CONSERVATION OF BIODIVERSITY IN THE NATURAL FORESTS OF CENTRAL INDIA: A CASE OF CRITICALLY ENDANGERED MEDICINAL SPECIES SAFED MUSLI IN BHOPAL FOREST (MP) INDIA

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ABSTRACT

Safed musli (*Chlorophytum borivilianum*)   is a small annual herbaceous plant, which grows in tropical dry deciduous forests in India. The plant is a major source of income to the indigenous communities living around the natural forests. Local peoples largely collects Musli tubers for commercial as well as medicinal purposes. The present deteriorating condition of the species in the natural forests of Bhopal territorial forest division is very serious and needs immediate attention, not only for conservation but also for propagation. The harvesting practices, ecological status, commercial uses, population decline and density of the plant shows that if control measures are not taken, the species fall into the extinction from wild category in the near future. The scoring of marks under various ecological parameters indicates that the condition of the plant is poor in Bhopal forest division (Avg. 39.44%). The species has scored fewer marks (25.00%) and as per norms it falls under Critically Endangered category. Fewer marks were observed in almost all the categories studied like plant ecology, biology, collection and Use/trade parameters. Unhealthy competition was observed among the harvesters whereby the mother trees were damaged during collection. Due to this tendency no tubers are left for regeneration and the mother plants are severely damaged. This is the cause of reduction of regeneration, less population and production of this useful medicinal plant. Ex situ conservation aspects and management of Musli plant in the natural forests was discussed in the present paper.

Key words: Density, Harvesting, Musli, Management, Over harvesting, Regeneration.

INTRODUCTION

India has a rich bio diversity of medicinal and Aromatic plants and holds a unique place in the world in the traditional system of medicine. In terms of the volume and value of medicinal plants exported India ranks second in the world. Most of the medicinal plants are naturally available in Madhya Pradesh forests. The overexploitations of herbal resources in unscientific manner by unskilled labor and poor natural regeneration have resulted in a virtual extinction of certain vital species of herbal flora. The cases where reproductive organs (fruit, flower seeds) or the vegetative organs (root, rhizome) are used, the species are much more endangered in comparison to a species from which only leaves have been collected. This may be exemplifies in case of *Chlorophytum borivilianum* which is a source of Sapoins (Marker *et.al* 1943) and whose tubers have been over exploited. In Patalkot (Chindwara district) *Asparagus, Curcuma, Gloriosa, Hemidesmus, Smilax* etc. are reported to be endangered (Prasad *et al.* 1990, Mishra 2000). They also reported that some of most important medicinal plants (*Curcuma caesia* and *Rauvolfia serpentina*) have already disappeared from many natural forests areas on Madhya Prasdesh. In the forests of Madhya Pradesh Sarpgandha, Aonla, Chironji, Safed musli were common in the past but due to unsustainable harvests and over exploitation problems they gradually decreased in the natural forests. *(*Prasad *et. al*. 2000). Lot of research work on standardizing methodologies for sustainable harvest of important medicinal plants i.e Safed Musli (*Chlorophytum* spp.), Baichandi (*Dioscorea deltoidea*), Aonla (*Emblica officinalis*) etc. has been taken up in the state of Madhya Pradesh by Mishra, 2000, Prasad et. al. 2001, Mishra and Kotwal, 2004. Study indicates that the present position of natural forests area is very alarming particularly in terms of less number of Aonla & Achar trees per hectare, large number of damaged trees, scanty natural regeneration and poor fruit quantity and quality. Later on Mishra & Kotwal 2007, Mishra & Kotwal 2009, Mishra 2009 reported that immature plants of Safed musli (*C.spp.*) were mercilessly uprooted to collect maximum tubers without much effort after the commencement of (early) rains. Apart from destructive harvesting and lack of value addition, general absence of local level institutions deprive the collectors fair and just wages for their works.

Kotwal (2003) studied ethno botanical research development of less known medicinal plants of Bhopal and Sehore districts of M.P studied medicinal plants like- *Boerhaavia diffusa, Plumbego zeylenica, Helictris isora, Gardenia gummifera , Celastrus paniculata* etc. For all these species, six categories viz. Habitat (5), ecology (3), biology (6), use/trade (3), collection (4) and legal & institutional (4) with a total of 25 parameters were identified. All the parameters have been ranked into three category namely- low, medium and high with scoring of 1,2 and 4 marks. Each of the species was studied and ranked on these parameters.

Among individual species *Plumbago zeylenica* scored minimum marks (38.6%) which indicates its rareness in the area and exploitation whereas *Helictris isora* scored a maximum of 53.4% marks, which is due to its gregarious nature and less destructive collection of its fruits. The author felt need to develop appropriate program for conservation and sustainable utilization of medicinal plants particularly for the health care of poor tribals and also to help in their livelihoods.

Study Area:
Bhopal Forest Division: According to the report of Forest Survey of India the total forest cover is 12.01% including the scrub which is less then the area reported under the land use classification while working plan of Bhopal forest division (T.) (1999) mentioned 15.77 % forest out of total geographical area of Bhopal. The division divided in to the two forest range i.e. Berasia and Samardha.

Berasia: Berasia forest range is situated about 45 km from Bhopal. The total area of range is 28389.09 ha with 64.93 % forest area.

Samardha: Samardha forest range mostly covered the around the forest of Bhopal city. The total area of range is 15330.22 ha with 35.07% forest area.

Research methodology
The primary data have been collected through various field surveys during the year 2008 to 2010 and the secondary data were sourced from various sources including forest department records etc. data were also collected from other published and unpublished literatures etc. The field-based study on sustainable harvesting of selected medicinal plants and socioeconomic dependence and development have been carried out in the selected district in Madhya Pradesh State. A total of 10 villages, 5 villages in each of 2 ranges were selected for the study. The study closely examined present harvesting practices, ecological and socio-economic status etc. of Musli (C. *borivilianum*). Random sampling employed for collection of data and 20% households were surveyed from each selected village. A structured schedule was canvassed to collect required primary and secondary data pertaining to forest area, infrastructure facilities etc.

Ecological observations
A standard summary sheet is prepared and the information evaluated according to set of criteria of sustainability (Table-2) drawn from Habitat, Plant biology & Ecology, their collection & trade and causes of population decline. On the basis of the assessment, each species is scoring with assigned numbers (total 100). A total of 25 parameters were identified under six broad headings. For each parameter rate of scoring marks was fixed as given below. Based on total scoring of marks the species were ranked as critical, vulnerable (Kotwal,2003).
Scoring: Low =1, Medium = 2 and High =4
Ranking: Critical 25, Vulnerable =25-50 and Non vulnerable = >50
The above assessment is comprehensive and provides a systematic checklist for collating and integrating information on a wide range of parameters. Intensive field observations were taken in the study areas. The primary sources of data were field observations on the selected species and interviewing various stakeholders' i.e. Vaidyas, medical practitioners, primary NTFP gatherers. Attempts were made to know the degradation of natural habitats, biotic disturbances and exploitation pressure on the selected species. Discussions and minute field observations were also done with local resource persons to draw valuable first hand information.

Table 1: Details study of site.

Name of District/ Division	Forest Range	Name of selected Villages
Bhopal Forest Division (T.)	Samardha	1.Samardha;2 Prempura; 3.Amla 4.Kakadia Naya dera 5.Daulatpura
	Berasia	1. Ramaha;2. -Bhim Kund 3. Majherha;4. -Garha Brahman 5.Rabatpura

Table 2: Various ecological parameters and ranking of species under natural forest conditions.

Scoring: Low =1, Medium = 2 and High =4

Ranking: Critical 25, Vulnerable =25-50 and Non vulnerable = >50

Sl. No	Parameters	Low	Medium	High
	A. Habitat			
1	Habitat suitability	Least suitable	Suitable	Highly suitable
2	Habitat specificity	Very specific	Less specific	Not specific
3	Climate (Rainfall, Temp.) (Tolerance to extent)	Harsh (Very sensitive)	Sub – normal (sensitive)	Normal (Less sensitive)
4	Biotic disturbance (Grazing, fire)	Common	Frequent	Least
5	Protection level	Poor	Good	Very good
	B. Plant Ecology			
6	Occurrences	Wild	Cultivated	Wild & Cultivated
7	Distribution	Fragment	Patchy	Contiguous
8	Abundance	Scanty	Occasional	Common
	C. Plant biology			
9	Growth	Poor	Medium	Good
10	Flowering	Poor	Good	Very good
11	Fruiting	Poor	Good	Very good
12	Seeding	Poor	Medium	Good
13	Regeneration	Poor	Medium	Profuse
14	Pest & Disease	Epidemic	Frequent	Few
	D. Use/Trade			
15	Plant parts used	Whole plants, roots	Flower, bark	Leaves, seeds
16	Other uses (wood, tannin, fiber etc	> 3 uses	2 uses	1 use
17	Trade	Commercial	Localized	Specific
	E. Harvesting			
18	Harvesting stage	Premature	Sub- mature	Mature
19	Harvesting extent	Total	Partial	Least
20	Harvesting method	Destructive	Partly destructive	Non destructive
21	Harvesting people	Outsiders/ Commercial	Un- organized	Organized/local
	F. Causes of population decline			
22	Over exploitation by locals	Poor	Partly effective	Effective
23	High demand to market for multiple use	Scanty	Some	Common
24	High cost of product/ plant	Few	Some	Frequent
25	Technical knowledge/training awareness about species	Least	Some	Frequent

Details of parameters studied:

Various parameters have been categorized in to 6 major categories i.e. Habitat (5), Ecology (3), Biology (6), Use/trade(3),Harvesting (4) and Causes of population decline(4). These parameters are based on the study of Kotwal (2003). However certain modifications have been made on the basis of field observations. All these parameters ranked into 3 categories namely low, medium and high with scoring of 1,2 and 4 marks. The basic objective of this classification is to study the ecological status of

selected species in Bhopal forest division of Madhya Pradesh and examine the threats and causes of population decline in various habitat situations. Parameters in brief are given below:

1. **Habitat suitability**: Each plant species requires special type of locality or habitat environment. They grow in particular places while they do not grow well under unsuitable conditions. The various components (abiotic) of habitat like soil, terrain, geography, and climate etc. form suitable environment to grow species in a given

habitat. These components do not change from time to time and affect the growth and other aspects of the plant species. Looking to the scope of the present study, attempt has been made to indicate suitability of the habitat as least suitable, suitable and highly suitable with concomitant scoring of 1,2 and 4 marks.

2. **Specificity**:
Some species have specific requirement of a very particular type of habitat such as shade or total open areas, marshy land or low lying areas. The plants with a specific habitat requirement are more vulnerable as compared to other plants capable of growing in a variety of habitats.

3. **Climate:** Components like rainfall, humidity and temperature affect living organisms. The abnormal climate like sever drought, frost or heavy rainfall affects the plant growth. Under these conditions some susceptible herbs, shrubs or even tree dry/die due to extremes of these climatic factors. So the climate plays crucial role in establishing plant as well as animal community in a particular area. On the other hand normal climatic conditions (rainfall & temperature) support to establish the plant.

4. **Biotic disturbances**: Recently various biotic disturbances are common. These are fire, grazing, illicit felling etc beside the disturbances caused by the human beings. The cattle population in the periphery of the forests has considerably increased and affected the regeneration and growth of various plant species. The dependence of local villagers on nearby forests (for wood & fuel requirements) also damages the forests. All these factors affected the growth and natural occurrence of medicinal plants particularly herbaceous species. In the natural forest areas where biotic disturbances were more, the medicinal plant growth and density are severely affected.

5. **Protection level**: At present protection and conservation of the natural forests are the prime importance areas of concern. Protection from various biotic disturbances provides better chances of natural occurrences and growth of medicinal plants. In a natural forest area one can find poor growth and health of plants, low density deficit regeneration due to poor protection.

6. **Occurrences**: Most of the medicinal plants were found in natural forests (wilderness areas) and some are cultivated also. The plants usually occur in the areas like forest, wastelands, pastures, grasslands, agriculture, fencing and roadside etc. In case of its occurrence only in

wilderness, the exploitation pressure may be more then productivity.

7. **Distribution**: The distribution of plant species in the natural forests depends upon factors like seed dispersal, germination, establishment of seedlings and growth. The suitability of the habitat and extent of biotic disturbances also affect distribution. Fragmented distribution will score less mark as compared to contiguous distribution.

8. **Abundance**: Some plants are of common occurrence in a variety of habitats over a relatively large area while others have exacting habitat requirements and do not occur everywhere. Plants of common occurrence would score more marks as compared to those of scanty or occasional occurrence.

9. **Growth:** Plant grows under various habitat and environmental conditions. Vigorous growth of all parts of the plants shows suitability of the plant to the environmental conditions of that particular area. In normal conditions the plant may achieve good growth and may score more marks as compared to poor growth.

10. **Flowering:** A number of medicinal plants flower once in a year, some time twice in a year. Similarly flowering takes place uniformly every year or good in alternate years and poor in lean years. Several climatic factors, diseases also affect the flowering. More often the good flowering may lead to good fruiting and seeding. Good flowering score more marks then poor flowering.

11. **Fruiting:** In most of vascular plants after flowering the fruiting take place and it depends upon the extent of flowering. Good fruiting score more marks then poor fruiting.

12. **Seeding**: Seeding also expresses the reproductive growth of the plant. The seeding depend upon the fruiting of plants. Good and fertile seeding would score more marks then poor seeding.

13. **Regeneration:** Each plant has a definite cycle (time period) and the long term survival of the plant species is dependent on regeneration. This can be done either by vegetative means or by seeds or by both means. More seed would ensure better chances of regeneration. A plant having capacity to regenerate by both means would score more marks.

14. **Pest & diseases**: A healthy plant will have normal growth, flowering, fruiting and seeding as compared to an infected plant. In the natural forest areas some medicinal plants species are susceptible to various diseases and some are not

strong. Vigorous and healthy plant would score more marks than the diseased ones.

15. **Plant parts used:** Each medicinal plant has parts like root, seed, fruit flower and leaves. Use of whole plant by uprooting caused more damage then leaves or seeds harvesting. Such uses score fewer marks.

16. **Other uses (wood, tannin, fiber etc.):** Every plant species is variously used by man, besides its medicinal use. The plant might have other uses like fuel, fiber, fodder, timber etc. More number of uses of single plant would exert more exploitation pressure on that particular plant species and would score lesser marks.

17. **Trade**: Over-harvesting of medicinal plants for commercial purposes may increase more exploitation pressure as compared to limited or specific use and would score fewer marks.

18. **Harvesting stage**: Harvesting of medicinal plants require scientific approach. It is necessary to understand that which part of the plant or at which stage of its growth medicinal constituents is optimum. In case of medicinal plants it was generally observed that primary collectors collect plant at an early stage of maturation due to competition among other villagers. To collect more and more they started harvesting before flowering and fruiting. These immature collections are the main cause of poor quality of material from the forests and also degradation. Hence premature collection would score less marks.

19. **Harvesting extent:** The extent of harvestable part is an important parameter to assess in the natural forests. Mostly people harvest medicinal plants totally from the forest without leaving behind seeds/vegetative part for further regeneration. Total harvesting of plant from the forests is not desirable and would score fewer marks as compared to partial harvesting.

20. **Harvesting method:** Sustainable harvesting implies that annual extraction does not exceed the annual accretion. Sustainable extraction of NTFPs has recently gained considerable attention to conserve tropical forests and as a measure to enhance the income of rural and tribal people. Over harvesting of NTFPs have negative effects on conservation of bio-diversity in mainly forest ecosystems in India. A number of NTFPs are destructively harvested by premature collection of fruits, seeds, roots, rhizome etc

21. **Harvesting done by people:** It is said that natural forests are open bank and are accessible to all at any time for collecting NTFPs. After getting more knowledge about the trade and availability, people from outside the villages(big town/adjoining revenue villages where forest area is less) come to the forest fringe villages and collect the plant in unsustainable way using destructive techniques of harvesting like uprooting of whole plant felling, cutting etc. Due to more competition among the villagers, local people are also involved in such practices, which earlier they were not used to. Hence local people residing near forest have a major role in harvesting of medicinal species.

22. **Over exploitation by locals:** In a natural forest some medicinal species are relatively abundant, whereas many others are moderately available and few important species are concentrated only in certain pockets, which are mostly threatened. Competition has resulted in the harvest of few species from the more accessible sites being completed before maturation of usable parts. The bulk is picked when the growth only 2/3rd or even half of their potential size by the locals. It is a clear threat in restoration of these important herbs.

23. **High demand to market for multiple use:** All the medicinal plant species are not in great demand in the national as well as international markets**.** Most of the medicinally important tree species have high medicinal value for which the people collect due to high demand in the market. However some species are less useful and therefore in less demand.

24. **High cost of product/ plant:** Most of the medicinal herbs, which are considered as economically profitable in harvesting from the wilderness. There are several species that are in high demand by the traders. Over exploitation of a particular plant from the natural forest mostly depends upon the high cost of the plant product in the market. Less quantity of product (Forest) also sometimes become cause of high rate of plant in the market.

25. **Technical knowledge/training awareness about species:** Due to lack of technical know-how about ecology, harvesting management and cultivation of medicinally important species and awareness about locally available medicinal plants among the primary collectors/local people caused bio-diversity loss and hampered the growth and regeneration of several species in the natural forests. Hence, total awareness of all aspects of plant life and good collection and cultivation practices is needed now days. Due to lack of awareness about harvesting, value addition, processing and marketing, the medicinal wealth is depleting at a faster rate particularly where plants were harvested from

the natural forest. Technical skills are much more needed now a day for conserving forest

26. the primary collectors scored fewer marks as

wealth and their sustainable management. Less awareness about the medicinal species among compared to more awareness, which is good sign of sustainability.

Table:3. Assessment of various ecological parameters to study the status of *C. borivilianum* in Bhopal forest division. (Avg. of 02 forest ranges)

Scoring: Low =1, Medium = 2 and High =4 Ranking: Critical 25, Vulnerable =25-50 and Non vulnerable = >50

Sl. No	Parameters	Low	Medium	High
	A. Habitat			
1	Habitat suitability	---	---	Highly suitable
2	Habitat specificity	Very specific	---	---
3	Climate (Rainfall, Temp.)	---	Sub - normal	---
4	Biotic disturbance (Grazing, fire)	Common	---	---
5	Protection level	Poor	---	---
	Sub total	3	2	4
	Scoring under habitat 9 out of 20 (45.00%)			
	B. Plant Ecology			
6	Occurrences	Wild	---	---
7	Distribution	---	Patchy	
8	Abundance	Scanty	---	---
	Sub total	2	2	---
	Scoring under Plant ecology 4 out of 12 (33.33%)			
	C. Plant biology			
9	Growth	---	Medium	---
10	Flowering	---	Good	
11	Fruiting	Poor	---	---
12	Seeding	Poor	Medium	Good
13	Regeneration	---	Poor	---
14	Pest & Disease	---	Frequent	---
	Sub total	2	4	4
	Scoring under Plant biology 10 out of 24 (41.66%)			
	D. Use/Trade			
15	Plant parts used	Whole plants, roots	---	---
16	Other uses (wood, tannin, fiber etc.)	---	2-3 uses	---
17	Trade	---	Localized	---
	Sub total	1	4	---
	Scoring under Use/trade 5 out of 12 (41.66%)			
	E. Collection			
18	Harvesting stage	Premature	---	---
19	Harvesting extent	Total	---	---
20	Harvesting method	Destructive	---	---
21	Harvesting people	More	Un- organized	
	Sub total	3	2	---
	Scoring under collection 5 out of 16 (31.25%)			
	F. Causes of population decline			
22	Over exploitation by locals	Poor	---	---
23	High demand to market for multiple use	---	Some	---
24	High cost of product/ plant	---	Some	---
25	Technical knowledge/training awareness about species	---	Some	---
	Sub total	3	4	---
	Scoring under Causes of population decline 7 out of 16 (43.75%)			

RESULTS AND DISCUSSION

Various parameters have been put in 6 groups' namely- habitat, plant ecology, plant biology, use/trade, harvesting and causes of population decline. Each group of parameters was discussed in brief for Bhopal forest division.

I. Habitat:
It is well known fact that medicinal plants are affected by the habitat conditions. In this forest division Musli has scored maximum marks 9 out of 20 (or 45%) as compared to other parameters studied. The low density and regeneration indicates its scanty occurrence and rarity in the study area.

II. Plant Ecology:
There are several parameters to assess the ecology of selected medicinal plant. However, only few were considered like-occurrence in wilderness, cultivation and both. The species having fragmented distribution in specific habitats of species would score low marks. Lowest marks (4 out of 12) in this regard indicate problems in respect of their ecology. This species have fragmented distribution and patchy abundance in their habitats.

III. Plant biology:
The various important factors of the plants like-flowering, fruiting, seeding, regeneration, resistance to pest and diseases etc play important role in plant growth. In case of Biachandi, the regeneration is seriously hampered because tubers are collected for medicinal purposes & plants were completely uprooted from the ground as the tuber contains high medicinal value and therefore, mature seed producing plants were removed from the forest. With reference to plant biology parameter, the plant has scored more marks 10 out of 24 (or 41.66%), as compared to other parameters.

IV. Use/Trade:
Tubers of Musli are being commercially traded in the local as well as national markets. The extent of harvesting under wild conditions depends on the part, which contains more medicinal and trade value. Use of tubers, entire plant would score fewer marks and use on large scale trade also score less marks then local use or specific scale. However, the species scored more marks 5 out of 12 (or 41.66%) due to use of its tubers for commercial purposes.

V. Harvesting:
Over harvesting of Musli tubers depend upon the market demand, availability and high rate (of harvested part) of the plant, which have medicinal

use. Due to low income from such type of harvesting, the primary collectors started more and more harvesting which ultimately posed exploitation pressure on the species. These unsustainable practices lead to poor medicinal value of plant, which is harmful in manufacturing Ayurvedic medicines. Hence, immature harvesting scored fewer marks 5 out of 16. Total uprooting of the plants from the ground floor without leaving any part for future regeneration, adversely affects plant growth under wilderness. Thus total harvesting scored lesser marks. These types of destructive methods of harvesting would score fewer marks. Inter competition among the villagers to harvest more and more also leads to dangerous condition. This damage to the plants would score fewer marks. Musli scored minimum marks (31.25%) mainly due to unsustainable harvesting and uprooting of whole plant. Because of high market demand and value, the tubers of were harvested destructively hence the availability of plant in the wild conditions become rare. Scoring of less/fewer marks indicates more threats and unsustainable method of collection of tubers.

VI. Causes of population decline:
The primary causes like human population growth, habitat loss & degradation and socio economic situations etc. in combination affect population density. The human activities that cause habitat destruction are mainly intensive corporate farming, urbanization, grazing, road building, pollution, the introduction of non-native species, fire etc. Trade related issues like commercial trade of medicinal plant and their derivatives is a big business. The plants that have high cost in the market scored fewer marks while low cost scored more marks (7 out of 16). Similarly, plants which have high demand in market for multiple use, scored less marks as compared to plant which have less demand. The low level of Technical knowledge/training awareness about the selected species scored low marks while high level of knowledge scored more marks. Musli showed fewer marks (43.75%) mainly due to high cost & demand (in the national/international market), high medicinal value, over exploitation etc. In the Bhopal forest division, on an average the plant has scored average 39.44% marks and as per norms it falls under **vulnerable** category (Table-4). Species is faced problem under harvesting (31.25%), plant ecology (33.33%) and use/trade (41.66%) parameters. On the other hand maximum marks (45%) were obtained by the parameter habitat in relation to other parameters studied.

Table 4: Scoring of marks for *C. borivilianum* species under various   parameters studied in Bhopal Forest Division. (Avg. of 02 forest ranges)

Category	Parameters	Total marks	Number obtained and % of marks
A	Habitat	20	9 (45.00%)
B	Plant ecology	12	4 (33.33%)
C	Plant biology	24	10 (41.66%)
D	Use/trade	12	5 (41.66%)
E	Harvesting	16	5 (31.25%)
F	Causes of population decline	16	7 (43.75%)
Total		**100**	**39.44%**

DISCUSSION AND CONCLUSION

The present deteriorating condition of Musli plants in the natural forests of Bhopal Forest Divisions is very precarious and needs immediate attention not only for conservation but also for propagation. Present study clearly shows that the position of Musli in the natural forest areas is very alarming in terms of less number of plants per hectare, and poor plant quantity and quality. The species falls under critically endangered category in the natural forests of Bhopal Forest division. The natural regeneration is also adversely affected due to immature harvesting of tubers/plant.

The competition for early collection among the locals living around the forests was more intense. The method of plant collection was not scientific and it affects the growth and occurrence of plant. Mishra (2000) reported present harvesting practices of critically endangered *Curcuma caesia* and *Rauvolfia serpentina* species are very deteriorating because of high price of product in the national & international markets, immature collection by locals, poor regeneration & population density. Prasad *et. al.* (2001), Mishra *et al.* (2004), Mishra, (2009), Mishra and Kotwal (2009), also reported that the current position of Safed musli in the natural forest and protected areas is very alarming in terms of less number of plants per hectare, and poor tuber quantity and quality.

They recommended that there is need to immediately stop the unsustainable harvesting of the plant by the local people and contractors.

It was also observed that the local collector largely collects its tubers for commercial purposes. This plant is a major source of income to the villagers/tribals living adjoining to the forests. Immature tubers of Musli were mercilessly uprooted to collect maximum tubers without much effort after the commencement of (early) rains. This practice needs to be stopped otherwise not only the availability of plant will become less and scarce, this valuable medicinal plant species may disappear altogether, causing economical as well as ecosystem misbalances. Sustainable management implies that extraction should not exceed regeneration. Umashankar *et al.* (1996) and several others (Browder 1996; Homma 1992; Nepstad *et al.* 1992) are of the view that unless levels of harvests are linked with total productivity, a sustainable level of extraction may be difficult to achieve. The present harvesting system of Mulsi is ecologically and socio-economically unsustainable. Apart from destructive harvesting and lack of value addition, general absence of local level institutions deprive the collectors fair and just wages for their works. There is no mechanism to discourage premature harvesting. The transport of this species as a non-nationalised

produce does not require any transit pass and therefore forest department does not have reliable statistics on the actual extraction.

Recommendations:
Sustainable wild harvest management schemes need to be supported by government/authorities. Management plans need to be installed as a standard prerequisite for any such harvesting in the wild. There is need to monitor and audit the harvesting process to determine whether it is sustainable. Uprooting of whole plant of Musli (*C. borivilianum*) for tubers need to be immediately stopped. Proper training of people for collecting tubers by scientific methods should be given to the local peoples. Ex-situ gene banks of the selected species need to be encouraged and germplasm bank should be developed at regional level.

The period of plant collection should be after October and no collection should be permitted before this, particularly tubers would be harvested in the month of November (after maturation). Time and sustainable method of harvest should be organized by forest deptt. or through local communities, Village Forest Committee (VFC), Forest Protection Committee (FPCs) etc. The unhealthy competition for immature plant collection within the villagers must be stopped for which awareness camps at village level should be organized. Processing of tubers (mature) by peeling skin, sun drying and packaging at household level may enhance income. The date of plant/tuber maturity needs to be notified by the forest department. Premature collection and uprooting whole plant should be discouraged or banned.

ACKNOWLEDGEMENTS

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