending on the season and the availability of the resource. Communities in the municipality of San Juan Chamula collect an estimated 215,000 inflorescences of *T. eizii* each year from mixed oak-pine forests. These are used to decorate sacred sites and altars. Other species are particularly valued for use in nativity decorations at Christmas. The species collected are slow growing and can take 12-15 years to flower so cultivation is unlikely to be developed. A marked decrease has been noted in the supply of the resource. Changes in land use prevent the recovery of populations affected by collection. Management recommendations have been made based on population studies to determine the density and population structure of the species, the size of minimum viable population, and the size of the sustainable collection (Wolfe & Konings, 2001). A basis for sustainable management has thus been established.

Schisandra sphenanthera – sustainable harvest for improved livelihoods and ecosystem conservation in China

The berries of the vine *Schisandra sphenanthera* are harvested for medicinal use in China. Historically this species, known as Southern Schisandra, has been used as substitute for the more valuable Northern Schisandra *S. chinensis*. Southern Schisandra is also used locally in fruit juices, soups, and alcoholic beverages, and has global potential as a component of health drinks and dietary supplements. In a recent project run by WWF, *S. sphenanthera* was selected as a target species for promoting sustainable management of traditional resources in Pingwu County, Sichuan Province. Since 2008 when the national policy of Forest Tenure Reform was enacted, villagers in the area have been given more freedom in using and managing their community forests. With encouragement from local government, the villagers began clearing vegetation from community forested lands to plant the "three tree species of commercial medicinal plants": Houpu (*Magnolia officinalis*), Duzhong (*Eucommia ulmoides*) and Huangbai (*Phellodendron amurense*). In this way, villagers significantly "improve" the productivity of the lands while still retaining the status of the lands as "forested lands". But this practice has no benefit to biodiversity, and has caused severe degradation of the secondary forests as habitat for wildlife, including Giant Panda. At the same time villagers have collected valuable medicinal plants illegally within the Wanglang National Natural Reserve. Through the project sustainable harvesting protocols have been developed for *S. sphenanthera* in the area of collectively owned secondary forest. Resource baseline surveys were undertaken at the start of the project with subsequent monitoring. Based on these surveys, resource management plans were developed with participatory approaches, which suggested the amount, locations, and methods of collection and processing by the villagers. All the major agreements were summarized in a Village Pact. Through the project an association of medicinal plant harvesters has been formed to ensure the implementation of the Village Pact, negotiate prices with buyers, safeguard the interests of collectors and monitor money transfers. An association of medicinal plant product dealers has also been formed to negotiate prices, sign trade contracts with international buyers, monitor harvesting and processing and work with certification companies to ensure product quality. There are currently six villages involved in collection, about ten intermediate dealers forming the local dealers' association and two major international buyers. There has been substantial increase in cash income from wild harvest of Southern Schisandra in the project area, of greatest benefit to vulnerable groups such as women, elders and children. For some women, this has been the first time they have made money from harvesting wild medicinal plants, providing cash for education and improving their status within the family and in the wider community. The project is reported to have reduced pressure on some of the more threatened medicinal plants in the Wanglang National Natural Reserve.

Murumuru - a Brazilian palm important for local livelihoods and international trade

The Amazonian palm *Astrocaryum murumuru* has a wide variety of uses. Locally, the leaves and seed are used for handicrafts, the fruits are eaten and an edible oil is extracted from the seeds. The oil is used more widely in food, cosmetics, soap and for other industrial purposes. Local collection and production along the Amazon and its tributaries provides an important source of seasonal revenue for local communities that depend primarily for their livelihoods on extraction of natural products. Murumuru production is generally organized by cooperatives which own machinery for extracting the oil. The cooperatives, and in some cases local intermediaries, are involved in the trade with large companies. Oil is traded within Brazil or exported to other countries, primarily for the cosmetics industry. Several papers have been published about use of the species by local communities and the cosmetics industry, but there is very limited published information on trade.

Palms growing in the Atlantic Rainforest reserve at São Paulo Botanic Garden, Brazil (Brent Stirton, Getty Images – WWF UK)

Normally, the separation of the seeds from the pulp is carried out by hand locally. Income obtained varies according to land tenure, number of intermediaries and local productivity. The federal government has set a minimum price for Murumuru seeds (R$0.50/kg). One company, Natura, obtains seeds from a number of agricultural cooperatives in the Amazon region, in 2010 paying up to R$4.22/kg following negotiation with the local community. Elsewhere prices may be lower: the community of São João do Jaburu in the State of Acre reportedly only obtains R$1.10/kg. It is possible to harvest 5 t/ha/year (fresh weight), generating an annual income of over R$1.500 per hectare (Revilla, 2001). The price of Murumuru fat, produced from its oil, varies from R$14.00 to R$20.00/kg, depending on costs of collection, storage methods and transportation costs. Processing companies and cooperatives generate a gross profit of around R$6 from each kg of seeds, a gross return of around 30%.

Some plantations of Murumuru have been established, but Revilla (2001) noted that virtually all harvest at that time was from wild populations. Population studies are limited but the wild population appears to be stable overall. Further research would be beneficial as would certification of sustainability for the export market.

Collecting plant material in Barcelos municipality, Amazonas state, Brazil (Ricardo Azoury)

Diospyros melanoxylon a major livelihood species in India

In India the leaves of *Diospyros melanoxylon*, known as Tendu, are used to make traditional cigarettes (*bidis*) and are a major source of income in the rural economy. The species grows in various kinds of tropical forest that are generally managed for tendu production. In some cases management may have adverse environmental impacts, for example fires set in early summer to encourage development of root suckers that give better quality leaves may be harmful to the forest ground flora. Tendu is a nationally listed NTFP, which means that all marketing must be done through state forest departments, associated forest marketing corporations, or licensed traders operating on behalf of the state. The majority of tendu leaf collectors are the rural poor; marginal farmers (owners of less than 2 ha) or agricultural wage labourers, including tribal people and scheduled casts. Women do most of the collection work though teenagers, small children and men may help. In some areas relatively rich farmers with irrigation facilities who can produce two crops per year are also involved. In 2004 tendu leaves and *bidis* were estimated to provide just over 100 million person days of employment in collecting activities and 675 million person days in secondary processing. In one study area the average total annual household income of producer households was just over US$100, around one-eighth of which was

Processing tendu leaves (Sudipto Chatterjee)

Bundles of tendu leaves (Sudipto Chatterjee)

derived from tendu (Kusters and Belcher, 2004). There are local traditional and customary nonstatutory rules governing access to and management of the product. Some of these rules have to do with the collection of leaves by families from specific areas and respect for the territory of other families, collection of only mature leaves, picking of leaves one at a time and not stripping stems of all the leaves, pruning of only small branches, no cutting down of major branches and so forth. The effect of traditional rules governing access and management of tendu leaves is believed to be generally positive in promoting sustainable exploitation and equitable access to the resource (Kusters and Belcher, 2004).

Production of gum resin from *Commiphora wightii* in India

Commiphora wightii is a shrub or small tree growing in semi-arid areas from Arabia to north-west India. It is the source of a valuable gum resin known as guggul, which has a long history of use in Ayurvedic medicine and which is also used in perfumery and incense production. The plant generally takes ten years to reach tapping maturity under the dry climatic conditions. Generally the gum resin is collected by tribal people using traditional tapping methods involving making several deep incisions on the stem to extract the maximum amount of gum.They then apply a paste around the incision consisting of horse or wild ass urine, gum resin and copper sulphate. Whilst this crude method increases the amount of gum three to four times over that obtained under normal tapping procedures, the shrub becomes subsequently unfit for tapping for the next couple of years and ultimately plants may die due to the injurious effect of copper sulphate. The yields are in the order of 200-500 gm of dry guggul per tree each season. The species has reportedly been greatly reduced in number through unsustainable exploitation and is regarded as threatened with extinction in India. It is currently classified as Data Deficient by IUCN, although this categorisation was made in 1999 and the status of the species is regarded as in need of reappraisal. There appears to be little cultivation of the species although in 2008 it was reported that the Indian National Medicinal Plants Board has launched a project that intended to undertake enrichment planting of guggul over several hundred hectares in the Kutch region. A large number of seedlings had been raised but it is not known how much progress has been made with planting. The Government of India has reportedly banned export of guggul gum. In 2007 a Save Guggul Movement was launched, working with local communities in the Aravali Hills in Rajasthan State, building awareness and encouraging sustainable management of the resource.

Cistanche tubulosa an important Chinese medicinal plant

Cistanche tubulosa is one of several species in the genus *Cistanche*, members of the broomrape family (Orobanchaceae) that parasitise the roots of various host plants. It is widely distributed in arid lands in central Asia from China west at least as far as Pakistan. It and other members of the genus (including the CITES-listed *C. deserticola*) have a long history of use in traditional Chinese medicine, being regarded as having similar properties to ginseng *Panax* spp. Since the 1960s demand within China has grown very significantly, leading to heavy exploitation of wild populations, including those in southern Xinjiang Province, north-west China. The principal host plant in China is *Tamarix chinensis*, a species that plays an important role in stabilisation of soils on sand-dunes. *Cistanche* can be harvested with little impact on the host plant if collection is carried out carefully. However, increased demand has led to much indiscriminate and damaging harvest, with wild populations of *C. tubulosa* also apparently adversely affected by abstraction of water for irrigation.

Cistanche tubulosa *a medicinal plant of the Taklimantan Desert, China (Li Zhijun)*

Cistanche tubulosa *(Li Zhijun)*

Reported production from wild harvest peaked in the 1960s at ca 500 tonnes per year, declining to less than 200 tonnes per year in the 1990s and less than 100 tonnes more recently. In recent years production has increasingly shifted to artificial propagation, which involves planting of the host and inoculation of the host with *Cistanche*. Planting of Tamarix chinensis has been extensively undertaken as an anti-desertification measure. Some 100000 ha of planted Tamarisk have been artificially inoculated with Cistanche in Hotan prefecture in southern Xinjiang, giving an annual yield of some 3000 tonnes of fresh product, equivalent to 600 tonnes dried. Economic benefits have been substantial. In one town in Minfeng county, artificially propagated *Cistanche* has been planted on 4000 ha, yielding an annual income of just under 4 million yuan, amounting to over 800 yuan per head, or some 20% of per capita income. Some product is exported, but it appears that the great majority is destined for sale within China. There is still demand for wild *Cistanche*, which is considered by some as superior in quality to artificially propagated material; it is unclear what impact collection of wild plants currently has.

Candelilla – a CITES-listed commodity sourced from the wild in Mexico for global trade

Euphorbia antisyphilitica is a succulent plant that grows in the US and Mexico. Along with almost all other succulent Euphorbia species it is included in Appendix II of CITES. It yields an important source of wax known as Candelilla that is used widely in the food and cosmetics industry. The collection of Candelilla wax is one of the most important economic activities for families in the Chihuahuan desert of Mexico. It is estimated that more than 20,000 families depend on the wax for their livelihood. Collectors of Candelilla known as 'Candelilleros' work in small groups, leaving their families for a minimum of five days to collect Candelilla in the wild. Experienced collectors pull up Candelilla plants by hand to avoid contact with the toxic and caustic latex of the plant. Bundles of entire plants with small roots are transported by mule to processing sites where adequate supplies of water used in processing are available. Approximately one quarter of the range of *E. antisyphalitica* is exploited and plants in the more remote areas remain untouched. Sustainable harvesting regulations in Mexico are established by SEMARNAT, 1999. The level of harvesting is not thought to impact detrimentally on the species. Recently *E. antisyphalitica* has been a topic of attention within CITES. In March 2010 a decision was made to exempt finished products ready for retail (lipsticks and other cosmetic products) containing *Euphorbia antisyphilitica* from CITES controls to ease the enforcement burden. There has been no follow-up to determine whether this decision has had any impact on the livelihoods of the candelilleros.

Sustainability of a medicinal herb *Trichopus zeylanicus* enhanced in India

In the Western Ghats, this small perennial herb has been used by the Kani people to overcome fatigue. Following screening by the Tropical Botanic Research Institute (TBGRI) in Kerala an Ayuverdic drug known as Arogyapacha has been produced using the species as one ingredient. Cultivation techniques have been developed. Kani tribals receive 50 percent of the license fee for manufacture of the drug and 50 percent of the royalty received by TBGRI on sales. The benefit-sharing experiment with Kanis and the subsequent formation of a Kani Trust fund have reportedly helped the tribes to take up social welfare schemes, provide opportunities of employment and income generation through cultivation and post-harvest processing of Arogyapacha, establish linkage and prospective partnership with institutions/corporate bodies outside their communities, and empower them to protect, preserve and maintain their knowledge, innovations and conservation practices. *In-situ* methods for longterm conservation of *Trichopus zeylanicus* have been developed with the help of the Forest Department of Kerala.

Matsutake harvesting for international trade

Matsutake growing in the wild (Prof. Luo Peng)

Matsutake are basidiomycte fungi within the large genus *Tricholoma* which produce edible mushrooms. They occur widely in the northern hemisphere in symbiotic association with woody plants such as pines and oaks. The fungi traded as matsutake form a currently unresolved taxonomic complex within the genus. Asian populations

are generally referred to *Tricholoma matsutake*, but these may be synonymous with the European *T. nauseosum*. Matsutake are collected for food in many parts of their range, but are highly sought-after only in Japan and, to a lesser extent, Korea. In Japan they are the most highly esteemed wild fungi. Production in Japan declined dramatically during the 20th century, with harvest levels in the 1980s estimated at only 10% of those in the first half of the century. The reasons for the decline are not well understoond, but may be related to the introduction of a pathogenic nematode causing extensive mortality of pines and to large-scale changes in forest management. Demand in Japan has remained strong, and a high proportion of current consumption is imported, from China. Attempts at cultivation have failed, and all product is wild-harvested.

The wholesale price of matsutake in the Japanese market is very variable, depending on the freshness and quality of the product, the latter dependent largely on the stage at which the mushroom is picked, and on availability, which fluctuates greatly both from year to year and within each season (typically from July to November). Matsutake harvested in Japan command a high premium, and can fetch over USD 1000 per kg, but now account for a very small proportion of the market – in 2009 just 1.5% of Japan's total consumption of around 1600 tonnes. In recent years 75% of imports have originated in China, with most of the rest coming from North America where a different but very similar species, so-called White Matsutake *T. magnivelare*, is harvested. Harvest in China, which began on a large scale in the late 1980s is mainly carried out in north-western Yunnan Province and the autonomous region of Tibet. In Yunnan according to government statistics around 600,000 people are directly involved in harvest and trade. Harvest is carried out by local people and the product typically passes through four or five intermediaries before being air-freighted to Japan. Harvest to retail should take place in less than 60 hours, otherwise the product begins to detiorate and its value fall. In 2009 the wholesale export price in China varied from USD 17 to USD 200 per kilo. Matsutake is the highest-earning NTFP or agricultural product in Yunnan, generating an estimated USD 44 million (from export of 1300 mt) in 2005. In the autonomous region of Tibet it is second only to the parasitic fungus *Cordyceps* in economic importance. In one county (Shangri-La) in Diquing Autonomous Tibetan Prefecture, government revenue from tax on matsutake trade accounted for USD 1.2 million in the period 1990-1994, around 30% of all county revenues. Some 80% of people in the county were believed to be involved in the trade. In villages with access to good matsutake habitat, harvest was reportedly been transformative, with villagers building new houses, and sometimes buying motor vehicles, or opening new businesses entirely on the basis of earnings from the harvest. Prices in 2005 were sufficiently high, with harvesters earning USD 40-50 USD per kg, that a single individual could earn around USD 100 in a few days of wild collection, amounting to 60-70% of the total per capita annual cash income.

A range of ethnic groups is involved in harvest and trade in matsutake. Differences in land-tenure arrangements and customary practices mean that no single pattern is followed. There are no formal, legal controls over matsutake harvest but some villages have established comprehensive regulation systems governing harvest on community land, covering access fees for outsiders, minimum harvest size, harvest techniques and the organising of forest patrols to ensure regulations are enforced. In other places enforcement of regulations is reportedly weak. Attempts by local government to standardise management of and trade in the product and to develop a single brand identity for matsutake exported from Yunnan have reportedly not been successful. Nationally, export is in theory submitted to a permitting system administered by the Chinese CITES authorities (although the species is not included in the CITES appendices), but it is not clear to what extent this occurs in practice.

According to Amend *et al* (2009) almost all harvesters in north-west Yunnan report declining harvests over the past ten years. The reasons for this are not known. There is no evidence that intensive harvest itself has a direct impact on populations and subsequent yields but some harvest techniques such as excavation of the surface ground layer may have an impact. Factors such as climate change and more general forest management practices may be the cause of decline.

A Chinese medicinal plant market (BGCI)

Conclusions

Astragalus mongholicus - *a medicinal species used for various treatments including reducing blood pressure (Long Chunlin)*

The harvesting of wild plant products is clearly important for rural livelihoods in many places in Brazil, China, India and Mexico. A large number of species is used for many, varied purposes. This diversity is well captured in the 80 or so case studies, all of which have focused on species that enter commercial markets to some extent – the range of plants used for purely subsistence purposes is clearly much wider still.

The species included in the case studies span a wide range of species of different growth forms and in different taxonomic groups. Half of the species included are trees of various kinds, with 40% of the trees being palms. The large number of palms – in this instance all featuring in case studies from Brazil and Mexico – is a reflection of the general usefulness of the group and its diversity in the Americas. The remaining species included a number of shrubs and herbaceous perennials, as well as a small number of epiphytes, bulbs, vines, saprophytes and one parasitic species (*Cistanche tubluosa*). Taxonomically, the species are very largely flowering plants, chiefly in dicotyledon families, with some monocots, chiefly palms, but also orchids, grasses and bromeliads. Other groups represent only a small proportion of the species considered, and include three species of cycads, one species of fern, a lichen and a fungus, the last two not strictly speaking being plants at all.

The parts used are extremely various. Fruits and flowers are the single commonest parts used, featuring in around one-third of the species, followed by leaves. Other parts used include bark, saps and resins, roots and underground stems of various kinds. In some cases the whole plant is used. Many species have multiple uses, sometimes with the predominant use varying across the range. This is the case for example with palms such as murumuru *Astrocaryum murumuru*, discussed above, which yields edible fruit, oil from the seeds used for cosmetics, leaves used to construct shelters, and medicinal products. Palms of the genus *Euterpe* are used for extraction of palm hearts, for fruits, and for leaves, used in roofing and to extract fibres. Use of wood for timber has not been considered in this study, although products such as oils extracted from timber, as in *Aniba rosaedora*, have. Several of the tree species are, however, also exploited as timber species and in some cases this may be the major driver of changes in population.

In all the case studies at least one product enters commercial markets to some extent, as species harvested purely for domestic subsistence have not been a focus of study. The markets may be local, national or international. Just as the products and markets for the species harvested vary, so do the production chains and the livelihood benefits delivered at various points along the chain. Some species are harvested at a small scale, others in large quantities over extensive areas. Some of the latter, such as palm-hearts in South America, matsutake *Tricholoma matsutake* in east Asia and Tendu *Diospyros melanoxylon* in India, form the basis for markets that involve large numbers of people and are worth tens or even hundreds of millions of dollars annually. Some are the sole or major source of income for those involved in their harvest while others may provide only supplementary, often seasonal, income. As a general rule the more links there are in the supply chain between the harvester or producer and the end-consumer the smaller the proportion of the ultimate retail value of the product is delivered to the harvester. With relatively few exceptions (of which matsutake is perhaps the most

Mauritia flexuosa *(W. Baker, RBG Kew)*

notable) the products tend to be of low unit value at harvest stage. Nevertheless, the income generated from their harvest can be of huge importance to harvesters, who are often among the poorest sectors of society.

In cases where there is an international market it has generally been difficult to determine on the basis of the available information the relative importance of national and international markets. In part this is undoubtedly because the four countries themselves have large and growing domestic markets. Indeed China is itself a major importer of wild-harvested NWFPs, chiefly those used in traditional Chinese medicine. However, in a few cases it does seem clear that international trade is the major driver of harvest. Notable examples include the Brazil nut *Bertholletia excelsa*, Tonka bean *Dipteryx odorata*, candelilla *Euphorbia antisyphilitica*, and matsutake.

Assessing sustainability

Determining the conditions for sustainability and assessing whether uses of particular plants are sustainable in particular cases is in theory relatively straightforward but in practice less so. To be sustainable, harvest of a particular species should not have a long-term negative impact on the species concerned or on the habitat of the species concerned. Determining whether this is the case requires some knowledge of trends in populations of the species, and some insight into the impacts of particular harvest and management regimes on the species and its habitat.

In general, as noted by Smith *et al* 2011 for CITES species there is a lack of knowledge on the biology and the impacts of harvesting on which to base sustainable management.

The case studies have shown that even where the harvest is well characterised in terms of volumes in trade and economic benefits, this information is very often missing or limited in extent. In virtually no case is there long-term, extensive monitoring of populations. Where there are indications of changes in population status these are generally non-quantitative or anecdotal and only apply to limited areas. This is not to say that such information is of not trustworthy or useful: local people often have a very clear understanding of changes in population of plants that they use. It is, however, difficult to collate this information and also to relate it to the impacts of particular uses.

Some insight can be gained into the likely impacts of uses from the type of collection and the biology of the species concerned. It is evident, for example, that harvesting of parts but not whole plants is clearly likely to have less impact on target populations than harvest that collects or destroys whole plants. Collection of flowers, fruit and other propagules is most likely to be sustainable, with harvest of other parts, such as leaves, shoots and bark likely to vary in impact. However, it may be difficult to deduce this from the actual parts that feature in trade. Harvest of *Tillandsia* flowering bracts in Mexico, for example, essentially entails harvest of whole plant which may have taken many years to reach harvest size. Similarly, some harvest of palm fruits sometimes entails felling the tree, a clearly unsustainable practice in the short term. There have also been suggestions that intensive harvest of fruits, for example of the Brazil nut *Bertholletia excelsa*, may have hampered regeneration by severely depleting the seed store. However, this does not appear to have been unequivocally established in practice. Conversely, harvest that is generally destructive may not be so in all cases. Notably, harvest of palm hearts normally destroys the tree in question, but in the case of the multi-stemmed Peach Palm *Bactris* gasipaes harvest does not kill the tree, so that one individual may be used productively over many years.

Astragalus mongholicus *is mainly cultivated but some harvesting from the wild occurs (Long Chunlin)*

The impact of particular harvest or other management practices on the wider habitat is often more difficult to determine. It appears that some harvest, such as that of the underground stems of Cistanche or the fruiting bodies of the matsutake fungus *Tricholoma* may have long-term damaging effects if it is not carefully carried out, although this does appear to have been the subject of systematic study. Similarly, management of some tree species, including several palms in Brazil and *Diospyros melanoxylon* in India may entail clearing of potentially competing species, burning or other practices that have an adverse impact on habitat integrity and other components of biodiversity in the habitats in question. Again, this does not appear to have been the subject of detailed study.

Although declines have been noted in at least some populations of a number of the species included in the case studies, most of them appear still to be widespread and not considered under imminent threat. Where there are thought to have been declines they have often been ascribed to other factors, such as logging and land-use changes, particularly clearance for agriculture. This is perhaps not surprising, given the relatively low unit value of most of the products harvested. It seems likely that harvest of these species may be in some ways largely self-regulating, in that once resources are depleted below a certain level, the rewards gained from harvesting them do merit the effort that is needed to do so. Where species produce goods of high value, by and large they have either historically been overexploited to the point at which it is no longer economically viable to harvest them (such as several valuable tropical hardwood timbers such as true mahogany *Swietenia mahagoni* and various rosewoods *Dalbergia* spp.) or they have been brought into cultivation. Exceptions are those species such as matsutake, which appear peculiarly resilient to overharvest (although it should be noted that populations are now reported to be declining, for unknown reasons) but that are also intractable in cultivation. It is perhaps relevant that matsutake is not a plant, but a fungus, with a very different biology from plants in general.

Heterotheca inuloides *a Mexican medicinal plant that is now cultivated by rural communities as a source of income (Edelmira Linares)*

Above: Collecting grasses for handicrafts in Brazil (Fernandes M. Fernandes)
Top: Negro river in Amazonas State, Brazil (Eduardo Fernandez)

However, this short study has shown that there are many instances where harvesting of wild plants is taking place to the benefit of local livelihoods without presenting a substantial threat to the species involved. Sustainable harvest may take place with little active management or control, resulting instead *de facto* from the prevailing ecological and social conditions, including the inherent characteristics of the species and its natural distribution and the incentives and opportunities for collection.
In some cases sustainable harvest may be achieved as a result of traditional management practices, or controls imposed by government or through project interventions of various kinds. However, it is clear that where conditions militate against sustainable management – for example because there is high incentive to collect the species, the species has a low intrinsic reproductive rate or because levels or governance and enforcement are poor, or more usually a combination of all these – it is difficult to create the conditions for long-term sustainability. Several of the Chinese case studies demonstrate that traditional practices have allowed for sustainable harvesting but with increasing commercialisation these practises are no longer followed – or not adopted in new harvesting areas – and then cultivation is generally introduced.

Recommendations and next steps

1. The use of wild plants is important for income and well-being worldwide as exemplified in the review of wild flora for rural livelihoods in Brazil, China, India and Mexico. More attention should be paid to the values of wild plants in biodiversity policy formulation, reporting and review.

2. Increased efforts are needed to research and document the status and utilization of non-timber wild plant resources particularly those of commercial value so that baselines can be established for sustainability at a species level. Mechanisms for more effectively sharing information should be developed using standardized protocols, including basic biology, production and extraction processes, markets, and the potential effects of climate change. Prioritisation should be given to collecting information on species that are heavily exploited, are of particular value for livelihoods and/or are suspected to be declining at an unsustainable rate.

3. Plans for sustainable production and consumption are urgently needed for key wild plant resource species to meet Aichi Target 4 of the CBD which calls for impacts of use of natural resources to be well within safe ecological limits and to meet Target 12 of the GSPC. This Target calls for all wild-harvested plant-based products to be sourced sustainably by 2020. Appropriate resource assessment methodologies and harvesting protocols need to be developed with participation of local communities. Successful models should be shared widely within countries and made available to the wider community through the GSPC Toolkit www.plants2020.net

Basketry - Mercado de Januária, Balaios. Brazil (M. Bacelar)

4. Documentation of the major plant species of livelihood significance that enter international trade is urgently required with an assessment of the most appropriate mechanisms for improved sustainability including consideration of certification and CITES listing.

5. Collaboration with the private sector is essential with regard to major plant species of livelihood significance not least to ensure that sustainable procurement policies are met.

6. CITES mechanisms and procedures should be utilized to the full to promote sustainable management and monitoring of listed species particularly with regard to NDFs. The linkages between CITES, sustainable trade and livelihoods could very usefully be investigated providing models that can be more broadly applicable in the implementation of GSPC Targets.

7. The developing linkages between the CITES non-detriment findings and FairWild certification should be supported to the full, streamlining approaches and standards for wild plant products traded internationally. The resilience work linked to this should help prioritise species that require attention to ensure mechanisms for sustainable harvesting. Assessing the conservation status of major species selected for FairWild certification and other useful plants of commercial value is considered a priority by IUCN.

8. Target 13 of the GSPC calls for indigenous and local knowledge, innovations and practices associated with plant resources, maintained or increased, as appropriate, to support customary use, sustainable livelihoods, local food security and healthcare. This Target is clearly of major importance in Brazil, China, India and Mexico where indigenous and local knowledge is highly significant for sustainable resource management and livelihoods. Understanding traditional knowledge and sustainable practices related to the use of plant resources may help to identify innovative approaches in collection and processing of plant resources, and management of natural populations. it is necessary to promote community development, recognize and respect the traditional forms of organization that promote equity and justice related to the sustainable use of plant resources, and to consider ecosystem services as a complement to the use of species.

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Market scene in China (BGCI)

Annex 1 Case study species

Species	Common Name	Source of Case Study	Natural Distribution	Notes
Brazil				
Aniba canelilla	Preciosa	from literature	Caribbean Islands; Central & South America	A small tree whose timber produces an essential oil traded internationally. Subject of a FairWild implementation project in Amazonia. Reference: [1]
Aniba rosaeodora	Brazilian Rosewood	from literature	South America	A small tree producing an essential oil used in the perfume industry (Chanel No 5). Important international trade. No detailed baseline data on stocks but apparent decline. IUCN Red List – EN; Included in CITES App II. Reference: [1]
Astrocaryum aculeatum	Tucumã	from literature	Tropical South America in Amazon and adjacent areas	A palm whose fruits are harvested for food. Harvest sole source of income for some families; seeds used to make necklaces; timber used in construction. Some management. No evidence of overall decline. Reference: [3]
Astrocaryum murumuru	Murumuru	consultancy	South America	A palm utilised for fruit, oil for cosmetic industry, leaves for construction, medicinal products. Minimum price for seeds set by Government. No evidence of over-use.
Attalea maripa	Inajá	from literature	Tropical South America in Amazon and adjacent areas	A palm. Large market for fruit in Eastern Amazonia; also jewellery and other uses. Species is abundant and no indication of over-use. Reference: [3]
Attalea speciosa	Babassu palm	from literature	Tropical South America in Amazon and adjacent areas	A palm. Seeds produce edible oil (babassu oil) also used in cosmetics, exported in significant quantities. Flour produced from the seeds; leaves used in thatch and for weaving; timber for construction. Reported to be the most valuable NTFP exported by Brazil and to benefit very large number of people. Population possibly declining.
Baccharis trimera	Groundsel Bush	from literature	South America	A shrub in the family Asteraceae. Leaves used for medicine. Little information on status of population, but species has a good capacity for regeneration and harvest thought likely to be sustainable. References: [2, 4]

Species	Common Name	Source of Case Study	Natural Distribution	Notes
Bactris gasipaes	Peach Palm	from literature	Central and South America	Palm. Fruit eaten fresh and processed, as preserves, flour and oil. Produces palm hearts in heavy demand within Brazil. Palm is fast-growing and can be harvested 18-24 months after planting. Multi-stemmed so palm heart can be harvested without killing the plant. References: [2, 3, 4]
Bertholletia excelsa	Brazil Nut	consultancy	Tropical South America	Large rainforest tree, source of brazil nuts, an important commodity in international trade. Plantation production reportedly not commercially viable, so that essentially all export is from wild plants. Extractive reserves established for the species; some literature suggests harvest is unsustainable. Local projects promoting sustainability eg Natura in partnership with a cooperative in Amapa State. IUCN Red List – VU.
Bulnesia sarmientoi	Guaiacwood	from literature	Argentina; Bolivia; Brazil, Paraguay	A hardwood tree. Essential oil from wood used in the perfume industry and traded internationally; timber also traded internationally IUCN Red List – LC; CITES Appendix II
Carapa guianensis (taxonomy recently revised)	Andiroba	consultancy	South America & Africa	A hardwood tree producing valuable timber and high quality oil used medicinally and as an insecticide. Widespread, some cultivation, no evidence of unsustainable harvest for NTFP products. FairWild implementation project in Amazonia.
Caryocar villosum	Piquía	from literature	Tropical South America	A hardwood tree; fruit and oil from fruit are sold at markets in Amazonia Collection is thought to be sustainable but the species may possibly suffer impact of logging. Reference: [3]
Copaifera langsdorffii	Copaíba	consultancy	Argentina, Brazil, Paraguay, Venezuela	A hardwood tree. Timber; medicinal: for its anti-bacterial and anti-inflammatory properties; essential oil used in perfume industry. Thought to be managed sustainably. Experimental plantations established.
Dipteryx odorata	Tonka Bean	consultancy	South America & the Seychelles	A hardwood tree. Major utilisation– exported used in anticoagulants and in perfumes, Secondary source of income after livestock & agriculture in surveyed areas of Pará Wild populations considered stable; decrease in juveniles appears to be compensated by regeneration in canopy openings. No evidence of unsustainable harvesting of tonka beans in Brazil.
Endopleura uchi	Uxi	from literature	Brazil	A hardwood tree. Fruits marketed locally & regionally, medicine (especially for lowering cholesterol) Vulnerable to land use changes. References: [2, 3, 4]

Species	Common Name	Source of Case Study	Natural Distribution	Notes
Euterpe oleracea	Açai Palm	consultancy	South America	A palm harvested for fruits and palm hearts; main source of income for some families. Also used in cosmetics. Felling is prohibited; abundant, some cultivation.
Euterpe precatoria	Acaí Palm	from literature	Central and South America; Trinidad and Tobago	A palm used by local people for human and animal health treatments; mesocarp used in food (often desserts); primarily used for edible palm hearts. Single-stemmed so limited or no potential for sustainable management based on natural regeneration. However included in one of the first non-timber FSC certification projects. Reference: [5]
Euterpe edulis	Palmito	from literature	Brazil, Argentina	A palm unsustainably harvested for palm hearts References: [2, 4]
Hevea brasiliensis	Rubber Tree	consultancy	Tropical South America	A tree producing rubber from the sap. Wild trees still used. Extractive Reserves created. However low density within natural forest creates an incentive for environmentally less desirable land uses.
Hymenaea courbaril	Jatobá	from literature	South America; widely introduced elsewhere	A hardwood tree used for timber, food, medicine, fuel, insect repellent. Medicines marketed and used locally. Local people benefit more from sale of medicines than selling logging rights. Threatened by overexploitation. Reference: [3]
Ilex paraguariensis	Mate	consultancy	Subtropical South America	A shrub whose leaves are harvested for tea and medicines.. Source of income for over 700,000 people. In the past mainly wild-harvested now cultivated. Wild populations historically reduced.
Licaria pucheri	Puxuri	from literature	Central & South America	A hardwood tree used for medicines to treat stomach disorders, rheumatism and insomnia FairWild implementation project in Amazonia. Reference: [1]
Mauritia flexuosa	Burutí Palm	from literature & consultancy	Tropical South America	A palm with multiple uses. Edible fruit, handicrafts, roofing, medicinal, oils, sun creams, other skin applications. A widespread species but increasing demand may be leading to unsustainable use. FairWild implementation project in Amazonia.
Maytenus ilicifolia	Espinheira Santa	from literature	S. Brazil, Argentina, Paraguay & Uruguay	A hardwood tree. Leaves used for medicine – in some cases providing around 20 percent of family income. Harvesting is legally controlled with authorisation based on management plans but concerns about sustainability. References: [2, 4]

Species	Common Name	Source of Case Study	Natural Distribution	Notes
Oenocarpus bataua	Patauá	from literature	Trinidad, Panama, Tropical South America	A palm. Fruit processed to make juice and oil, jewellery, medicine, construction Overharvested in the past to supply a substitute for olive oil. Reference: [3]
Pfaffia glomerata	Brazilian Ginseng	from literature	Brazil; Argentina; Bolivia	Herbaceous plant. Roots harvested for medicine – for some communities providing up to 50 percent of household income. Uncontrolled collection has lead to rapid declines. References: [2, 4]
Pilocarpus jaborandi	Jaborandi	from literature	South America	A shrub whose leaves are used in medicine: they are rich in the alkaloid 'pilocarpine' used for treatment of glaucoma and more recently xerostomia. Officially threatened in Brazil, with leaf harvests declining since about 1987, due to increasing over-exploitation to meet international demand, plantation development by a pharmaceutical company.
Platonia insignis	Bacuri	from literature	Tropical South America	A hardwood tree whose fruit is increasingly popular in local markets – collected for sale seasonally to supplement farming. Demand for wood is high, oil also used for skin Populations decreasing mainly through wood use. References: [2, 3, 4]
Protium pallidum	Breu Branco	consultancy	Tropical South America	A hardwood tree whose resin is traditionally collected by Amazonian Indians. Used for incense & handicrafts. Harvesting may have reduced the more accessible supplies but at a landscape level probably sustainable because price and market demand are relatively low.
Syngonanthus nitens	Golden Grass	consultancy	South America	A grass whose flowering scapes are used in handicrafts. Widespread, increasing popularity may cause decline on a local scale particularly where not subject to harvesting controls.
Tabebuia impetiginosa	Pau D'Arco	from literature	Central and South America	A hardwood tree used for timber, medicines and tea. IUCN Red List – LC. Ranching, logging & fire are causing declines. As the trees have become scarcer bark for medicinal use is collected from sawmills. Reference: [3]
Theobroma cacao	Cocoa	from literature	South America	A shrub or small tree. Harvested January to March; wild cocoa know for its supreme butter quality; growing market for organic chocolate paste has resulted in increased production and price elevation.
Trema micrantha	Nettle Tree	from literature	South America	A tree whose bark is used to make paper. Shortage of local raw material led to bark imports becoming necessary; some evidence of traditional management.

Species	Common Name	Source of Case Study	Natural Distribution	Notes
China				
Astragalus mongholicus (syn: Astragalus membranaceus)	Astragalus	consultancy	China; Mongolia	A small shrub. Medicinal, used to control excessive sweating; to alleviate oedema and reduce blood pressure. Mainly cultivated but wild material considered superior. Local traditions and folk regulations for management & harvesting. Wild populations are becoming rare in some areas where harvesting bans are ignored.
Bletilla striata	Purple Ground Orchid	from literature	Korea; Hong Kong; China; Japan	A terrestrial orchid. Medicinal, used to stop bleeding and reduce swelling. CITES Appendix II
Cibotium barometz	Woolly Fern	from literature	Asia	A tree-fern. Medicinal, used to treat the liver and kidneys; and to strengthens bones and muscles; eases back ache. CITES Appendix II – trade reviews have been carried out and a NDF case study.
Cistanche tubulosa	Desert Cistanche	consultancy	Taklimantan Desert; China	A parasitic plant growing on roots of Tamarix and other semi-arid shrubs. Medicinal anti-aging and to promote longevity. Recent development of cultivation is improving livelihoods. Wild collection prohibited & cultivation has been developed through inoculation of planted Tamarix. CITES;
Dioscorea deltoidea	Elephants Foot	from literature	Asia	A climbing plant with a tuberous root. Medicinal plant of major importance traditionally and as a source of steroids. Endangered in parts of its range by overexploitation; CITES; Documented in a TRAFFIC review 2008. Reference: [7]
Fritillaria cirrhosa	Fritillary	from literature	Eastern Himalayas Nepal; India;	A bulb. Very popular medicine used to treat asthma, bronchitis and tuberculosis. The species has been over-exploited but restoration is underway using bulbs grown from wild-collected seed.
Gastrodia elata	Tianma	consultancy	Bhutan; Japan; China; North Korea; Siberia; Taiwan	A saprophytic terrestrial orchid. Medicinal: for epilepsy, tetanus and rheumatoid arthritis. Collection of wild seed for cultivation is an important source of local income. Has been considered threatened by trade. Protected by law; now cultivated from wild-collected seed. CITES listed.
Nardostachys grandiflora	Spikenard	from literature	Bhutan; China; India; Nepal	A terrestrial perennial. Used in: perfume, incense CITES – an NDF case study prepared; Documented in TRAFFIC review 2008; overcollection leading to rarity; cultivation promoted in India. Reference: [7]

Species	Common Name	Source of Case Study	Natural Distribution	Notes
Schisandra sphenanthera	Southern Schisandra	consultancy	China	A vine. Medicinal – livelihood improved on a project basis through guaranteed international marketing. Declining due to habitat loss. Sustainably managed on a project basis. FAIRWILD implementation project.
Taxus wallichiana	Himalayan Yew	from literature	Asia - widespread	A coniferous tree. Used in Ayurveda medicine; source of the anti-cancer drug paclitaxel Decline in China due to over-harvesting, CITES Appendix II. Reference: [7]
Tricoloma matsutake	Pine Mushroom	from literature; & consultancy	Asia; Europe & North America	A basidiomycete fungus. Food – mainly exported providing an important source of income for local villagers and local government revenue. Despite commercial collection in Yunnan there appears to be no evidence of unsustainable use.

Imported plant products on sale in Seoul, South Korea (BGCI)

Above: A traditional market in Chiapas, Mexico (Sergio Avendaño)

Species	Common Name	Source of Case Study	Natural Distribution	Notes
India				
Aconitum heterophyllum	Indian Atis	consultancy	India; Nepal; Pakistan	A herbaceous perennial. Medicinal Considered to be endangered through collection & habitat destruction in India; Cultivation is being promoted.
Ailanthus triphysa	White Palle	from literature	Asia & Australia	A tree. Harvested for resin; essential oil Improved method for extraction high quality resin and sustainability. FairWild implementation project. Reference: [1]
Cinnamonum tamala	Bay Leaves	consultancy	India	A hardwood tree. Spice, tea and medicine – a semi-domesticated tree that supplements the incomes of forest dwellers. Wild trees are protected; tribal communities in Meghalaya have evolved sustainable management practices.
Coleus barbatus	Indian Coleus	from literature	India	A perennial epiphyte. Medicinal used to expel worms, treat cuts. Previously collected by cutting the branches off oak or pine trees, on which it grows; FairWild implementation project. Reference: [1]
Commiphora wightii	Guggulu	consultancy	Northern Africa to India	A shrub or small tree. Over-exploited in parts of its range. In India collected by tribal people using traditional tapping methods - considered to be unsustainable.
Diospyros melanoxylon	Coromandel	from literature & consultancy	India	A tree. Tendu leaves for cigarette making & anti-microbial properties; most important NTFP by value in India. Traditional rules governing access & management of tendu leaves are generally positive in promoting sustainable exploitation and equitable access to the resource but there are concerns about implementation of State level policies.
Embelia tsjeriam-cottam	Babrang	from literature	Northeast India	A vine harvested for its fruit. Fairwild implementation project. Reference: [1]
Madhuca latifolia	Mahua	consultancy	India	A large hardwood tree. Major use – fruits, fodder, timber, medicinal, flowers – every part is used for local livelihoods. It is found scattered in pastures and cultivated fields in central India and is cultivated near villages. Different State policies but there are concerns about unsustainable exploitation
Myristica malabarica	Rampatri, Nutmeg	from literature	Endemic to India	A large hardwood tree that occurs in the Western Ghats. Medicinal: for coughs, fever, sprains and sores. IUCN Red List – VU Fairwild implementation project. Reference: [1]
Parmelia perlata	Lichen species	from literature	India	Lichen. Medicina use for cardiac problems and bronchitis. Used as: incense for religious ceremonies and worship Reference: [1]

Species	Common Name	Source of Case Study	Natural Distribution	Notes
Pterocarpus santalinus	Red Sandal Wood	from literature	India; Sri Lanka	A hardwood tree. Used to treat diabetes, skin disorders,used to make incense, timber utilised & production of dyes IUCN Red List – EN; CITES; TRAFFIC review. Reference: [7]
Rauvolfia serpentina	Snake Root	from literature	Widespread in Asia	A herbaceous perennial. Used for millennia contains the compound resperine which treats high blood pressure and mental disorders including schizophrenia; also used as an antidote to snake venom CITES Appendix II; Documented in TRAFFIC review 2008; increasing demand and illegal harvesting reported. Reference: [7]
Rhodiola rosea	Roseroot	from literature	Himalaya & temperate & subarctic areas of the northern hemisphere	A herbaceous perennial. Helps to alleviate depression Community projects to raise awareness of the need to conserve, helping empower communities for better plant management.
Salacia chinensis	Shiragunji	from literature	China, India, Southeast Asia	A vine. Invigorates blood circulation. Fairwild implementation project. Reference: [1]
Saussurea costus (syn: Aplotaxis lappa; Aucklandia costus; Aucklandia lappa; Saussurea lappa; Theodorea costus)	Putchock	from literature	Indian Himalayas	A terrestrial perennial. Medicinal: for rheumatoid arthritis, altitude sickness, gall bladder and liver problems; used in incense; domestic use & exported mainly to China & Japan. CITES Appendix I; CITES review in 2011; registration of farmers who cultivate this species.

Plant products on sale at a market in Mexico (Sergio Avendaño)

Species	Common Name	Source of Case Study	Natural Distribution	Notes
Mexico				
Aechmea magdalenae	Pita	from literature	Costa Rica; Mexico; Ecuador	An epiphytic bromeliad. Fibres from the leaves and rosettes are used to make a fine strong thread used in a leatherwork stitching called 'el piteado' Collection and processing can be combined with other activities making it an attractive product; collected two or three times a year when money is needed; larger leaves produce longer fibres so old plants used. Reference: [8]
Agave cupreata	Maguey	consultancy	Endemic to the Mexican states of Michoacan and Guerrero	A succulent. Mescal production – important culturally & income source. Traditional management system and community rules enhance regeneration of wild populations; also communal nurseries being established. Government regulation of harvesting. Thought to be sustainable.
Brahea dulcis	Soyate Palm	from literature	Mexico & Central America	A palm. Leaves boiled, dried and plaited into strips and woven into hats, mats etc. Community-imposed restrictions (over-exploitation effects leaf size); collection and processing occurs during quieter periods of the year to provide an income when there are few other economic options. Reference: [8]
Bursera citronella	xochicopal, náhuatl	consultancy	Mexico	A tree. Incense used in traditional funeral rites Restricted range, relatively limited use – no evidence of unsustainable use.
Ceratozamia mirandae	Amendaui	consultancy	Mexico	A cycad. Ornamental IUCN Red List: EN; CITES; local nursery production.
Chamaedorea elegans	Camedora Palm	from literature	Rainforest of Southern Mexico and Guatemala	A palm whose fronds are collected and traded as bundles of floral greens. Collected from communal land with free access; wild harvesting between April and October; some species on the Mexican protected species list so require a permit but permit is expensive so leads to illegal cutting. Reference: [8]
Chamaedorea quezalteca	Palma camedor	consultancy	Mexico	A palm whose leaves are collected for floral arrangements & exported; improved marketing arrangement developed to enhance local income. Has been threatened by over-exploitation; regeneration by local communities is restoring wild populations.
Chamaedorea tepejilote	Pacaya Palm	from literature	Sub-Tropical and Tropical Americas	A palm whose inflorescence (cluster of flowers) is collected and sold fresh as a vegetable; has provided a valuable source of income when coffee prices low. Local use, has been over-exploited but nursery production initiated. Reference: [8]

Species	Common Name	Source of Case Study	Natural Distribution	Notes
Dioon edule	Tiotamal	consultancy	Mexico	A cycad. Ornamental IUCN Red List - NT; CITES; local nursery production.
Dioon merolae	De Luca	consultancy	Mexico	A cycad. Important traditional use - in festivities of Holy Cross Day. IUCN Red List – VU; CITES; studies of effect of harvest has lead to specific recommendations.
Euphorbia antisyphalitica	Candelilla	from literature & consultancy	Mexico and US	A shrubby perennial. Harvested for wax used in cosmetics, pharmaceuticals and food industry CITES. Reference: [9]
Heterotheca inuloides	Arnica	consultancy	Mexico	A perennial herb. Medicinal: for bruising and as an anti-inflammatory. Now cultivated.
Manilkara zapota	Sapodilla	from literature	Mexico, Central & South America	A hardwood tree. Since Aztec times the fruit has been eaten and the white latex tapped for use as chewing gum called 'chicle'. Overharvesting by the 1930s-1950s, after which the synthetic gum industry developed. A re-interest in 'natural' products has again meant an increase in chicle tapping. FSC certified produce available.
Pouteria sapota	Mamey Sapota	from literature	Mexico	A hardwood tree. Fruit traded at a national level. A combination of wild harvest & cultivation allows for enhanced sustainability. References: [2, 4]
Sabal yapa	Yapa Palm	from literature & consultancy	Mexico	A palm. Wide range of subsistence uses including roofing & very minor source of income. Ecological studies indicate that the resource is abundant; harvest practices are sustainable and compatible with the conservation of both the species & forest.
Tillandsia eizii	Lengua tsotsil	consultancy	Mexico	Epiphytic bromeliad. Widespread use in Chiapas for ceremonial decoration, sold at local markets. Strong decrease in supply of the resource. Change in land use prevents the recovery of populations affected by collection.
Tillandsia guatemalensis	Lengua tsotsil	consultancy	Mexico	Epiphytic bromeliad. Widespread use in Chiapas for ceremonial decoration particularly at Christmas, sold at local markets. Strong decrease in supply of the resource.
Tillandsia ponderosa	Lengua tsotsil, Mazorca	consultancy	Mexico	Epiphytic bromeliad. Widespread use in Chiapas for ceremonial decoration particularly at Christmas, sold at local markets. Strong decrease in supply of the resource. Change in land use prevents the recovery of populations affected by collection.
Zea mays	Teotintse	consultancy	Mexico	A grass, wild relative of cultivated maize used for fodder and food.

Selected references

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2. Alexiades and Shanley, 2004
3. Shanley *et al*, 2011
4. Ruiz-Perez *et al*, 2004
5. Weinstein and Moegenberg, 2004
6. Non-Wood News, 2010
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Mauritia flexuosa, *a South American palm with multiple uses (W. Baker, RBG, Kew)*

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