

Sustainable Harvesting of Non Timber Forest Products

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1. Introduction

A healthy forest can provide many benefits for people, more than timber/woods, a most common product of forest. Initially in India the NTFP collection from wild was less in quantity up to 1990 but gradually the market demand has forced excessive resource extraction. Foresters initially were confident about natural replenishment of this stock in forests but in reality sustainable harvest of NTFP require quite a bit of careful step by step management, controlled harvesting and period monitoring for sustainability of resources. The controlled exploitation of NTFPs holds great potential as a method, for integrating the use and conservation of resources. Though there are more than 800 types of NTFPs harvested in India, reliable harvest data of only a few are available, which are often in the category of Nationalized by the state Governments, because of that harvest/collection of large number of NTFPs by local people go unrecorded in government data bank (Forest Sector Report India 2010).

NTFP play the crucial role of safety nets for poor people who rely on forest for their dependence it contributes in food security, health cover, cash income and also provide dependable wage labor to local people in remotest areas where income opportunities are almost nil. In rural areas marginalized, landless and very poor in different states of India meet their livelihood requirement varies from 35-80% based on several factor (Bahuguna, 2000; Gadgil 2003; Bhattacharya and Hyat 2004). Women are mostly dependent on NTFPs due to the nature of its production, quantity, collection procedure, processing and local selling. They use the most of NTFPs for their own consumption and they have better knowledge on resources. Few research based studies give the information like in South India Kerala, Karnataka and Tamilnadu women use 62 different NTFP item in their food as vegetable and regular medicine for health care. Similarly in North Eastern part like in the state of Tripura, Arunachal and Meghalaya; women regularly go forest areas and wetlands for collection of leafy vegetable from the range of 85 items in the list, surprisingly all are uncultivated source. Many primitive tribes of India still made their huge share of nutritional sources from range of NTFPs in different forest types. Most NTFPs are seasonal and we observe there are various cultural rituals in attached in society which, are corresponding with the availability of these NTFPs either fruits, leaf, flower, twigs, roots/rhizomes and various other animal NTFPs.

Historically the NTFP sector was neglected for many decades from main stream forestry and they were considered as 'minor', of late the importance is recognised. Though commercial dimension of NTFP is

very impressive, traditionally that uses to serve meaningful manner in various parts of India. Export of NTFPs and its products contributes 68%, out of total export from forestry sector.

Herbal products raw materials from NTFP source contribute 90% of the supply for the industry which are practically sourced from natural forests. About 7000 plants are used in Indian system of Medicine, 960 of these items have been recorded in trade and 178 are traded in high volumes in quantities exceeding 100 MT per year. According to a study, a total annual demand of botanical raw drugs in the country for the year 2005-06 has been estimated as 3,19,500 Metric Tons (MT) with corresponding trade value of 1069 crores while according to another study the Indian share of global medicinal plants trade is increasing at an annual growth rate of 23%. India stood 3rd biggest exporter of medicinal plants during 2009 after China and Canada respectively (NMPB, 2011).

Due to various reasons like overharvesting, premature collection, Climate change (extreme draught and flood situation) production of several NTFP has gone down. Excessive demand by the herbal industries, forced premature product collection from various forest ranges through local villagers. Local people are engaged by traders and suppliers for collection of selected products. Due to destructive collection practices their regeneration going down and plants are coming under threat. There are studies from original field survey give a picture of reduction production from different forest division from 30 to 85% in last 30 years time. Biodiversity experts observed the population size of such trees are coming down very rapid manner, the associated animals, honey bee and bird species and their population also gone down drastically which has created negative impact on reproductive biology of several NTFP tree species (Bhattacharya,2013).

All the forests in India are managed under the prescription of the working plan prepared on the basis of principles of sustainable forest management and recognized innovative silvicultural practices which is recognized by National Working Plan Code, MoEF (Anon, 2004). Indian forestry has an established system of planning in the form of Working Plan, this system commenced during the period 1871-1900. A working Plan is a written scheme of management aiming at continuity of policy and action and controlling the treatment of a forest (BCFT). This document is a means of enforcing systematic obligatory and mandatory regulations for continuous management of a given forest property. NTFP harvesting in various forest division now started bringing under working plan, tries to answer four fundamental questions in forestry viz, how much, where and when to satisfy the given objective of management and direct the forest development towards normalcy and tries to achieve sustained production and yield from the forest under the plan. The working plans are prepared within the framework of national policy and five year development plans and other considerations of national and regional level planning.

It broadly involves the following:

- Survey and assessment of the past results, present facts resources and constraints
- Analysis of the facts with respect to prospects leading to conclusion on policy, objects of management

- A plan for future action in definite period in conformity with the long-term plan
- Provisions for control of prescriptions for maintenance of records and collection of new facts by research and new techniques (Prakash, 1986).

A review five state initiated NTFP based benefit sharing models are available in India those have started from 1970s- 2000, these states are namely Madhya Pradesh, Chhattisgarh, Andhra Pradesh, Orissa and Uttarakhand , but yet to established their sustainable harvesting models . Various activities of micro-enterprise effort based on NTFPs are available in the respective selected states. Different stakeholder groups of NTFP (primary collectors, traders, processing units, and FD staff) primarily observed that institutional innovation has changed the trade situation in big way and further many fold improvement is possible. Primarily all above 5 states governments has established separate organizations which are dedicated to the procurement, primary processing, storage and further marketing of raw products for NTFPs and recently government of India has started the Minimum Support Price (MSP) procurement for 12 items in 8 states aims to benefit 100 million people. This step is a long desired policy step in NTFP sector, but there is a chance that without having a sustainable harvest model MSP may lead to more unsustainable collection of NTFPs in respective areas.

The demand for the certified products are increasing in European and American markets and India being one of the major exporters of NTFP to these market, the need for certifying its product cannot be ignored. The demand for certified products calls for scientific certification system to ensure that the resources are managed sustainably (Parrotta 2002, Bhattacharya and Prasad 2008). In spite of this increasing demand, the medicinal plants are still not given due recognition in Forest Working Plan in the country which is still timber oriented, as a result of which there is a threat for sustenance of the NTFPs in view of the ever increasing demand in the national and international market, exploitative and unsustainable harvesting practices and discrepancies in the Management Plan.

NTFPs are collected from wild without any awareness to the stage of maturity and parts required to be collected. It is essential to ascertain the quality of a plant material before it is employed which is governed by following factors:

1. Place from where the plants are collected.
2. Climate, soil, habitat.
3. Ignorance about genuine raw drugs, its appropriate time of collection etc.

As the price paid to the dwellers tends to be very low, hence they apply destructive methods to generate their income. A critical factor in wild harvesting is the non-availability of skilled labour for good collection of herbs. Unmanaged collection practices results in depletion of medicinal plants population and the outcome of drugs are reducing day by day.

State wise, there are certain norms for collection of medicinally important plants. There are also restrictions on collection of some threatened medicinal plants species, collected from the wild sources. These species must be protected in nature through *in-situ conservation and ex-situ cultivation*, and existing laws. However, unmanaged and over-harvesting / urbanization, habitat loss and increasing demand have caused considerable threat to large number of NTFPs existence. This has compelled all

stakeholders and Government to give a serious thought to evolve methods of sustainable harvesting practices to ensure sustainability. Looking at the concern for its conservation and sustainable management, which is the purpose of writing this paper.

Objectives of Sustainable Harvesting

The main objectives of sustainable harvesting of NTFPs are as follows:

1. To ensure conservation of species through sustainable harvest
2. Long term availability of various product in natural ecosystem, making balance between different biodiversity component
3. To enhance earning of local people in a sustainable manner
4. To eliminate drudgery to women and children mostly engaged in collection of NTFPs
5. Capacity building among the local people towards conservation of natural resources and organizing themselves for better marketing access and to eliminate the possibility of distress selling of NTFP.

2. Concepts of Sustainability, Sustainable Forest Management and Sustainable Harvesting

2.1 Concept of Sustainability

Sustainability is the ability of the system to maintain a certain well defined level of performance over time and if required, to enhance the same in response to changing needs, either by itself or through linkages with other system without damaging the long term productivity of its resource base and essential ecological integrity of the system (Jodha, N.S., 1995).

2.2 Defining Sustainable Forest Management

International Tropical Timber Organization (ITTO, 1997) defines Sustainable Forest Management (SFM) as “The process of managing forest to achieve one or more clearly specified objectives of management with regard to the production of a continuous flow of desired forest products and services without undue reduction of its inherent values and future productivity and without undue undesirable effects on the physical and social environment”.

2.3 Sustainable Management of NTFPs

A sustainable system for exploiting non timber resources is defined as one in which fruits; nuts, latexes and other products can be harvested indefinitely from a limited area of forest with negligible impact on the species being exploited.

Harvesting of NTFPs, therefore, forms a key area of management in the tropical forests. Very little research is done in this area and hence data and information related to this area is lacking. Since this area is already much dented leading to the extinction of some of the valuable NTFPs, there is an urgent need to have some scientific basis of management of NTFP within a reasonable period of time to prevent further damage to these natural resources.

2.4 Defining Sustainable Harvesting

A sustainable system for exploiting non-timber forest resources is defined, as one on which fruits, nuts, latexes and other products can be harvested indefinitely from a limited forest area with negligible impact in the species being exploited.

Sustainable harvest of a resource ensures an undiminished flow of benefits from the resource to its users over time in such a way that the harvest of NTFP does not have any deleterious effect on regeneration of target population or any other species in the community or on ecosystem structure and functioning. A broad definition of sustainability includes inter-generational equity, that is, maintenance of site values and opportunity for future options for use.

2.4 Types of Unsustainable Harvesting

1. Destructive Harvesting – e.g. uprooting the whole tree/plant or devoiding the tree from bark, cutting, lopping, debarking, tapping for gum/ resin, latex etc.
2. Premature Harvesting – plucking of fruits before maturing resulting in low regeneration
3. Overharvesting – extracting more than the areas productivity

The trees, shrubs, herbs and climbers yielding medicinal forest or seeds and found in natural forest are subjected to several problems; some of these problems are as follows:

2.4.1 Tendency to collect unripe fruits

In most states, collection of fruits and seeds from the forest is free to public; any person can go to forest and collect forest fruits. Therefore, there is large number of people going to forest for collecting forest fruits. Further, these collectors are instigated by the pharmaceutical companies and other industries using these fruits for preparation of these products. So there is a competition among the collectors and also among the industries for the collection of maximum quantity of fruits; with the result that immature fruits are collected from the forest. For example Aonla fruit ripens during February but many times collection starts from October- November in central India. Similarly, other fruits such as bel, chironji, harra, bahera, etc. are also collected much before these are ripened. The situation is more serious in fruits which are in demand by pharmaceutical and other industries. The problem is not so severe in case of fruits collected and used locally. Even after the formation of JFMCs, the situation has not improved. The collection of unripe fruits is common in almost all important fruits (Prasad et al.1999).

2.4.2 Tendency to damage the tree

It is seen that most trees are damaged by the collectors while collecting the fruits. The branches are lopped; sometimes even the tree is cut disregarding the fact that the tree if cut would not give any fruit from the next year. The collectors look for the easiest way of collection, they do not want to climb the trees as many trees are difficult to climb and there collection targets are high. Therefore, the collectors

tend to fell the branches and some time even the tree unmindful of the damage being caused to the tree and the ecosystem. The damage is more pronounced in larger trees. In shrubs and herbs which can be handled from the ground, the damage is not that significant. In herbs and annuals, the tendency is to uproot the plant along with stem and branches like for Anantmul, Asperagus, Kalmegh etc.

2.4.3 New recruitments are poor / absent:

In general, regeneration in forest is poor or absent in most forest types. The medicinal plants which occur in different forest types are no exception. New recruitments and younger plants of trees and shrubs are generally absent. Repeated fires, uncontrolled grazing, illicit removal, etc. cause serious damage to the new recruitment and younger plants. The density of herbs, creepers and climbers is gradually reducing. Several plants occurring as a ground flora are highly susceptible to fire and grazing. Firstly, the fruits/seeds that are medicinally important are collected on a large scale and only a small percent of fruits fall on the ground. These fruits being unripe have poor viability and germination capacity resulting in very poor germination. Even if some seeds germinate, the biotic pressures like fire and grazing kill the newly germinated seedlings. The result is no recruitment and very less regeneration. The situation therefore, is very serious, and after few years when presently fruit yielding trees die there will be no tree to take their place and fruit yield will reduce and there will be no yield one day,

2.5 Determining Sustainable Harvesting Limits

The conservation of commercially important forest resources in state owned natural tropical forests is a challenging task because these forests constitute a common property resource and local people have the right to free access to collect NTFPs. Owing to increased commercial utilization of forest resources, local user communities are encouraged to over exploit forest products, ignoring the traditional practices of sustainable harvesting of utilizable resources from natural forests. In the prevailing forest management system, extraction of NTFPs is not at all sustainable, either in ecological or economic terms. A participatory approach involving local forest dependant user community seem to be inevitable tool for sustainable management and *in situ* conservation of indigenous forest resources.

Keeping this in mind, Madhya Pradesh State Forest Research Institute, Jabalpur, India, has taken the lead to determine the sustainable harvesting limits of over exploited NTFPs in natural forests, employing an integrated participatory approach in the tribal dominated forests of Madhya Pradesh. It used different treatment plots with 20%, 40%, 60% and 80% levels of harvesting. The result of various levels of harvesting is as follows:

S. No.	Treatment Plots	Sustainability Index		
		2005/06	2006/07	Average
1.	T ₁ (20% harvesting)	3.54	1.91	2.723
2.	T ₂ (40% harvesting)	2.09	2.15	2.121

3.	T ₃ (60% harvesting)	1.95	2.24	2.094
4.	T ₄ (80% harvesting)	1.193	1.783	1.488

From the table it is clear that 80% harvesting as it gives maximum productivity. Therefore it was recommended that full protection should be observed for having maximum productivity of 80% harvesting and maintaining sustainability. Whereas some studies, recommends for harvesting around 50% product, rest should be left for its ecosystem functions as thumb rule (Murali, et al.1996, Bhattacharya et al. 2008).

In theory, any harvesting plan should consider the availability of resources, the rate of use, and the renewal rate of the resources. Thus, only plans that promote harvest below the resource regeneration threshold and that do not modify the natural prevalence of the harvested species should be used (Lawes & Obiri, 2003). Seedling mortality is even if the germinate, over 90%of the new seedlings usually die before becoming established in the understory. Only a very small fraction of these seedlings (less than 1 in 100,000) will make it to the canopy and produce fruits, so there are many biological factors we need to consider to understand sustainable harvesting (Table-1).

Table 1 Overall framework of NTFP and conservation biology parameters understanding harvesting

	Low	Medium	High
Resource Group	Bark, stem tissue, roots	Some resins, fruits and seeds	Latex, fruits and leaves
Yield/Plant	Low	Medium	High
Species characteristics:			
Flowers	Few, large	Intermediate	Small, many
Fruits	Few, large	Intermediate	Small, many
Seed germination	Low viability	Intermediate	High viability
Sprouting capability	None	Low	Low
Population structure:			
Size-class distribution	Type III curve	Type II curve	Type I curve
Tree density/hectare	0-5 adults	5-10 adults	10+ adults
Spatial distribution	Scattered	Clumped	Homogenous
Regeneration guild	Early pioneer	Late secondary	Primary
Flower/Fruit Phenology	Unpredictable	Supra-annual	Annual
Reproduction biology:			
Pollination	Biotic, with specialized vector	Biotic, with generalized vector	Abiotic
Pollinator abundance	Rare; bats, hummingbirds	Intermediate; beetles, moths	Common; small insects
Seed dispersal	Biotic, with specialized vector	Biotic, with generalized vector	Abiotic
Disperser abundance	Rare; large birds, primates	Intermediate; small mammals	Common; bats, small birds

Source: Charles M. Peters (1994)

2.6 Sustainable harvesting rate

Maximum percentage of harvesting at which maximum value of regeneration is recorded to determine the capacity of regeneration of selected medicinal plants after harvesting (Annual & Biannual).

$$\text{Regeneration Index} = \frac{\text{No. of plants regenerated}}{\text{No. of plants harvested}} \times 100$$

Extent of regeneration can be indicator of sustainable harvesting of NTFP.

Sustainability Index can be defined as $SI = (N_h + N_r) / N_t$

N_h = No. of plant harvested

N_r = No. of plant naturally regenerated

N_t = Total No. of plants before harvesting

For sustainability the value of SI should be > 1

2.7 Difficulties in Sustainable Harvesting

There are a variety of different ecological characteristics that can make sustainable harvesting a very difficult objective to achieve. The major problem areas are:

- the high diversity and low population density of plant species
- the irregularity of flowering and fruiting
- the importance of animals for pollination and seed dispersal
- the high mortality and low success rate during seedling establishment
- the sensitivity of population structure to changes in the level of natural regeneration

In order to conserve valuable species of medicinal value and other NTFP yielding species, harvesting of plants and their products have to be sustainable. This paper, therefore, focuses on sustainable harvesting practices of various species of NTFP importance, even for ecological and economical importance. The plant species have been categorized on the basis of the parts used for NTFP purpose which are as follows:

- Fruit
- Flowers
- Leaves
- Root / rhizome leaves and flower
- Bark
- Gum/ resin
- All plant parts being medicinal

The complete process of sustainable exploitation may have various steps like: i) species selection, ii) forest inventory, iii) yield condition, iv) regeneration surveys, v) harvest assessment, vi) harvest adjustments.

2.8 Important Indicator of Sustainable Harvesting

- Size class distribution of trees important indicator of regeneration rate.
- Monitoring of seeding, sapling and adult tree densities help in appraising the sustainability of current harvest.
- While monitoring the size class distribution, if density drops below these values, the intensity of harvesting should be reduced.

3.0 Protocols for NTFP harvest

- ❖ Plant species should be harvested under the best possible conditions avoiding wet soil, dew, rain or exceptionally high air humidity. Leaves, stems or flowers should always be gathered on a sunny day after the dew has evaporated off the plants but before the full heat of the day. For plants with volatile oils.
- ❖ Based on gatherer's perception, the following retentions of different plant parts are recommended during collection:
 - For harvesting fruits, 25% have to be left for regeneration.
 - For harvesting seeds 30% must be left for regeneration.
 - During the harvest of flowers, 30% of flowers of each plant and 20% of the population must be left untouched.
 - In case of harvesting leaves, 70% of the plant leaves have to be left out.
 - Similarly, for harvesting roots or bulbs 80% of the plant population has to be left untouched.
 - For harvesting whole plant at least 30 % of population should be left untouched.
 - Leaves and roots of annual plants should be collected after flowering to ensure regeneration and better product quality unless otherwise recommended.
 - For harvesting roots, a hole should be dug straight down and to one side of the roots. Gradually remove soil on one side of the hole towards the root. Then simply pull the root sideways into the hole. This method will damage the roots less than the common practice of digging down
 - For harvesting bark from trees or shrubs, the entire tree or shrub should not be girdled by removing the bark all the way around the tree, unless the tree has been or is to be removed for other purposes, e.g. , for timber harvest, or is otherwise is to be destroyed.

- ❖ Rain water washes away some of the aromatic oils from many herbs, so after a rainstorm, harvesting should be done after 2-3 days after rains to let the plants oil collect again.
- ❖ The collectors should select harvest sites where the target plant could be readily found and the plant materials are likely to be of good quality and free of contamination from pollution and other negative environmental influences. Picking of herbs alongside highways or farm fields unless it is organic must be avoided.
- ❖ If herb leaves are to be harvested, the harvested stems or branches must be hanged upside down in bunches for few days. This will bring the sap present in the stems or branches into the leaves.
- ❖ Sharp cutting tools like chopper, sickle, secateurs, scissor, and hedge scissor must be used to avoid undue damage to the tree. With tender, non woody stemmed herbs, gathering of leaves, stems, or flowers can be accomplished easily with the help of scissors or sharp knife. Cutting tools must be cleaned and sharpened between two collections to reduce contamination.
- ❖ For harvest that involves taking the entire plant (e.g. roots) the harvest should be limited in any population to leave a portion sufficient for regeneration of that population. Harvesting should be done only after the fruit has ripened and the seed has been released, if the species is seed propagated.
- ❖ Plant species listed under RET or on of the Convention of International Trade in Endangered Species (CITES) or those which are not allowed to be harvested under State regulations due to concern about over harvest should not be harvested (e.g. *Taxus baccata* in Himalayas, Sarpagandha in M.P. & Chhattisgarh).
- ❖ Collection must be made from the abundant stands. Harvesting from stands where the plant is sparse or that are outside the species normal range should be avoided. For harvest only well grown and adult plants should only be selected.
- ❖ Whenever possible and acceptable for meeting quality standards the bark should be harvested from the branches rather than the tree trunk.
- ❖ While harvesting roots of perennial plants, some plants from each life stage should be left out. For species that regenerate from portions of roots or root crown a portion of the root should be left in the ground or the whole or divided crowns should be replanted, as appropriate (e.g. Satawar).
- ❖ For propagation by seeds, the seeds of collected species that reproduce sexually in a suitable environment should be planted. For asexual propagation, the whole or divided root crown, as appropriate, or other asexual propagation material should be prepared and planted in a suitable environment.

- ❖ All containers used during harvesting must be clean and free of contamination from the previous plant material. When the containers are not in use, they must be kept under dry conditions free of pests and inaccessible to rodents, livestock and domestic animals.

Examples of Important Commercial NTFP Trees, need immediate care before depleting from state forests

- | | | | |
|---|-----------------------------|---|-----------------|
| ○ | | <i>Aegle marmelos</i> (Bael) | Central India – |
| ○ | MP CG, OR | | |
| ○ | | <i>Terminalia arjuna</i> (Arjun) | Central India |
| ○ | | <i>Garcinia indica</i> | South India – |
| ○ | Karnataka, TN | | |
| ○ | | <i>Saracca ashoka</i> (Ashoka) | Tripura |
| ○ | | <i>Litsea dlutinosa</i> (Maida) | Orissa and |
| ○ | North East | | |
| ○ | | <i>Commiphera wrightii</i> (Guggal) | North Central |
| ○ | India, Gujarat, Madhya | | |
| ○ | | Pradesh, Rajasthan | |
| ○ | | <i>Emblica offinalis</i> (Aonla) | Central and |
| ○ | South India | | |
| ○ | | <i>Bucnenia lanzan</i> (Chironzi) | Central India |
| ○ | | <i>Aquilaria malaccensis</i> (Agarwood) | Tripura |
| ○ | | <i>Acacia catechu</i> (Katha) | Central India |
| ○ | and Himalaya foothills | | |
| ○ | | <i>Cinnamonum tamala</i> (Tejpatta) | South |
| ○ | India and Northern Himalaya | | |
| ○ | | <i>Sapindus sp.</i> (Ritha) | Andhra Pradesh |
| ○ | | <i>Taxcus baccata</i> (Thuner) | Uttarakhand |
| ○ | and Northern Himalaya | | |

4.0 Big Questions on NTFP Sustainable Harvesting?

Author strongly consider that NTFP sustainable harvesting must address the concern like the real assessment of production, regeneration status, climate vulnerability affects, correlations of NTFP availability with Wild life, whether to support any NTFP based enterprise as per the threat status, and given such situation how long NTFPs will be available in India's forests. NTFP resource assessment in tropical regions is relatively new and received little scientific attention; consequently only local methodologies have been developed by individual researchers.

How often we are open to accept some of these methods incorporate existing local knowledge with inventory methods from wildlife management, horticulture and other disciplines? Only a limited extent of these methods is scientifically tested. On the other hand the existing scientific inventory methods are not easily adjustable to local circumstances and are not easily understood and interpreted by local management .Therefore research should relinquish the need for inventory methods, which include traditional knowledge as well as some extent of scientifically rigor.

4.1 Production picture-

Some of the important NTFPs which were widely collected from tropical dry deciduous forests of central India have been almost wiped off *Emblica officinalis*, *Chlorophytum borivilianum* , *Asparagus racemosous* and *Comifora wrightii* were widely found in Sheopur. The table- 2 clearly reflects the declining trend of the NTFPs in this region, information could gather through Participatory Rural Appraisal (PRA) methods as there was no base line data, this information consider as authentic, which was further cross checked with Forest Department office and during observation in the forest survey.

Table 2: Change in volumes of NTFP Collection in last 20 years

MAP collected	species	Place of collection	Quantity traded			
			15 years before	10 years before	5 years before	Present Rate
	<i>Emblica officinalis</i>	Sirgitti	10 trucks*	2-4 trucks	1-2 truck	Very low<1 truck
	<i>Sterculia urens</i>	Rohini	4 trucks	2 trucks	1 truck	< 1 truck
	<i>Baswellia serrata</i>	Khairi	10 trucks	5 trucks	2 truck	1/2 truck
	<i>Aegle marmelos</i>	Khori	15 trucks	10 trucks	6 trucks	5 trucks
	<i>Chlorophytum borivilianum</i>	Khori	2 trucks	1 trucks	1/2 trucks	20kg
	<i>Commiphora Wighitti</i>	Birpur	1-2 trucks	< 1 tuck	Not found	Not found
	<i>Asparagus Racemosous</i>	Birpur	60-70 trucks	20-25trucks	8-10 truck	2-5 trucks

Source: PRA exercise with NTFP trader and local NTFP collectors conducted during a workshop at Sheopur

* One truck could transport 8-10 tons of NTFP

4.2 Regeneration status of NTFP bearing trees in forest

Case studies revealed that increased commercialization and trade in NTFPs is a global phenomenon which has significant implications for their conservation and sustainable use. There has been a marked change in the climate of the region due to different anthropogenic and biotic factors. The erratic rainfall and the change in the temperature has not only decreased the production and regeneration potential of the NTFP species which also affected the total biodiversity. The reproductive biology of many trees responsible for seed dispersal and pollination which are affected due to decrease of beneficial insect and bird population. This in turn has affected the regeneration potential of many NTFP species. Regeneration of NTFPs viz *Commifira wrightii*, *Anogeissus latifolia*, which were occasionally found in the forest area has declined completely. Only few species like *Aegle marmelos* and *Boswellia serrata* still maintaining their regeneration status as was 15 years back (Table.3).

There is a need to understand size class distribution of trees, few other important indicators like regeneration rate, monitoring of seeding, sapling and adult tree densities that helps in appraising the sustainability of current harvest, while monitoring the size class distribution, if density drops below the values, the intensity of harvesting should be reduced our wise that impact on the regeneration of species in the wild.

Table 3: Regeneration Status of NTFPs in Forest

Name of the MAP species	15 years before (%)	10 years before (%)	Present (%)
<i>Emblica officinalis</i>	100	1-2	0
<i>Aegle marmelos</i>	100	90	80
<i>Asparagus racemosus</i>	100	90	60
<i>Boswellia serrata</i>	100	80	75
<i>Annnogeissus latifolia</i>	100	10	0
'Kala Dhavara'	100	90	70
<i>Chlorophytum borivilianum</i>	100	2-5	0
<i>Buchanania lanzans</i>	100	10	0
<i>Acassia Catechu</i>	100	80	50
<i>Sterculia urens</i>	100	20	5

Source: PRA data of workshop conducted in Sheopur, 2008 keeping 15 years base line.

4.3 Future Climate Vulnerability affect

Climate vulnerability is more rigraus than it was predicted earlier. Climate variability and climate change may alter the productivity of forests and thereby shift resource management, economic processes of

adaptation and forest harvests (Alig et al. 2004). Bhattacharya and Prasad (2008) paper narrate a case which amplifies the scientific and economic evidences by demonstrating the risk of climate impact to most vulnerable primitive tribal group of dry deciduous forest of Sheopur district in Central India. The dry forest, covering 2592 sq km, having rich variety of commercially valuable Non-Timber Forest Products (NTFPs) as lifeline and first step survival options is at stake due to gradual climate change in the area. The mean annual rainfall is 800 mm but during past 5 years the people have experienced drought in successive years, the number of rainy days has drastically changed, rainfall ranging from 460-790 mm without any definite pattern, resulted in to agricultural and forest crop failure and lack of fodder for cattle force them for migration to other states for employment. The study conducted in 12 sample villages and in all villages' climate change responses has impacted on phenology of trees, their flowering; fruiting and seeding pattern as well as pollination pattern got affected. In social dimension, the income level from such impact has reduced 20-60% in their economy due to low production. The annual average income by the households is of INR. 4500 (approx. US \$ 90) from collection and sale of NTFPs in the local market. Due to the resource scarcity and unsustainable harvesting on limited resources the regeneration of all important tree species has gone down drastically.

The other observation made by the local people is that the bird population and wild honey bee population has also reduced in recent past which may have created impact on reproductive biology of tree species. The decline in production of NTFPs has been 10-90% in the past 10 years. Many NTFP items e.g. *Chlorophytum borivilianum* (roots), *Buchanania lanzans* (kernals), are no more available for collection. The production of fruits of Aonla (Indian goose berry - *Emblica officinalis*), *Asparagus racemosus* (roots), *Sterculia urens*, *Anogeissus latifolia* and other gums have also drastically reduced (50-75%). The study provide strategy how to incorporate such initial research results and local knowledge system in planning and management of forestry so that government can take appropriate action for supporting local community to opt suitable adaptation measures.

4.4 Correlations and dependency of NTFP availability with Wild life

The majority of forest fruits available in natural forest ecosystem are eaten specially by large mammals like sambar (*Cervus unicolor*), gaur (*Bos gauras*), sloth bear (*Melursus ursinus*) and large number of birds. Over exploitation of such NTFP have profound effect on the relative abundance of the animals that feed on the exploited resource (Murali, et al.1996). Several evidences have been found which suggests that high levels of NTFP harvest and enhancement plantings may alter the composition and diversity of bird or animal populations dependent upon them, which corroborates the hypothesis that exploitation can affect plant-animal interactions. Galetti & Aleixo (1998) illustrated that harvest of *Euterpe edulis* palm hearts negatively affected the abundance of two of 15 large frugivorous birds known to eat its fruits. Large mammals such as primates, bears, wild boars etc. are also important seed dispersers and predators, and harvesting of their food resources may produce competition with human harvesters (Kinnaird 1992). Harvest and management of NTFP may also have effects on pollinator populations which yet to be studied under thorough research projects, that may provide new role of NTFPs for ecosystem services so our silvicultural management must look into the relationship of NTFP other than human being.

- Species differ in their responses to harvest depending on the

- plant part extracted
 - harvesting techniques
- Regeneration and population densities of medicinal plant species are adversely affected by intensity of extraction.
- Such adverse effects are attributed to
 - damaging harvesting practices
 - accompanying anthropogenic disturbances

4.5 How long NTFPs will be available in India's forests?

There is a need to understand given such huge demand and exploitative harvesting pattern; it may not support the resource in nature for long time. Sustained and coordinated efforts are needed to transformed currently unsustainable practices of NTFP “mining” from wild sources to more ecologically sustainable, socially acceptable and economically equitable production and utilization system (Parrotta2002). Many NWFP species are highly sensitive to the level of harvest and fragility of the eco-system. Probably NTFP resources will only be available in protected areas like national parks, sanctuary and biosphere areas in future. These resources are a critical lifeline for poor, if they go for more and more exploitative harvest when NTFP resources become scarce. Increase demands and scarcity of resources will ultimately leads to total non-existence, which may even end up in endangering the very existence of the resource, and only then the concept of domestication will be a welcome step for NTFP conservation.

5.0 Prescribe Silvicultural Manipulation for NTFP

Silvicultural manipulations aim at providing suitable conditions for the growth of the most desired species. Management of NTFPs through silvicultural manipulations is most difficult task because of multiplicity of species, their varied nature and growth requirements.

Silvicultural requirement:

Different plant species have different requirement for growth. Some species are light demanders, while others may be shade bearers and still some others may be shade demanders. Some species require more water for growth than others while several other species can grow under dry conditions. According to the nature of growth of plants, they tend to occupy different layers and different kinds of habitats. Most trees occupy either top canopy or under storey, shrubs generally form lower canopy. The herbs and grasses form the ground flora. Most shrubs are shade bearers or shade demanders while most trees are light demanders. Smaller trees are shade bearers. The nature of trees, shrubs, herbs and other plants vary considerably from the point of view of light, moisture and temperature requirements. The silvicultural manipulations may include the following operations.

- Manipulation of top canopy
- Manipulation of middle storey
- Manipulation of ground vegetation
- Seedling adoption and weeding around the desired plant

1. *Manipulation of top canopy:*

Top canopy is generally occupied by large trees. When an area is allotted to a specific NTFP working circle, the area has to be managed keeping the requirement of that NTFP. Other species become subordinate to that species. Some important NTFPs species are located in the shrub canopy or the under storey or underground vegetation, it may require manipulation of the top canopy. The extent of manipulation may depend on the nature of under storey species. Many small trees, shrubs, herbs and annuals grow better under shade than under full light conditions. Therefore it may not be necessary to manipulate top canopy extensively. For light demanding or to some extent shade bearing species manipulation of top canopy may be required.

2. *Manipulation of under storey:*

Dense under storey trees and shrubs often create problems to the ground vegetation. Manipulation of under storey may be required to remove intense competition in the under storey and create favourable condition of growth for the ground vegetation. Care has to be taken to create judicious openings in the under storey to favour some important species of ground vegetation. Many shrub species such as *Lantana camera*, *Carissa spinerum*, *Dodonea viscosa*, etc. create dense under growth and cause intense root and light competition with the ground vegetation resulting in poor or no growth of underground vegetation. Under these conditions removal some under storey shrubs becomes necessary the regeneration of NTFP species.

3. *Manipulation of ground vegetation:*

A large number of species having medicinal and other uses occupy the level of ground vegetation and remain in the form of herbs, grasses, annuals and creepers. In order to provide favourable conditions of growth to the desired species or individuals and to remove competition among the ground vegetation, manipulation of ground vegetation becomes essential. Many species of the ground level and shrub level are considered weed as their uses are not to known or some of them may be less useful. Such species like weeds and relatively less useful species may be removed to favour more useful species.

4. *Seedling adoption and weeding around the plant:*

Natural regeneration in form of recruits takes place in many species of NTFPs but these recruits do not develop further to become seedlings, saplings and mature plants because these recruits are generally smothered by weeds and other vegetation growths. The seedlings of important NTFPs if available, these can be adopted and future growth can be ensured example for big trees like Mahua, Bahera, Harra, Chironji etc. The process of natural regeneration of selected species can be assisted and regeneration can be ensured. For this, the seedling of one or several species can be marked on the ground and these seedlings can be adopted through weeding around the plant. The area has to be protected against fire and grazing in order to insure natural regeneration of important NTFPs.

6.0 Strategy for Sustainable Harvesting of NTFPs

1. *Enrichment planting or seeding:*

When an independent working circle for the conservation and management of NTFPs is constituted, then objective is to manage the area for the conservation and development of some specific medicinal plant or group of medicinal plants and other NTFP species. There are several species of NTFPs which once occurred in some forests in higher densities but now have become rare in these areas. These areas may be taken up for enrichment planting or seeding. Some of these species include *Chlorophytum, spp, Rauvolfia serpentina, Withania somnifera, Andrographis paniculata, Asparagus spp, Aloe barbadensis, Centalla asiatica, Curcuma spp.* and a large number of others. The following points have to be kept in mind in enrichment planting and seeding.

- ❖ The ecological requirements of NTFPs have to be known. The most efficient way of regeneration has to be found out. Most species regenerate through seed, some species regenerate through cuttings or other vegetative parts, some other species regenerate through nursery raised seedlings. The most efficient way of regeneration has to be used.
- ❖ The area included in the NTFP working circle can be of a few square km. A very large area is not required. The area selected should be such that it meets the ecological requirement of the species or group of species.
- ❖ Since most of the NTFPs grow in the under storey, it is therefore, feasible to identify even good forest area for enrichment seeding and planting of MADPs. The climbers get support of the existing trees and no artificial support is required.
- ❖ The seed and other planting material collected for enrichment seeding and planting should be the one most desired i.e. superior in quality.
- ❖ The species selected for enrichment planting or seeding should be one which is in great demand or whose population has dwindled in forest due to over exploitation.

2. *Prescribe Deferred or Rotational Collection:*

Continuous harvesting of NTFPs has resulted in dwindling of these plant resources. Sustainable harvesting is generally not practiced in case of most NTFPs. These being common resource, every collector tend to collect maximum quantity. The fruits are collected before these are ripe; the plant is totally damaged in case of root / rhizome collection. Even when only fruits or flowers are required, entire plant is cut. Collection of bark leads to girdling resulting in death of the plant. The gum and resin tapping cause serious injury to the plants. It is therefore, suggested that some area be rested for some time where as collection may continue in other areas. It is suggested that 5 years rest may help to rejuvenate the NTFPs resource. The period of rest can be decided keeping in view the condition of the resource. The JFMCs may also be motivated to practice rotational collection of NTFP in their area.

The M P Biodiversity Rules 2004 formulated on the basis of Biodiversity Act 2002 also prescribed closure of area for certain period. The closure can be for some seasons. The entire area can be closed for one or few seasons. Some areas can be prohibited for collection. This prohibition can be for certain years. The harvest limit can also be fixed taking into consideration the requirement of the area and the species.

3. Control on fire, Grazing and shifting cultivation

A large proportion of NTFPs are herbs, annuals, climbers and creepers. Fire and grazing in forests cause serious damage to these plants. The trees and shrubs however escape the damage to a certain extent. Repeated fires during summer cause irreversible damage to annuals, herbs and other ground flora. These plants do not withstand the intense heat and succumb to fires. Several herbs and ground flora have become locally rare due to repeated fire. Annual fires during summers create drier conditions resulting in loss of moisture loving species. The fires also alter soil properties resulting in poor growth of some of the species.

When a large number of livestock graze over the area, many species get trampled by their hooves; the tender parts are eaten by animals. The flowers, fruits, etc. are also eaten resulting in poor regeneration. It would therefore appear that fire and grazing together create serious adverse effects on the ground flora including herbs, annuals, climbers, etc. Similarly, shifting cultivation results in creating adverse condition for the growth these species. These operations have to be regulated in order to protect fast dwindling ground vegetation.

4. Establish Preservation Plots in each Felling series:

In order to check rapidly decreasing forest biodiversity due to heavy biotic pressure and unsustainable harvesting, it is necessary to have at least one preservation plot in each felling series. These preservation plots may be protected areas from the point of view of harvesting. These plots may be of 5-10 ha to 50-100 ha depending upon the availability of forest area and will of the local population. Such preservation plots may be identified both in the map and also on the ground.

These preservation plots should be of permanent nature. As far as possible, these PPs should be well marked on the ground and if possible, the area be fenced to avoid any damage.

5. Increase Research Efforts:

There is a limited data on the management of these plants. It is necessary to document whatever data is available and to initiate research on NTFPs. This is very necessary so that the resource can be managed scientifically. The area of research may include ecological, silvicultural, economical, production, processing, etc. the best management practices may be documented and circulated among the researchers and managers. Research should be focused on the assessment of various factors influencing NTFP management rather than only on factors influencing their collection and use. Up to the present, most typologies of NTFPs have been based on their use characteristics. Such classifications should be considered as a first step in developing a typology of NTFP management. Little attention has so far been

paid to elaborating these typologies and placing NTFPs within a typological framework that explains patterns of NTFPs management (Ruiz, 1995; Peters 1996, Bhattacharya 2013).

6. Include management of NTFPs in Working Plan Code:

Working plan is the guide for the territorial decisions for managing forest. Any activity which is prescribed in the working plan is to be implemented. Working plan is prepared as per guidelines issued by the GOI. The present Code does not prescribe detailed management planning of NTFPs. It is therefore, suggested that in Working Plan Code may be revised to include all states, the provision for preparation of working plan of NTFPs rich areas in a manner it is done for timber species by constituting independent working circles or overlapping working circles.

Unfortunately, neither the Panchayat (new owner of the resources), nor the Forest Department is taking interest in extending conservation and regulatory services in most cases for NTFPs. At present there is no governance mechanism to ensure that harvesting is not unsustainable. Good collection practices (GCP) and Good Manufacturing practices (GMP) are develop but yet to follow at field level to control wastages. Protocols for harvest are developed and practiced for many commercial NTFPs in different locations and good results are found by participatory involvement of local people. Methods for community based ecological monitoring and robust methods of sustainable harvest practices need to be followed. Suitable training required for the harvesters / local collector, traders, forest managers and biologist so that all stake holder understand the benefit of sustainable harvesting.

Some of the fundamental principal followed in barefoot silviculture like group selection system, multiple products concept, species association, natural succession, vertical stand structures and even role wildlife, are develop over thousands years of trial and error (Ganz,2000).The indigenous knowledge system have lots of insights towards sustainable harvestings of so diversified products list, barefooted silvicultural system still exist in Mexico, Peru, Bolivia, Thailand, Laos, Indonesia and India, that supports to incorporate people's wisdom. Before 200 years of scientific forestry history, local communities were using such practices and still they are available having strong cultural knowledge. The success of such silviculture and management is not only promotes ecological and economic sustainability, but also cultural sustainability and globally we are following the concept of Sustainable Development.

7.0 Conclusions

The responsibility of maintaining and practicing sustainable harvesting is considered as forest department's job but there are various stakeholders involve in the affair which needs urgent celerity in the system. The accessibility of NTFPs for local communities are still not clear for the Forest Department as well as local communities in terms of collection, trade and manufacturing / processing related areas in reference to FRA 2007 and PESA 1996 provision. The paper does not address the innumerable economic and social factors which are also important in determining the overall sustainability of forest resource exploitation. Presently there is no single NTFP policy at national level, there are several acts , policies, or administrative orders like JFM resolutions and other legislations which partially address NTFPs in reference to the ownership, benefit sharing, monopoly, transit rules, tax ,conservation need

etc. at national level and at various states across the country . Information on sustainable NTFP resource management need much attention at national level for development of baseline data and for large scale plantation under Green India Mission to support NTFP sock improvement for next 10 years. Future forestry may take up various scientific projects to further work on sustainable harvesting of many more species and develop various refined protocol to address future conservation need and economic development keeping in view of certification needs as well as for environmental audit.

In many states field realities concludes wild population of NTFP species have severe fluctuations in the yield, and the impact due to unsustainable harvest at individual level, population level, ecosystem level, and at the genetic level. Integration of NTFP in forest management is necessary in order to achieve sustainable forestry. Because forestry technologies are developed with timber values uppermost, it is vital to develop forest management technologies that take into account both timber and non-timber values. Global examples show that traditional knowledge could play a vital role while developing silvicultural regimes, and in situ experimentation will strengthen the regimes.

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