EXTRACTION OF NON TIMBER FOREST PRODUCE FROM SELECTED TREE SPECIES IN BETUL FOREST DIVISION AND ITS IMPACT ON THE POPULATION STRUCTURE OF THESE SPECIES

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CERTIFICATE

This is to certify that **Anupama Koliyal** of the Wildlife Institute of India has carried out an original piece of research work entitled " Extraction of non timber forest produce from selected tree species in Betul Forest Division and its impact on the population structure of these species" in partial fulfillment of the M.Sc. (Wildlife Science) degree of Saurashtra University. These investigations were carried out under our supervision at the Wildlife Institute of India from November 1996 to June 1997. We also certify that this work has not been submitted for any other degree of any university.

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SUMMARY

This study, carried out from November 1996 to May 1997 in North Betul Forest Division (NBFD), aimed to investigate the impacts of NTFP collection on the population structure of three extracted species namely, *Buchanania lanzan, Emblica officinalis* and *Madhuca indica*. Population structure, particularly the proportion of the younger recruitment classes in the extracted site, was compared to that in Satpura National Park, an ecologically similar but undisturbed area, a perfect natural 'control' site. Regeneration of all three were negligible in the harvested site when compared to that in the unharvested site. Interestingly, Timber Forest Products, viz. *Tectona grandis*, *Bauhinia racemosa*, and *Chloroxylon sweitenia*, which are harvested for parts other than the fruit/seed, showed good regeneration in both sites.

The second component of the study *viz.* the socio-economic investigation of the dependent people showed that they ranked other occupations like Forest Department jobs and agriculture above NTFP collection and realised that collection had a negative impact on the forests. It seems that it is only the want of other income generating opportunities that forces them to continue extraction. Again this offers scope for conservation measures to be implemented. Though a short study like this is limited in its scope for providing long-term solutions, it clearly demonstrates that NTFP collection, particularly of *Buchanania lanzan, Emblica officinalis* and *Madhuca indica* in dry deciduous forests of central India does have a significant impact on the forests in general and these species in particular.

1. INTRODUCTION

Throughout history, people have shaped the forests by harvesting forest products, to obtain their livelihood. Man's dependence on forests for his existence dates back to the origin of the human race.

Forest products have customarily been divided into two groups: 1. Major and 2. Minor. The first category consists of timber, small wood and fuel wood. While the second comprise all forest produce other than timber and fuelwood and include medicinal plants, essential and fatty oils, spices, edible wild plants, gums, resins, fodder, flosses, fish poison, insecticides, etc (Gupta & Guleria,1982).

Further, the Fourth World Forestry Congress in 1954 suggested that the minor forest products be classified as "economic forest produce other than wood" as the term "minor" does not indicate their economic and social significance. Agenda 21 (UNCED, 1992, see Tiwari,1993) on environment and development termed it as "non wood forest produce" (NWFP) for reasons of both simplicity and appropriateness. National Seminar on forest produce in India (organised by ICFRE at Coimbatore, see Tiwari, 1993) recommended the term " Non Timber Forest Products (NTFPs)". The term " Non Timber Forest Products" (NTFPs) emerged as an umbrella term to recognize the products derived from the various forest resources as a group. **NWFPs or NTFPs be can defined as all goods for commercial, industrial or subsistence use derived from forests and their biomass, which can be sustainably extracted from a forest ecosystem in quantities and ways that do not downgrade the plant community's basic reproductive functions** (FAO: Forestry Topic Report No. 4, 1995).

In India over 3,000 plant species produce economically significant products (Tiwari, 1993). Communities living in and around forests rely directly upon this wide variety of forest products for their daily subsistence needs as well as for economic, religious and cultural sustenance. Kothari *et al.* (1989) report that 14 (36%) of the 39 national parks and 104 (56%) of the 185 sanctuaries in India had reported extraction of NTFPs. NTFPs are vitally important for livelihood to a large and economically poor population in tropical countries, for example, nearly 50 million people living in and around forests in India rely on NTFPs for their sustenance (NCHSE, 1987). Also, since NTFPs involve a large variety of seasonal products, returns are relatively continuous. Other estimates suggest that some 35% (Tewari, 1994) of income of tribal households in India comes from the sale of NTFPs. Moreover, there is a significant scope for increasing the employment opportunities for these people by processing NTFPs locally. In India, over 50% of forest revenue and 70% of forest export income are obtained from NTFPs (Gupta & Guleria, 1982). Likewise, in Brazil, 1.5 million people or 20% of the economically active persons in the Amazon region, derive a significant portion of their livelihood from extraction of natural products (Browder, 1992).

NTFPs are truly the people's product, and their use and trade are integral components of local economics and culture. But now with the increase in human population the gap between increased demand for forest products and supply from within the forest is widening. The various components of human demands on forests are becoming incompatible day by day. Various lines of evidences suggest that over harvest of NTFPs can have adverse effects on the normal functioning and values of forest ecosystem . The impacts of NTFPs collection on the ecosystem are poorly understood, they may not be as immediate and visible in terms of change as that of timber harvesting but they have potential for affecting the long-term sustainability of the living resources like any other landuse practices (Nepstad *et al.* 1992). The study by Uma Shaankar *et al.* 1996 states that as a result of the large scale harvest Amla (*Phyllanthus emblica* or *Emblica officinalis*), by indigenous people the tree has an inadequate number of individuals in the recruitment class. Tewari, 1994. documented hampered natural regeneration of *Buchanania lanzan* due to over-exploitation of its seeds in the forests of Madhya Pradesh. The evidences for unsustainable harvest leading to depletion of resources is not only confined to India but also to other locations in the Tropics. The Brazil nut (*Bertholletia excelsa*) tree which occurs through out the Amazon Basin, shows an absence of smaller size class in a stand of mature forests is probably due to a combination of factors, including over-harvest of the fruits (Nepstad *et al,* 1992). Reining *et al,* (1991) show that two palm species collected and exported for floral arrangements are harvested on an unsustainable basis in Maya Biosphere Reserve in Guatemala, and Nepstad *et al* (1992) present evidence for depletion in Amazonian forest produces used by native population. Browder (1992) cites many examples from South America of NTFP used primarily by local communities that are also being depleted by unsustainable harvest. If harvested judiciously the high economic importance of NTFP makes it a potentially powerful tool for grass root level conservation. Thus, there is a growing interest in the subject of NTFP among conservationists and managers. "Sustainable" use of living resources however is often discussed in subjective term which is inadequate . Information on quantified "sustainable levels" of harvest is sketchy. The harvest is sustainable if the harvest has no long term deleterious effect on the reproduction and regeneration of the populations being harvested in comparison to similar unharvested population. Furthermore, sustainable harvest should have no discernable adverse effect on other species, on ecosystem structure and functions (Hall & Bawa, 1993). In order to assess sustainabilty of harvesting nontimber forest products, knowledge of the natural distribution, abundance, population structure and productivity, across a landscape is required for each species. The primary focus of research so far has been on improving the quality and quantity of NTFPs and their exploitation for the Socio-economic benefit, instead on their long term conservation (Tewari, 1994). In general, quantitative information on the abundance, distribution and impact of NTFPs collection on forest structure are lacking.

The present study conducted in the dry deciduous forests of Central India aimed at studying the impact of collection on the population of three NTFP species, *viz* Mahua (*Madhuca indica),* Amla (*Emblica officinalis),* and Achar *(Buchanania lanzan),* which are among the important NTFPs collected by local people in Central India . Field work for the study was conducted from November 1996 to May 1997 which coincided with the fruiting and collection of Amla and Achar fruits ; and the flowering and collection of Mahua flowers.

Madhuca indica J.F Gmel. a member of family Sapotacae is a large deciduous tree of medium height (Plate 9). Flower and fruits (for seeds) are harvested from Mahua tree. The succulent, cream coloured corollas fall to the ground in showers during March and April (Plate 10) . Mahua flowers are eaten raw or cooked. The flowers when dried are sold by the tribals to the distillers for the manufacture of distilled country liquor. The fruits of Mahua ripen in May-June. The seeds are separated from the fruits and then dried and shelled to get to get the kernels. The greenish yellow oil (Watt, 1889) extracted from the kernel of the fruit is used by forest tribes for cooking and burning and is sold for the manufacture of margarine, soap and glycerine (Prasad, 1993). The fruits are reddish yellow when ripe, one to two inches in length and are eaten by birds, macaques, and squirrels.

Achar (*Buchanania lanzan* Spreng.) belonging to the family Anacardiaceae is an evergreen tree found in most of the dry deciduous forests of India, up to an altitude of 1,200m. The fruits ripen during April-June (Plate 7) and are fed by langurs, macaques, fruit eating birds, sloth bear. The fruits are extracted by the tribals for the kernels which is an important article of trade and is largely used in native sweetmeats. They form a common substitute for almonds in flavouring sweetmeats (Watt. 1889). The kernels yield a light yellow, sweet oil used as an indigenous medicine.

Amla (*Emblica officinalis* Gaertn), member of the family Euphorbiaceae, a small or medium sized deciduous tree flowers during February and March and fruits in November and December (Plate 4). The fruits are green and globose and eaten by sambar, spotted deer, langurs and macaques. The fruits of Amla trees are collected by the tribals for commercial purposes as it is used as an ingredient for medicines of the indigenous Ayurvedic system (Krishanmurthy, 1993). It is also used as a source of dyes and tannins and for making pickles, jellies and preserves (Krishanmurthy, 1993).

1.1 Objectives

In this study an attempt was made to address the following objectives:

1. To ascertain the methods of collection and processing of selected NTFP tree species.
2. To determine the relative abundance and population structure of these selected NTFP tree species in a harvested an unharvested site.
3. To determine the role of NTFP collection in the economy of the local people.

2. STUDY AREA

The study was conducted in North Betul forest division (NBFD) and Satpura National park (SNP) forming part of the Satpura ranges in Central India. The NBFD lies between latitude 22° 24' 15" and 21° 46' 15" North and longitude 78° 23' 45" and 70° 16' 30" East, of Betul district of Madhya Pradesh and the total geographical area of the forest division is 2199.7 km². This forest division extends over five forest ranges and includes both reserved and protected forests *(Map 1)* (Shrivastava R, Undated).

The Satpura National Park situated to the North of (NBFD) has 400.345 sq km of reserved forest and 124.025 km² of protected forest and lies between 22°56'40" and 22°40'30" North latitudes and 77°56'0" and 77°44'0" East longitudes in Hosangabad district of Madhya Pradesh, *(Map 2)*.

Both the areas are a part of Deccan Penninsula Biogeographic zone of India. The terrain is rugged, the altitude varies from 300 m to 1351 m above mean sea level. The entire area lies in the catchment of the river Narmada.

2.1 Geology

The tract is mainly covered by Gondwana sandstone, with a basal bed of Deccan trap formation made up of coarse grained basalt. The gondwanas comprise of the Talchirs, Barakars, Moturs, Bijori beds and Jabaur formations (Shrivastava R, Undated). The crystallines found in the tract comprise both of the Archaean and Proterozoic group, while the alluvium is found along river and nala banks. The forest soil varies from loose sand or reddish murrum to dark stiff clayey loam or black cotton soil, inclusive of all intermediate gradations.

2.2 Climate

The area receives a good rainfall from the south-west monsoon. The summer season is from April to mid-June, rainy season from mid-June to September, post rainy season is October and winter season from November to March. The mean daily temperature varies between 18.1°C to 48.2°C. The mean annual rainfall varies locally from 1200 to 1400 mm. The climate is humid and the prevailing conditions are conducive to good growth of deciduous vegetation.

2.3 Flora

The combination of various climatic and edaphic factors at varying altitudinal level gives rise to rich and luxuriant tropical flora.

According to the revised classification of forest types by Champion and Seth (1968), the forests of the study area falls under the sub group 3B (South Indian Moist Dry Deciduous Forests), 5A (Southern Tropical Dry Deciduous Forests), 4E/ $R5_1$ (Riparian Fringing Forests) and 5/E2 (*Boswellia* forests). Forests consists mainly of teak species. Main associates of Teak in the top canopy include Saja *(Terminalia tomentosa)*, Lendia *(Lagerstroemia parviflora)*, *Dhauda (Anogeissus latifolia)*, Haldu *(Adina cordifolia)*, Tinsa *(Ougenia oojeinensis*), Mahaua *(Madhuca indica*), Kalamb *(Mitragyna parviflora)*, Kari *(Miliusa tomentosa)*, and Jamun *(Syzygium cumini)*. Salai *(Boswellia serrata)* is found only on higher elevation. Middle storey is often composed of Amla (*Emblica officinalis*), Kakai (*Flaccourtia* *indica*), Achar (*Buchanania lanzan*), Bhelwan (*Semecarpus anacardium*) (Table 1 & 2).

2.4 Fauna

Satpuras is known for its rich faunal diversity. Major mammalian species found here includes tiger, leopard, wolf, wild dog, gaur, and sambar . Among the animals recorded in Satpuras, there are 31 species of mammals, 280 species of birds, 26 species of reptiles, and 19 species of fish.

2.5 Intensive study area

The intensive study area includes Bhaura forest range of NBFD and Sohagpur forest range of SNP. Both areas are assumed to be similar in all aspects except for biotic interference. Thus Bhaura range of NBFD was taken as harvested area and Sohagpur forest range of SNP as a control i.e unharvested area free from all kinds of biotic interference. The total geographical area of Bhaura range is 292 km^2. Within this range there are 32 revenue villages (RV) and 8 (FV) forest villages. My study was conducted in and around the three villages of Bhaura range, *viz* Kuppa forest village, Taitor revenue village and Bod forest village. The Kuppa village has 110 households and 613 people, Taitor has 52 household and 402 people, and Bod has 32 households and 201 people. Human communities residing inside the reserved forest includes indigenous tribes called *Korkus, Gonds, Thatia, Pradhan* and backward class designated as *Goalies*' who are mainly agro-pastoralists . The tribals own very less livestock as compare to *Goalies.* The main occupation of human communities residing in the forest is agriculture.

As such no rights exist in the reserved forests but for the concessions are given by the state government for grazing and harvest of minor forest produce.

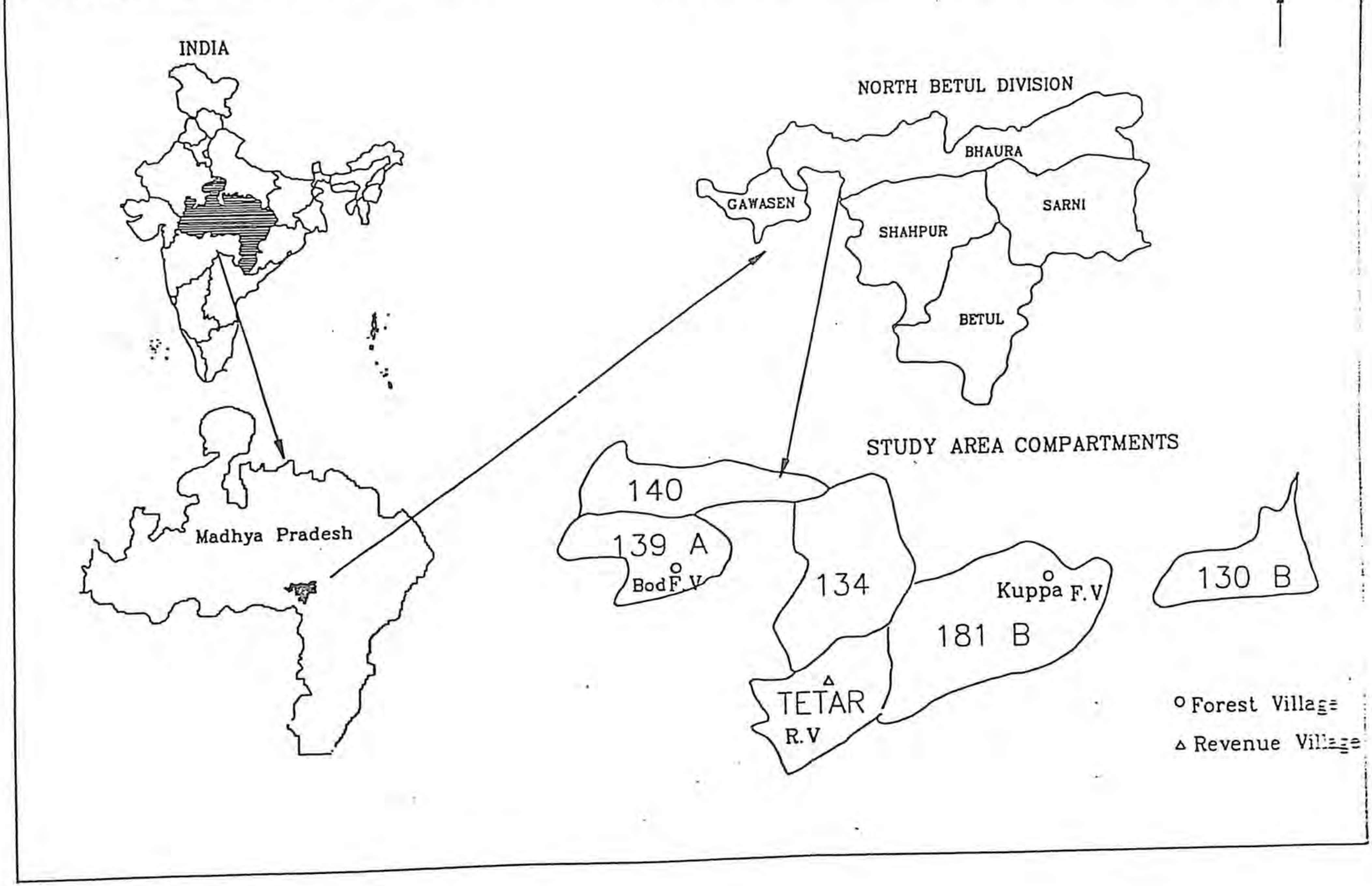
3. METHODS

3.1 Vegetation Sampling

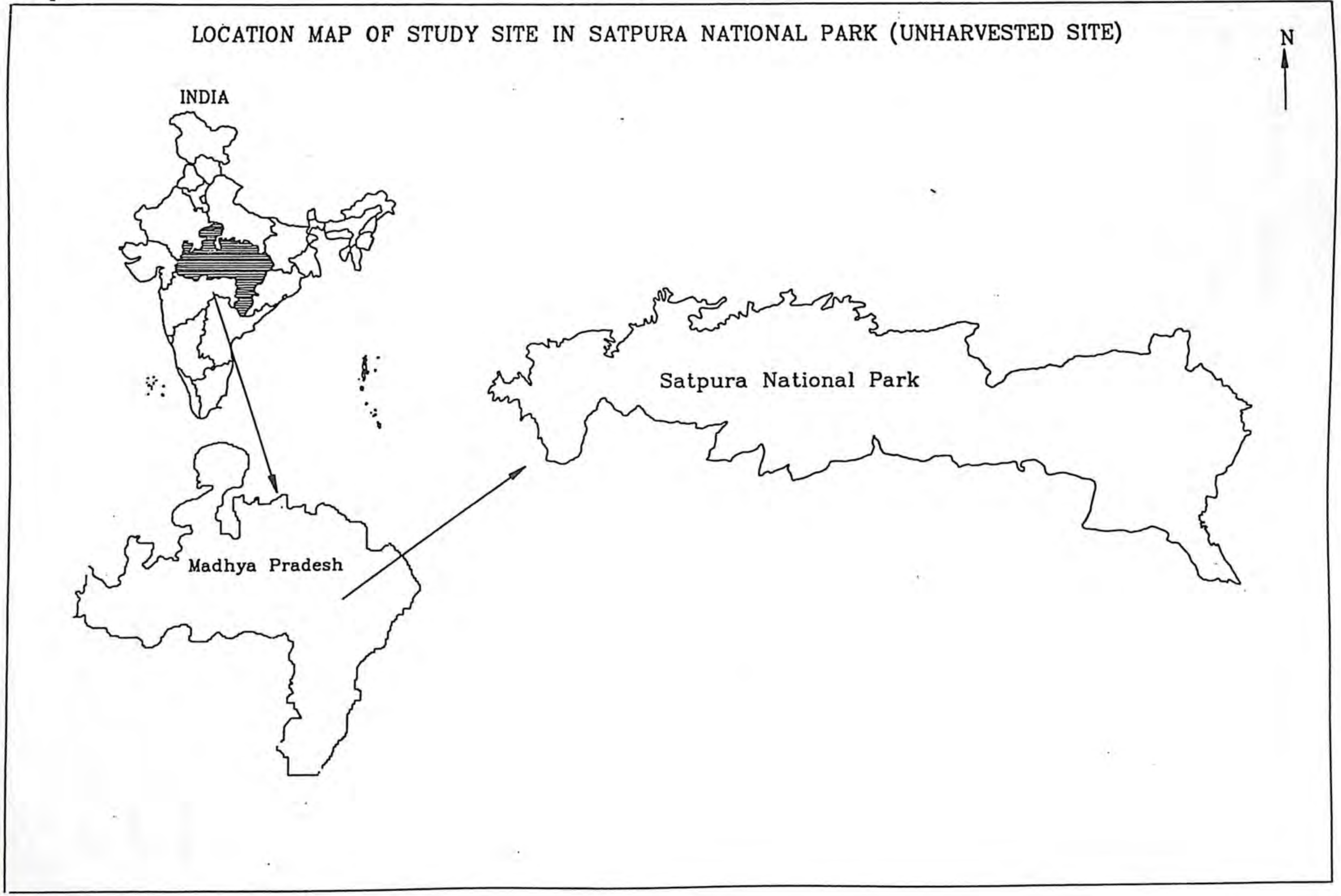
Stratified random sampling was done (Muller-Dombois and Ellenberg, 1974) for obtaining data on vegetation. Both harvested and unharvested area were divided into three strata each according to terrain and vegetation type , *viz* hill stratum (Mixed forest, Plate 2), hilly undulating terrain (Teak mixed forest, Plate 1) and broad valley (modified land, Plate 3). In the unharvested site, broad valley stratum was a village twenty two years ago. Five transects of approximately 1 km length were laid randomly in the harvested site (disturbed or Site 1) and three in unharvested site (undisturbed or Site 2). At every 100 m point along these transects, 20 m on either side of the transect, concentric circular plots of 10 m and 5 m radius were laid. The 10 m plot was used for collecting data on tree density and their girth at breast height (GBH), and in 5 m radius plot data on saplings and livestock dung were recorded. Five 1 m radius plots were laid inside the 10m radius plots for gathering data on seedlings. Individuals of GBH ≥ 20 cm were taken as trees, GBH < 20 cm > 4 cm and height more than 1.2 m were considered as saplings, girth < 4cm and height < 1.2 were taken as seedlings. The saplings were considered as recruitment class. If saplings were coppice then they were not recorded. A total of 300 plots in harvested site and 180 plots in unharvested site were laid. The number of trees lopped, felled (stump) and dead stump of trees encountered were counted inside the 10m radial plot. The tree which was dead and cut by the people was taken as "dead stump".

Map 1

LOCATION MAP OF STUDY SITE IN NORTH BETUL FOREST DIVISION (HARVESTED SITE)



Map 2


LOCATION MAP OF STUDY SITE IN SATPURA NATIONAL PARK (UNHARVESTED SITE)
N
INDIA
Madhya Pradesh
Satpura National Park

To increase the number of individuals and to cover all girth classes of the species of research interest, plots were also laid non-randomly. Wherever species of interest were present, 10 m radial plots were laid taking that individual as the central point and data on same parameters were gathered. While laying non-random plots emphasis was on including individuals of lower girth class.

3.2 Production and extraction data

The following assumptions are involved in quantifying production of fruits and flowers (in case of *M.indica*):

1. Production per tree excludes the produce (fruits and flowers) that might have been consumed by wild and domestic animals prior to harvest.
2. It also excludes the produce that might have fallen on the ground before harvest.
3. Production is similar for similar GBH class in all strata.

3.2.1 Method used for quantifying production

Amla *(E.officinalis)*, fruit production per tree was estimated by weighing the fruits collected during extraction and adding the estimated weight of fruits left on a tree. To calculate weight of fruits left on the tree after extraction the number of fruits left on a tree were counted, and the number of fruits in 1 kg were also counted. Then weight of one fruit was deduced from it. Methods of collection were also ascertained by direct observations. Collection took place in a large area and the collection season lasted for a very short duration, as this year was a lean production period for" Amla" fruits in NBFD. Hence only limited data was collected by direct observations . To overcome the problem of low sample size another method was employed. Houses of collectors were visited during the collection season, yield collected by them were weighed, and the fruits collected were traced back to the trees of their origin with the help of the collectors. Thus production was again calculated by weighing fruits collected by a collector and the amount left on the tree. The very fact that 35% of the trees shown by them showed signs of fresh lopping which confirmed that collectors had shown the actual trees. Still data on production, for many GBH classes were missing so a third method was employed for further quantification. Intensive search of unextracted, missing GBH class trees was carried out and professional collectors including my field assistants were asked to harvest these trees.

For measuring fruit production per tree, of Achar (*Buchanania lanzan*) data was collected by direct observations at the time of extraction. In case of Mahua (*Madhuca indica*) I could not see fruit harvest as it was not during my study period, but quantification of flower production was done. Trees of desired GBH were marked before the harvesting season started and during peak collection period flowers collected from the marked tree were weighed on site. Damage done to the trees individual during collection i.e lopping and felling was also recorded.

Data regarding the methods of processing of collected NTFP, were obtained by visiting and interviewing the collectors at their residence.

3.3 Socio economic data

Three villages, having settlements of tribals and backward class were sampled for obtaining information on NTFPs as a source of income. Villages were selected such that they represented all communities of the area. Proximity to the base camp was also a major consideration in the selection of these villages. The people of all three villages utilise a common forest patch, for obtaining the forest produces. Two of these villages Taitor (R.V) and Kuppa (F.V) are only a Kilometre away from each other while third village Bod is about 10 Km from the first two villages. The data was collected by interviews. The community was broadly divided into tribals and Goalies. Twenty percent of the total households of each community were interviewed. The contents of the interview schedule dealt with education level, family size, income from NTFPs and other sources, for this and the previous year, and other sources of income. No official records exist for any of the extracted products but for *D.melanoxylon,* a fact which forced me to depend solely on information collected from interviews.

May 1995 to May 1996 was the time period which comprised previous year data, while June 96 to May 97 provided data for this year. The NTFPs included *Diospyros melanoxylon* (Tendu) leaves, *Emblica officinalis* (Amla) fruits, *Buchanania lanzan* (Achar), *Madhuca indica* fruits called 'Gulli' and flowers. The sources of income were NTFPs, agriculture, Forest department daily wages labourer, and others (animal husbandry, agricultural and non-agricultural labour).

The information on income figures provided by respondents were considered reliable, as the income figures for *D.melanoxylon* stated by them when cross-checked corresponded to the Forest department's records for the same.

3.4. Analysis Of Data:

Analysis of data was done by using computer software Lotus123, and SPSS. The significance level was set at 0.05.

3.4.1 Difference in density and Importance value index (IVI):

Density and IVI (Greig-Smith, 1983) of tree species encountered in vegetation plots were calculated for the harvested and unharvested sites. One tailed t-test was done to see whether the density of selected NTFPs trees and TFPs (Timber forest produce) is higher in unharvested site (site 2) than the harvested one (site1). TFP included *Tectona grandis* (Teak), *Chloroxylon swietenia* (Bhirria), and *Bauhinia racemosa* (Astra), in decreasing order of their timber value. *C.swietenia* is used by tribals for making pillars of their huts and also as fuel wood when dry. *B.racemosa* is good fodder for cattle and the bark (of branches) is also used for making ropes largely for their own use.

3.4.2 Disturbance index in harvested site

Disturbance index was calculated as the proportion of live cut trees, dead stumps and of lopped trees to the total standing number of trees in a vegetation plots (Murali, *et al* 1996). Proportion of number of plots having livestock dung to the total number of plots sampled was also calculated for the disturbance index.

3.4.3 Differences in population structure

It was analyzed for the selected NTFP species and also for selected timber species (TFP).

Kolmogorov-Smirnov test for size class distribution of individuals was done for each selected NTFP and TFP species at two sites. Test was performed first by including saplings and then by excluding saplings to see whether the size class distribution of the selected species at two sites differed. Null hypothesis H_o was Population (Size-class) distribution is the same at two sites (two-tailed test) for each selected NTFP and TFP species.

Chi square test of proportion (Zar, 1984) was done to see difference in proportion of saplings of selected species of in two different sites. H_o= proportion of saplings is the same in two sites, i.e harvested and unharvested area.

3.4.4 Fruit and Flower production

The fruit production by a tree was calculated as the sum of fruit extracted (kg) and fruits left on a tree (kg). For Mahua flower, production was estimated by amount taken by the collectors i.e it was actually a measure of "extractable production".

Production (of fruits or flower) per unit area was quantified by plotting production against the GBH of the trees and a regression equation was obtained for trees $\geq$30 cm GBH. Minimum and maximum average production of a product (fruits and flowers), from a tree was calculated by using regression equation and average GBH of each selected NTFP species. Which was then multiplied by the density of tree species per hectare to get production per unit area.

Off-take or extraction per tree (in petcentage) was calculated by dividing the amount of product taken by the collector with total production of that tree. For calculating extraction per unit area, total production per unit area (kg per ha.) was multiplied by average off-take (in percentage). Damage done to the tree species from which collection was done was also quantified as the proportion of number lopped and felled trees to the number of total standing trees observed during direct observation. Production data was collected only from harvested area.

3.5 Socio economic data analysis

Mann Whitney U test was done to see differences in the annual incomes of two communities (tribals and backward class *Goalies*) and differences in the income generated only by NTFP. Null hypothesis, therefore were H_o= there is no difference in the annual Incomes of both the communities. H_o= there is no difference in the income generated from NTFPs for both the communities.

There were eight major sources of income for the people. The interviewees were asked to rank each of these, in order of preference on a scale of one (least important) to eight (most important). For each source of income, the mean of the ranked scores was taken as the index of perception for that income source, by the people. Similarly, each source of income was also ranked according to the income generated by it. The Spearman rank correlation was done to see the correlation between the index of perception and the mean annual income generated by each source.

4. RESULTS

4.1 Density and IVI

The density of trees was 411.8 per ha in the harvested site (site 1) and 703.6 per ha in unharvested site (site 2). Teak showed higher density than any other tree species in both the Sites comprising 28.22 % in site 1, 19.03% in site 2 (Table 1 and 2).

Among the selected NTFP tree species, *M.indica* forms 5.51 % of all the species in site 1 area and 6.00% in site 2. *B.lanzan* forms 1.08% and 7.00% of all the species in Site 1 and Site 2 respectively. *E.officinalis* comprises 1.97% and 5.00% of tree species in Site 1 and Site 2 respectively. There was a highly significant difference in the density of selected of selected NTFP and TFP tree species between the two sites but *T.grandis* and *B.racemosa* (Table 3).

TABLE 3 Comparison of tree density of NTFP and TFP at Site 1 (NBFD)and Site 2 (SNP), documented between Nov.'96-May '97. Using the one tailed t-test, at α=0.05, n_1=300 (Plots in Site 1) n_2=180 (Plots in Site 2).

Species	P values
Tectona grandis	0.11
Bauhinia racemosa	0.39
Chloroxylon swietenia	0.0001
Buchanania lanzan	<0.0001
Emblica officinalis	<0.0001
Madhuca indica	<0.0001

T.grandis was the dominant species in both the sites, with an Importance Value Index (IVI) of 69.26 (n= 300 plots) and 44.04 (n=180 plots) at Site 1 and Site 2 respectively. *M.indica*, with IVI 45.44 and 26.77 for Site 1 and 2 respectively was the next species in order of dominance. There were 26 and 12 species with IVI <1 in Site 1 and Site 2 respectively (Table 1 and Table 2).

Table 1: Abundance, Density, and IVI of tree species arranged in ascending order of Abundance in Site1 (NDFP). Documented between Nov.'96 to May'97. (n1 = 300 Plots)

Common Name	Scientific Name	Abundance	Density (ha)	Percent Density	IVI
Medsing	*Dolichandrone falcata*	1	0.11	0.03	.11
Gular	*Ficus glomerata*	1	0.11	0.03	.12
Rohan	*Soymida febrifuga*	1	0.11	0.03	.13
Pipal	*Ficus religiosa*	1	0.11	0.03	.50
Bhilawa	*Semecarpus anacardium*	1	0.11	0.03	.10
Semal	*Bombax ceiba*	1	0.11	0.03	.28
Kekda	*Garuga pinnata*	1	0.11	0.03	.16
Koilar	*Bauhinia purpurea*	1	0.11	0.03	.12
Kahu	*Terminalia arjuna*	1	0.11	0.03	.12
Khair	*Acacia catechu*	1	0.11	0.03	.11
Mango	*Mangifera indica*	1	0.11	0.03	.14
Dahipal	*Cordia macleodii*	2	0.21	0.05	.24
Bjarbat	*Litsea chinensis*	2	0.21	0.05	.22
Chichola	*Albizia odoratissima*	2	0.21	0.05	.25
Kullu	*Sterculia urens*	2	0.21	0.05	.42
Imli	*Tamarindus indica*	2	0.21	0.05	.22
Kuku	*Mallotus philippensis*	3	0.32	0.08	.14
Phephad	*Ficus virens*	3	0.32	0.08	.42

Common Name	Scientific Name	Abundance	Density (ha)	Percent Density	IVI
Tumdi	*Strychnos potatorum*	3	0.32	0.08	.17
Kalam	*Mitragyna parviflora*	4	0.42	0.10	.48
Chilore	**Unidentified*	4	0.42	0.10	.48
Ber	*Zizyphus mauritiana*	5	0.53	0.13	.43
Salai	*Boswellia serrata*	7	0.74	0.18	1.12
Baranga	*Sterculia villosa*	7	0.74	0.18	.60
Kasai	*Bridelia squamosa*	8	0.85	0.21	.87
Jamun	*Syzygium cumini*	8	0.85	0.21	.77
Haldu	*Adina cordifolia*	9	0.96	0.23	1.65
Reunjha	*Acacia leucophloea*	14	1.49	0.36	1.67
Neem	*Azadirachta indica*	16	1.70	0.41	.70
Phassi	*Dalbergia paniculata*	18	1.91	0.46	2.08
Tondri	*Casearia elliptica*	20	2.12	0.51	1.34
Shisham	*Dalbergia latifolia*	20	2.12	0.51	2.56
Dudhai	*Wrightia tinctoria*	21	2.23	0.54	.69
Jamrashi	*Cassia suffruticosa*	21	2.23	0.54	1.27
Dhauda	*Anogeissus latifolia*	26	2.76	0.67	2.88
Kakai	*Flacourtia indica*	30	3.18	0.77	2.56
Saaj	*Terminalia tomentosa*	36	3.82	0.92	4.38
Ghatore	*Zizyphus xylopyra*	36	3.82	0.92	2.88
Achar	*Buchanania lanzan*	42	4.46	1.08	4.09
Dhaman	*Grewia tiliaefolia*	47	4.99	1.20	3.88
Amaltas	*Cassia fistula*	49	5.20	1.26	3.13
Kosum	*Schleichera oleosa*	54	5.73	1.38	4.94
Moiyan	*Lannea coromandelica*	57	6.05	1.46	6.32
Palas	*Butea monosperma*	68	7.22	1.74	6.28
Tinsa	*Ougeinia dalbergiodes*	70	7.43	1.79	6.08
Amla	*Emblica officinalis*	77	8.17	1.97	6.66

Common Name	Scientific Name	Abundance	Density (ha)	Percent Density	IVI
Papda	*Gardenia latifolia*	134	14.22	3.43	6.08
Kari	*Miliusa tomentosa*	163	17.30	4.18	10.35
Astra	*Bauhinia racemosa*	168	17.83	4.31	11.11
Gilchi	*Casearia graveolens*	170	18.04	4.36	8.94
Mahua	*Madhuca indica*	215	22.82	5.51	45.44
Bhel	*Aegle marmelos*	231	24.51	5.92	13.31
Bhirria	*Chloroxylon swietenia*	271	28.76	6.95	18.66
Lendia	*Lagerstroemia parviflora*	303	32.16	7.77	18.88
Tendu	*Diospyros melanoxylon*	320	33.96	8.20	17.05
Teak	*Tectona grandis*	1101	116.84	28.22	69.2

Table 2 Abundance, Density, and IVI of tree species arranged in ascending order of Abundance in Site 2 (SNP). Documented between Nov.96 to May 97. n2 = 180 plots

Common Name	Scientific Name	Abundance	Density (ha).	Percent Density	IVI
Tondri	*Casearia elliptica*	1	0.18	0.00	.11
Haldu	*Adina cordifolia*	2	0.35	0.00	.12
Rethu	*Cordia dichotoma*	3	0.53	0.00	1.34
Kekda	*Garuga pinnata*	4	0.71	0.00	.10
Hingua	*Balanites aegyptica*	4	0.71	0.00	.19
Imli	*Tamarindus indica*	4	0.71	0.00	.65
Bhilwa	*Semecarpus anacardium*	5	0.88	0.00	.52
Semal	*Bombax ceiba*	5	0.88	0.00	1.05
Kumai	*Careya arborea*	5	0.88	0.00	.46
Baheda	*Terminalia bellerica*	5	0.88	0.00	.50
Jamrasi	*Cassia suffruticosa*	6	1.06	0.00	.43
Baranga	*Sterculia villosa*	7	1.24	0.00	.52
Khirni	*Manilkara hexandra*	7	1.24	0.00	.52
Salai	*Boswellia serrata*	8	1.42	0.00	1.66
Rohan	*Soymida febrifuga*	12	2.12	0.00	1.15
Kullu	*Sterculia urens*	12	2.12	0.00	2.50
Chichola	*Albizzia odoratissima*	13	2.30	0.00	1.43
Jamun	*Syzygium cumini*	16	2.83	0.00	1.39
Koilar	*Bauhinia purpurea*	17	3.01	0.00	1.14
Kosum	*Schleichera oleosa*	20	3.54	0.00	2.34
Kakai	*Flacourtia indica*	21	3.72	0.01	1.74
Bija	*Pterocarpus marsupium*	21	3.72	0.01	1.56
Amaltas	*Cassia fistula*	24	4.25	0.01	.73
Phendra	*Gardenia turgida*	24	4.25	0.01	1.05
Kalam	*Mitragyna parviflora*	29	5.13	0.01	2.39

Common Name	Scientific Name	Abundance	Density (ha).	Percent Density	IVI
Bhel	*Aegle marmelos*	31	5.48	0.01	1.84
Tinsa	*Ougeinia elliptica*	33	5.84	0.01	2.27
Kasai	*Bridelia retusa*	37	6.55	0.01	3.77
Karki	*Miliusa tomentosa*	38	6.72	0.01	2.48
Phassi	*Dalbergia latifolia*	42	7.43	0.01	5.53
Palas	*Butea monosperma*	53	9.38	0.01	6.29
Moiyan	*Lannea grandis*	63	11.15	0.02	6.79
Ber	*Zizyphus jujuba*	64	11.32	0.02	4.03
Dudhai	*Wrightia tinctoria*	64	11.32	0.02	.54
Reunza	*Acacia leucophloea*	87	15.39	0.02	8.49
Papda	*Gardenia latifolia*	89	15.75	0.02	6.11
Lendia	*Lagerstroemia parviflora*	99	17.52	0.02	6.50
Astra	*Bauhinia racemosa*	105	18.58	0.03	7.04
Dhaman	*Grewia tiliaefolia*	114	20.17	0.03	7.80
Dhauda	*Anogeissus latifolia*	128	22.65	0.03	8.55
Ghatore	*Zizyphus xylopyra*	133	23.53	0.03	10.06
Tendu	*Diaspyros melanoxylon*	201	35.56	0.05	13.17
Amla	*Emblica officinalis*	207	36.62	0.05	15.06
Khair	*Acacia catechu*	208	36.80	0.05	14.39
Mahua	*Madhuca indica*	258	45.65	0.06	26.77
Achar	*Buchanania lanzan*	275	48.66	0.07	17.06
Saaj	*Terminalia tomentosa*	296	52.37	0.07	21.58
Bhirria	*Chloroxylon swietenia*	326	57.68	0.08	18.47
Teak	*Tectona grandis*	757	133.93	0.19	44.04

4.2 Disturbance Index

Disturbance index calculated for site 1, showed that 7.11% of all standing trees were lopped, 12.77% were felled 2.7% are dead and cut stump (Table 4), and 42% of vegetation plots in site 1 showed presence of livestock dung. Among six selected TFP and NTFP species, maximum lopping was on *E.officinalis* and least on *T.grandis*. On the other hand more stumps of *C.sweitenia* were found at Site 1. Maximum mortality was seen in case of *B.racemosa* (Table 5). There were no evidences of lopping, felling and grazing at the Site 2.

Table 4 Disturbance Index at Site 1 (NBFD) and Site 2 (SNP), documented between Nov.'96 to May'97. (n = 3880 total number of trees)

	Lopped Trees (Site1)	Lopped trees (Site2)	Cut Trees (Site1)	Cut Trees (Site2)	Dead stump (Site1)	Dead stump (Site2)
Percentage %	7.11	nil	12.77	nil	2.7	nil
Density (ha)	28.02	nil	49.15	nil	10.9	nil

Table 5 Damaged trees of selected NTFP and TFP tree species at Site 1(NBFD), documented between Nov.'96 to May'97.

Species	Lopped %	Cut stump%	Dead Stump%
Tectona grandis (n=1101)	1.5	4.7	0.009
Chloroxylon sweitenia (n=271)	6.2	14.7	3.3
Bauhinia racemosa (n=168)	17.8	11.3	4.1
Madhuca indica (n=21)	1.8	5.1	0.46
Emblica officinalis (n=77)	22	3.9	3.9
Buchanania lanzan (n=42)	11.9	4.7	0

4.3 Population Structure

The girth class distribution of individuals of each selected NTFP and TFP species in two sites was significantly different (Table 6, Fig.4.1 to 4.6).

Table 6 Differences between girth class distribution of individuals of selected NTFP and TFP species at Site 1 and Site 2 (with sapling class), documented between Nov.'96 to May'97. (K.S Test, Two Independent Samples, α=0.05)

Species	P Values	K-S Z	Number of trees in two sites
Tectona grandis	<0.0001	5.797	n_1=1001 n_2=1213
Chloroxylon Swietenia	<0.0001	3.735	n_1=373 n_2=546
Bauhinia racemosa	<0.0001	2.331	n_1=202 n_2=115
Emblica officinalis	<0.0001	6.412	n_1=274 n_2=548
Madhuca indica	<0.0001	6.083	n_1=364 n_2=591
Buchanania lanzan	<0.0001	8.545	n_1=233 n_2=580

To account for difference in distribution, sapling class (4 cm to <20 cm GBH) were removed. It was found that distribution of the individuals of GBH class > 20 cm in two sites was also significantly different (Table 7). Thus, it shows that saplings were not solely responsible for difference in the size class distribution of the individuals in the two sites.

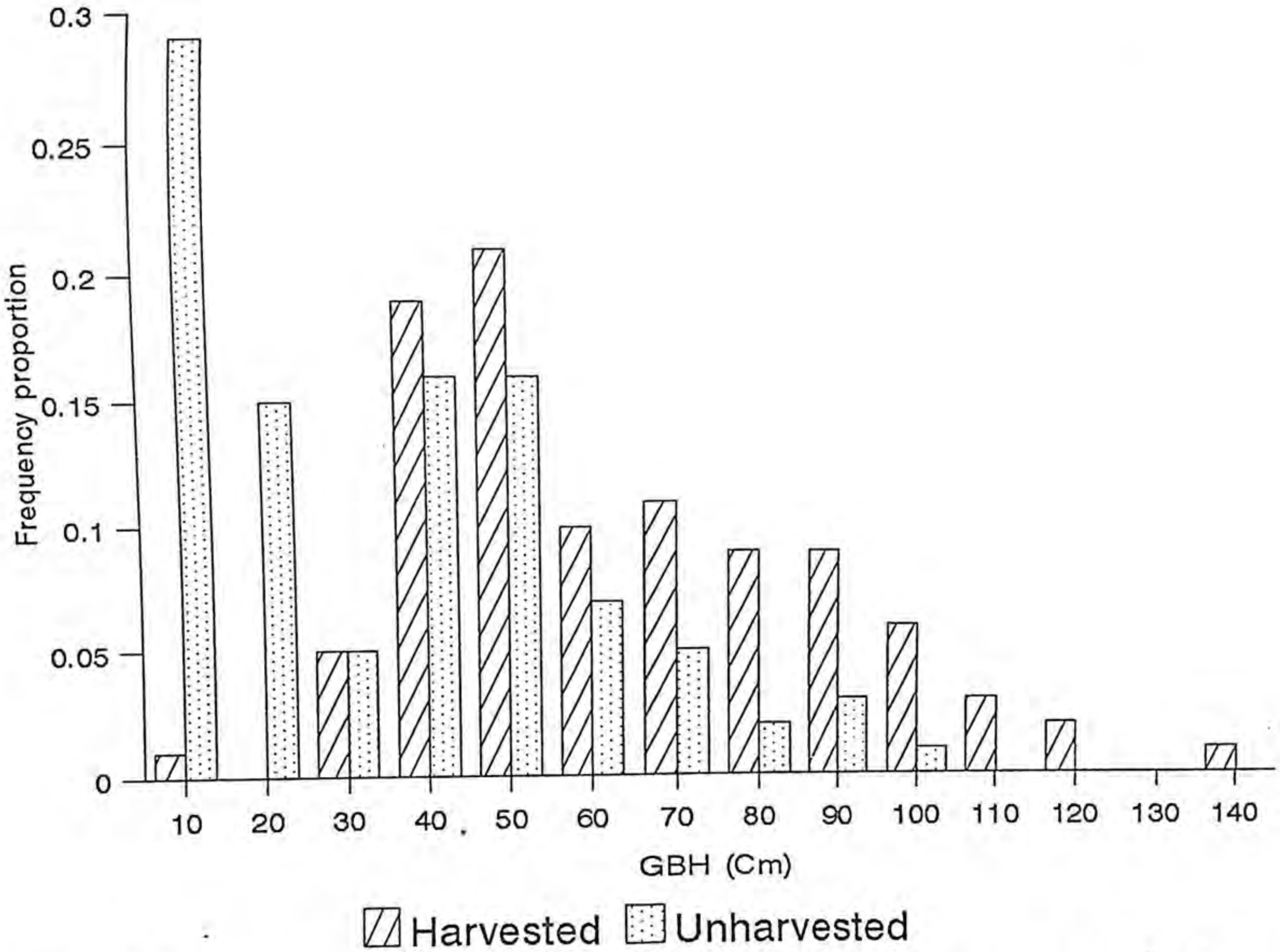


Fig. 4.1: Size class distribution of Buchnania lanzan at two sites

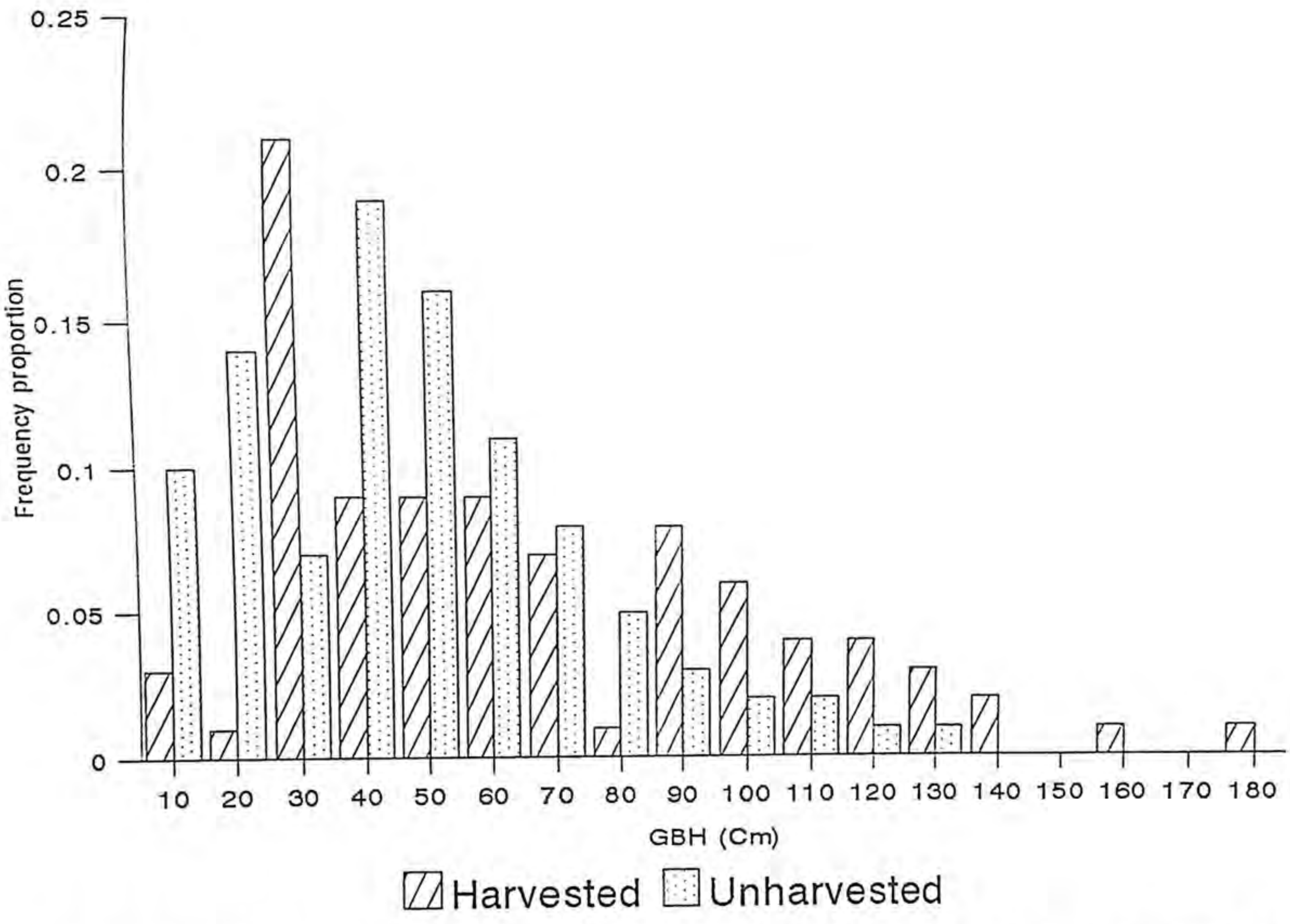


Fig. 4.2: Size class distribution of _Emblica officinalis_ at two sites

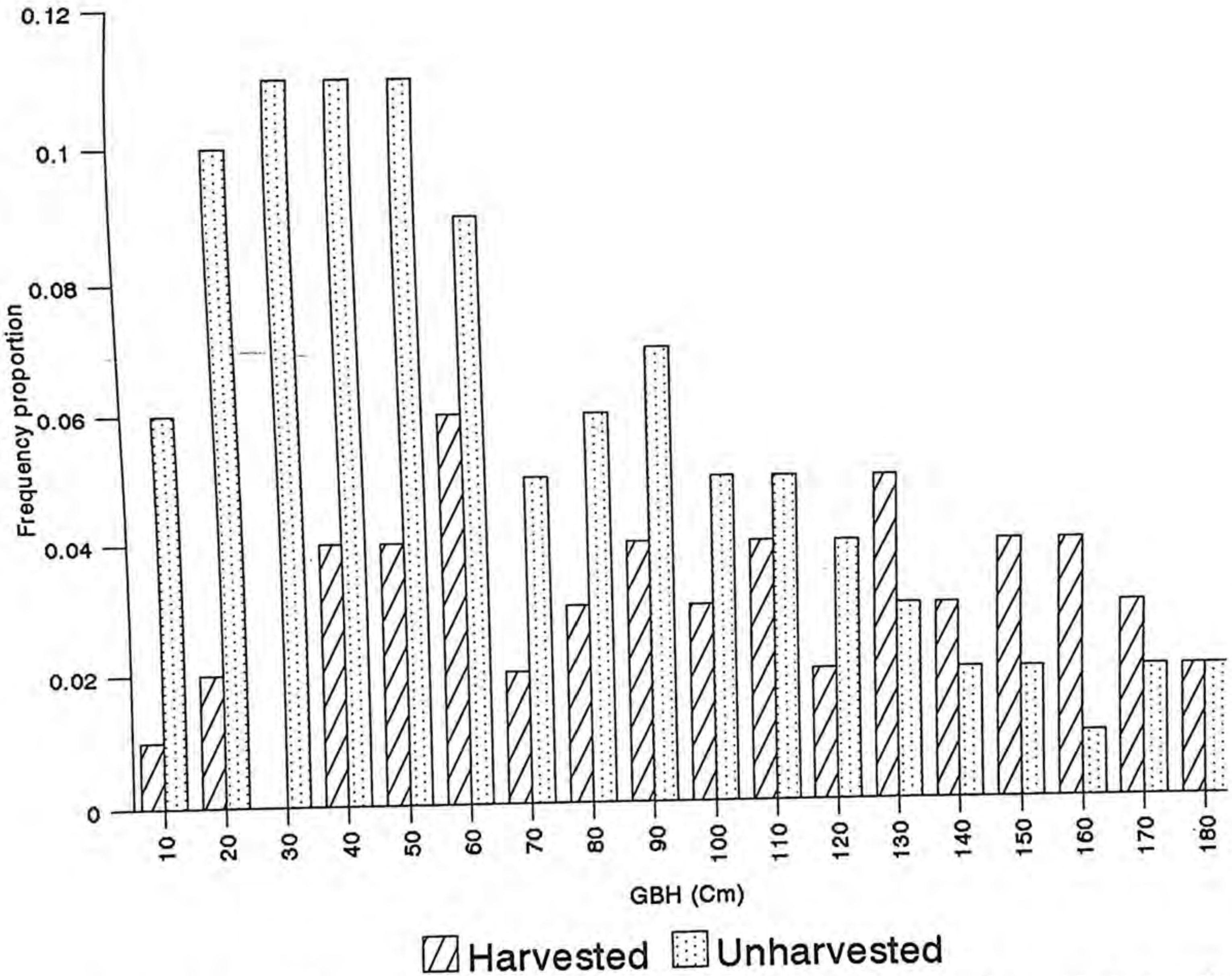


Fig. 4.3a: Size class distribution of *Madhuca indica* at two sites

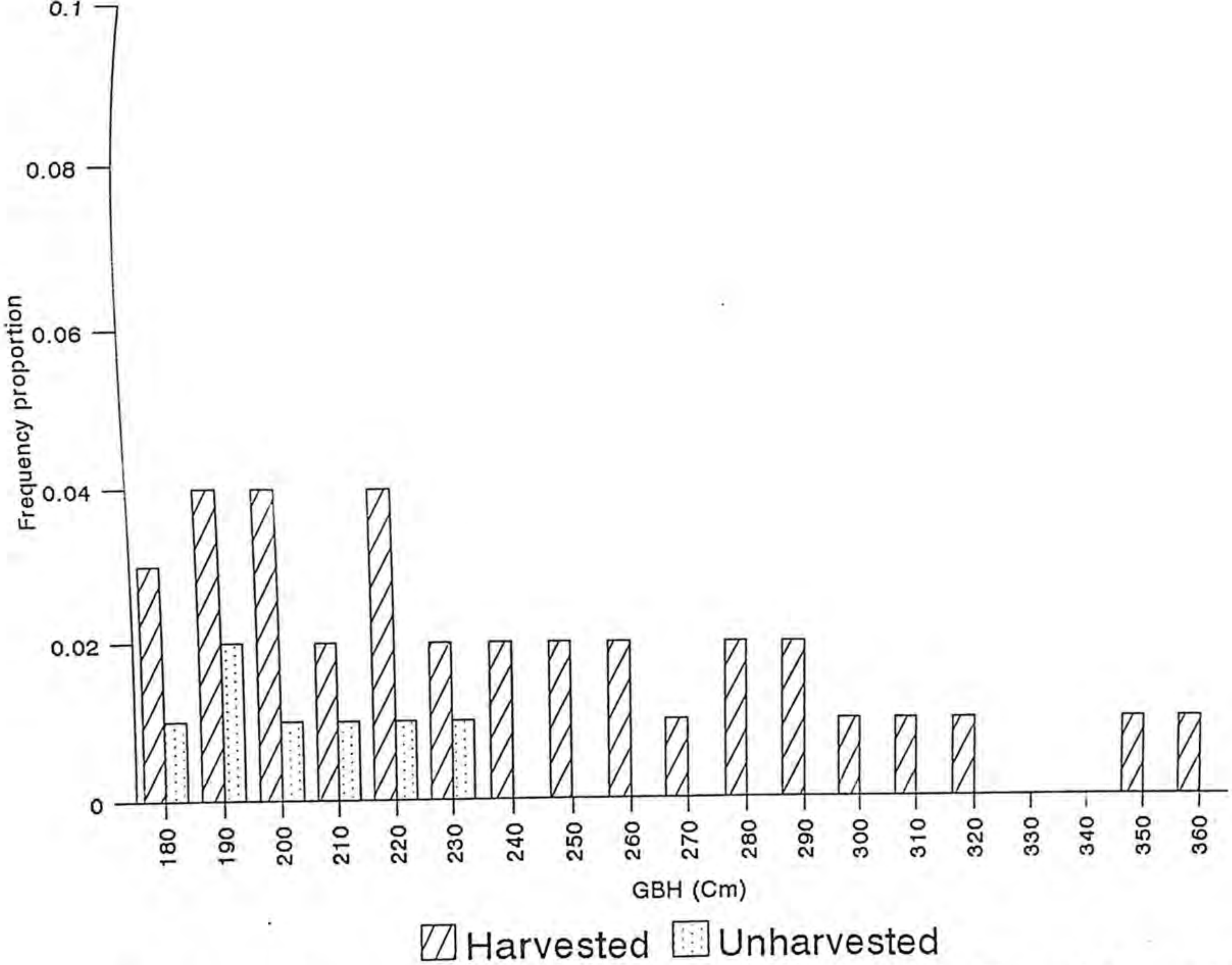


Fig. 4.3b: Size class distribution of Madhuca indica at two sites

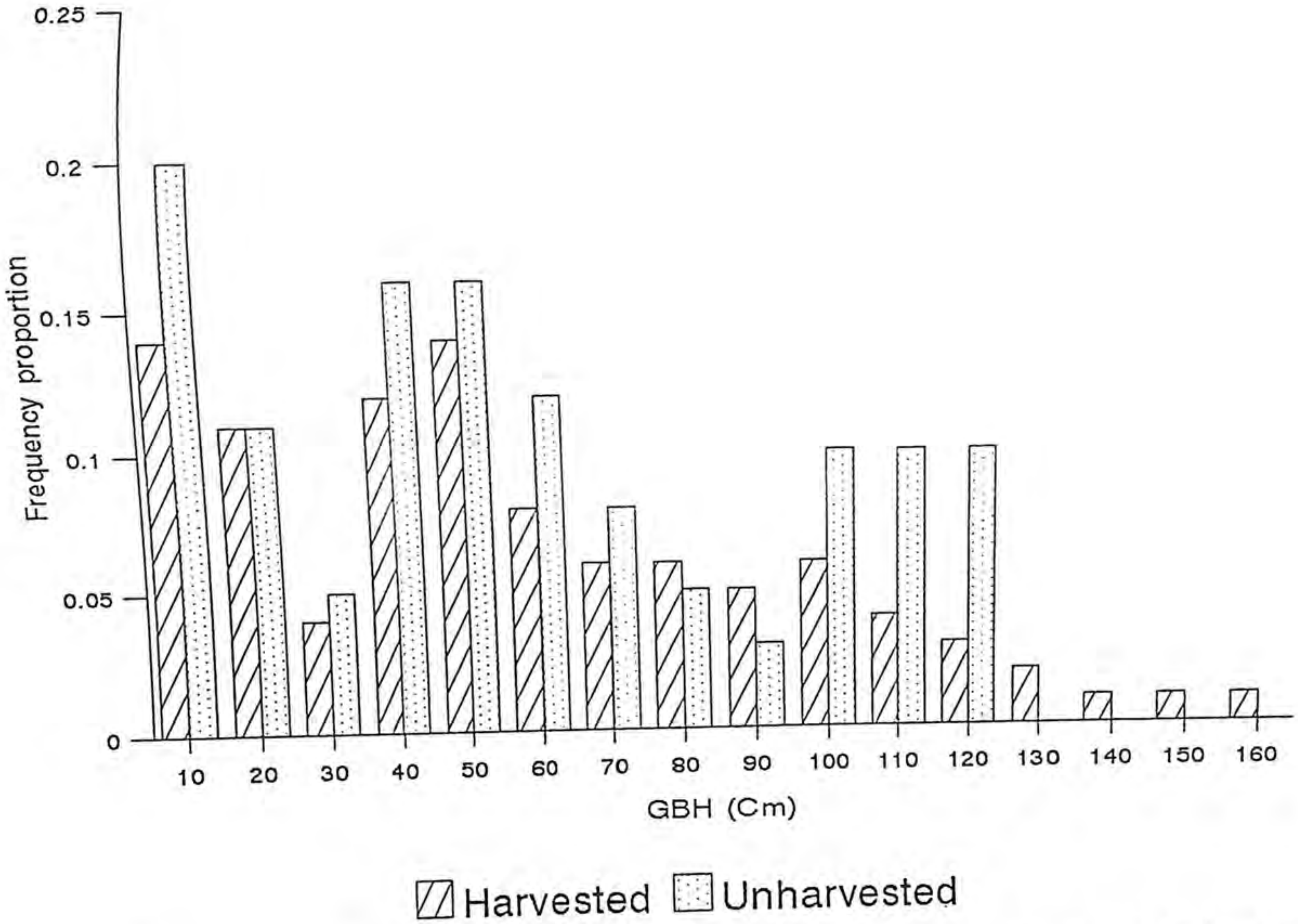


Fig. 4.4: Size class distribution of Tectona grandis at two sites

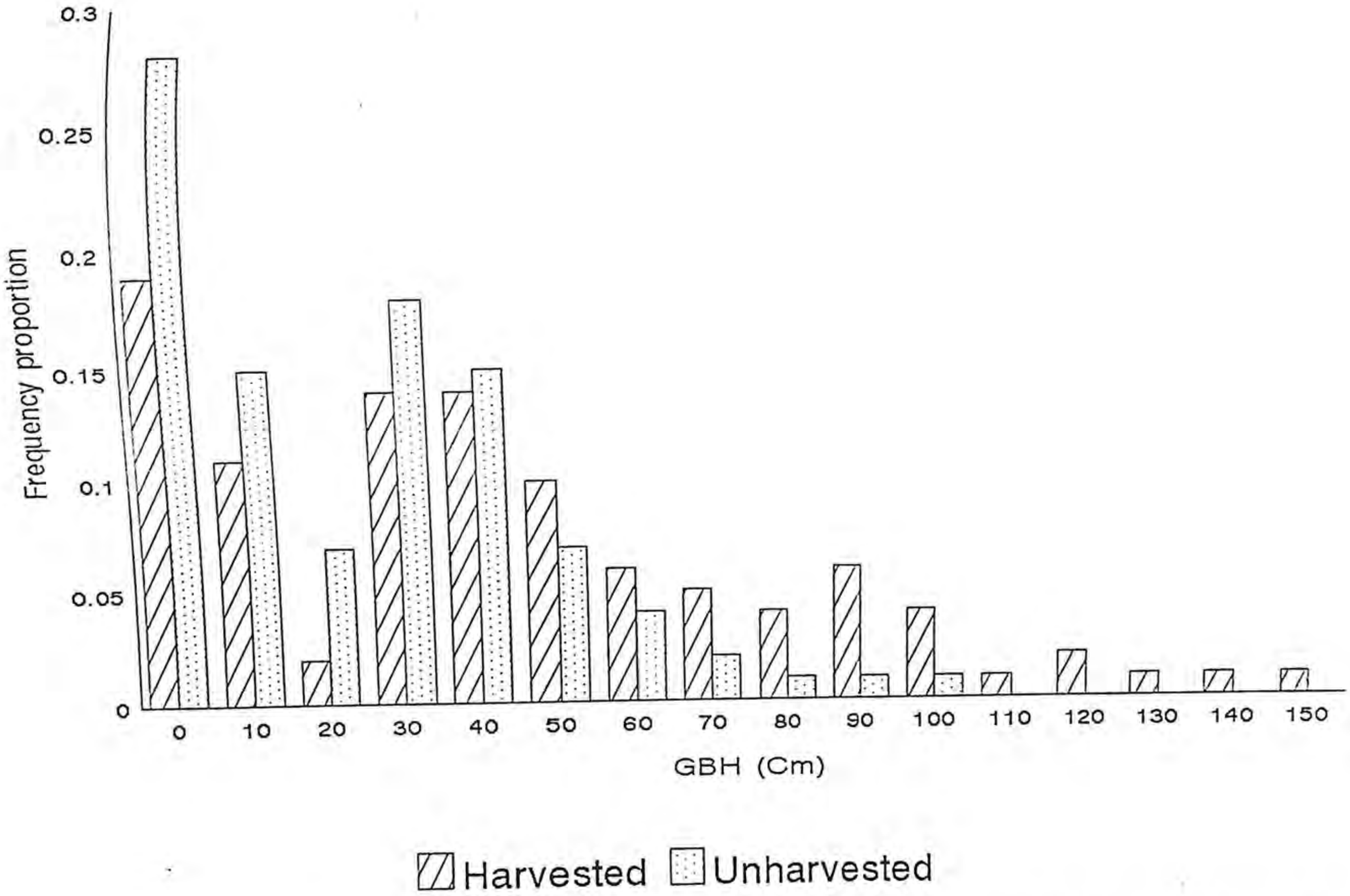


Fig. 4.5: Size class distribution of Chloroxylon sweitenia at two sites

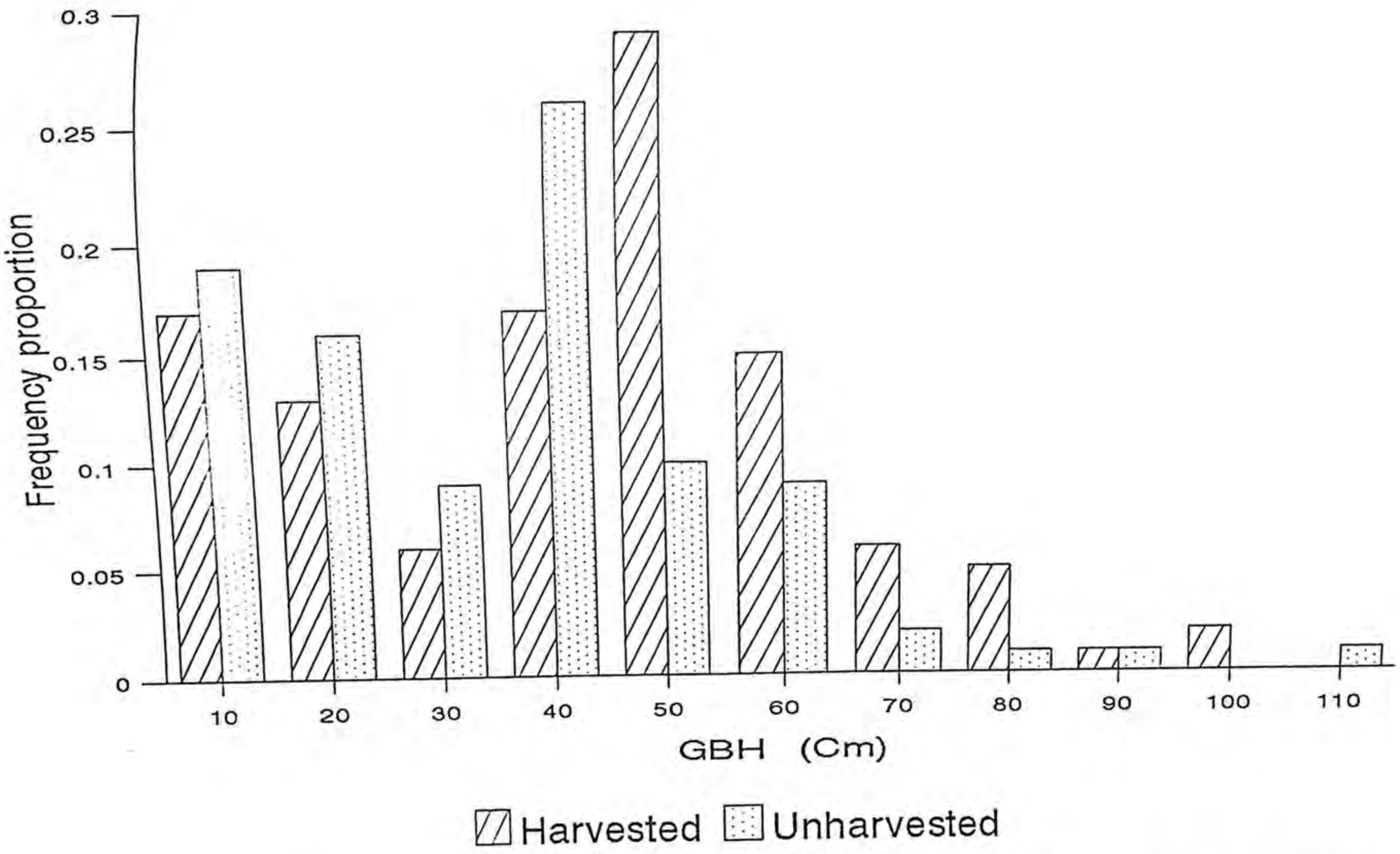


Fig. 4.6: Size class distribution of Bauhinia racemosa at two sites

Table 7 Difference between girth class distribution of individuals of selected NTFP and TFP species at Site 1 and Site 2 (excluding sapling class), documented between Nov.'96 to May '97. (K.S Test (Two Independent Samples) α=0.05) .

Species	P Values	K-S Z	Number of trees (n1 and n2 in Site 1 & 2
Tectona grandis	<0.0001	5.161	n_1=1084 n_2=759
Chloroxylon Swietenia	<0.0001	3.453	n_1=262 n_2=313
Bauhinia racemosa	<0.0001	2.551	n_1=166 n_2=94
Emblica officinalis	>0.0001	5.469	n_1=266 n_2=410
Madhuca indica	>0.0001	5.645	n_1=344 n_2=490
Buchanania lanzan	>0.0001	7.7908	n_1=225 n_2=456

By doing Chi- Square test of proportions, a significant difference was seen in the proportion of saplings of NTFP species between the two sites. But for TFP species the difference was not significant (Table 8) between the two sites. Thus the result showed that the proportion of saplings for selected NTFPs was higher in site 2 i.e showing good regeneration (Fig. 4.1- 4.6). In case of selected TFPs proportion of saplings is the same in both the sites.

Table 8 Comparison of proportion of saplings in Site 1 and Site 2, using Chi Sq. test of Proportion, documented between Nov.'96 to May '97.

Species	Z value at α=.05	P value	Number of plots (n1 and n2 in site 1 & 2)
Tectona grandis	1.936	>0.05	n1=216 n2=111
Chloroxylon swietenia	1.534	>0.05	n1=73 n2=80
Bauhinia racemosa	1.647	>0.05	n1=65 n2=61
Buchanania lanzan	2.680	<0.05	n1=26 n2=80
Emblica officinalis	4.249	<0.05	n1=42 n2=85
Madhuca indica	-4.28	<0.05	n1=68 n2=92

4.4 Production and Extraction

Production and extraction data shows that production (fruits or flowers) per tree is higher for larger GBH class i.e GBH is positively correlated with production of flowers and fruits (Table 9). In case of Mahua flowers, production per tree is equal to the amount extracted. Thus, for Mahua flowers production and extraction figures are the same.

Table 9 Fruit (*Emblica officinalis* & *Buchanania lanzan*) and flower (*Madhuca indica)* production of selected NTFP at Site 1, documented between Nov.'96 to May '97 in NBFD.

Species	No. of trees (n)	Average density of tree (ha)	Production per tree* C.I (95%)		prod. per unit area Kg/ha	r^2	P value
			Max (kg)	Min (Kg)			
Emblica officinalis	71	8.67	30.7	0	266.8 max 0 min	0.59	0.00
Buchanania lanzan	46	4.25	15.55	2.557	66.0 max 10.6 min	0.60	0.00
Madhuca indica	107	22.17	202.4	104.99	4478 max 2288 min	0.60	0.00

For *B.lanzan* fruits, maximum extraction was found to be 56.89 kg per ha. while the minimum was 9.13 kg per ha. For *E.officinalis* fruits show extraction per unit area, was 249.72 kg per ha (Table 10).

Table 10 Extraction of fruit (*Emblica officinalis* & *Buchanania lanzan*) and flower (*Madhuca indica*) of selected NTFP at Site 1, documented between Nov.'96 to May '97 in NBFD.

species	Number of trees (n)	Mean off-take or extraction per tree (%)	Extraction per unit area (Kg/ha)
Emblica officinalis	71	93.60	249.72 (Max)
Buchanania lanzan	*46*	86.21	56.89 (Max) 9.13(Min)
Madhuca indica	107	100	4478 max 2288 min

Amla fruit production was less this year, only 28% of sampled trees fruited and fruit extraction was from 65% of these fruiting trees.

4.5 Methods of collection and processing the produce

For extraction of amla fruit, extractors either lops the branches or beat the fruit bearing branches with long sticks and then the fallen fruits are collected from the forest floor. Table 12, shows the damage done to the trees while extraction, it also shows that 65% of trees are harvested by beating the branches i.e without any major physical injury to the tree individuals.

Fruits of *Buchanania lanzan* are extracted largely by lopping the fruiting branches or plucking. Cases of felling trees was also observed during the study (Table 11). Fruits are extracted when they are unripe (Plate 7 & 8).
Fallen Mahua flowers are collected by picking them from the ground which is cleared of litter either by burning or by sweeping to facilitate collection and carried by the collectors on their heads, in a basket (Plate 11).

The processing of Amla fruits involves boiling of fresh fruits and removal of seeds from the pulp (Plate 6). The pulp is then dried in the sun for at least a week . Mean average weight of dry pulp was found to be 25% (SD± 0.03) of its fresh weight.

Mahua flowers are also dried in the sun before they are ready for use. The mean average weight of dried mahua flowers was found to be 0.425 ± SD 0.040, i.e 45% of the fresh weight.

Fresh fruits of B.lanzan are first pounded to remove the pulp and then the seeds are dried in the sun. Weight loss by fruits in this case was not quantified as the study period was over by that time.

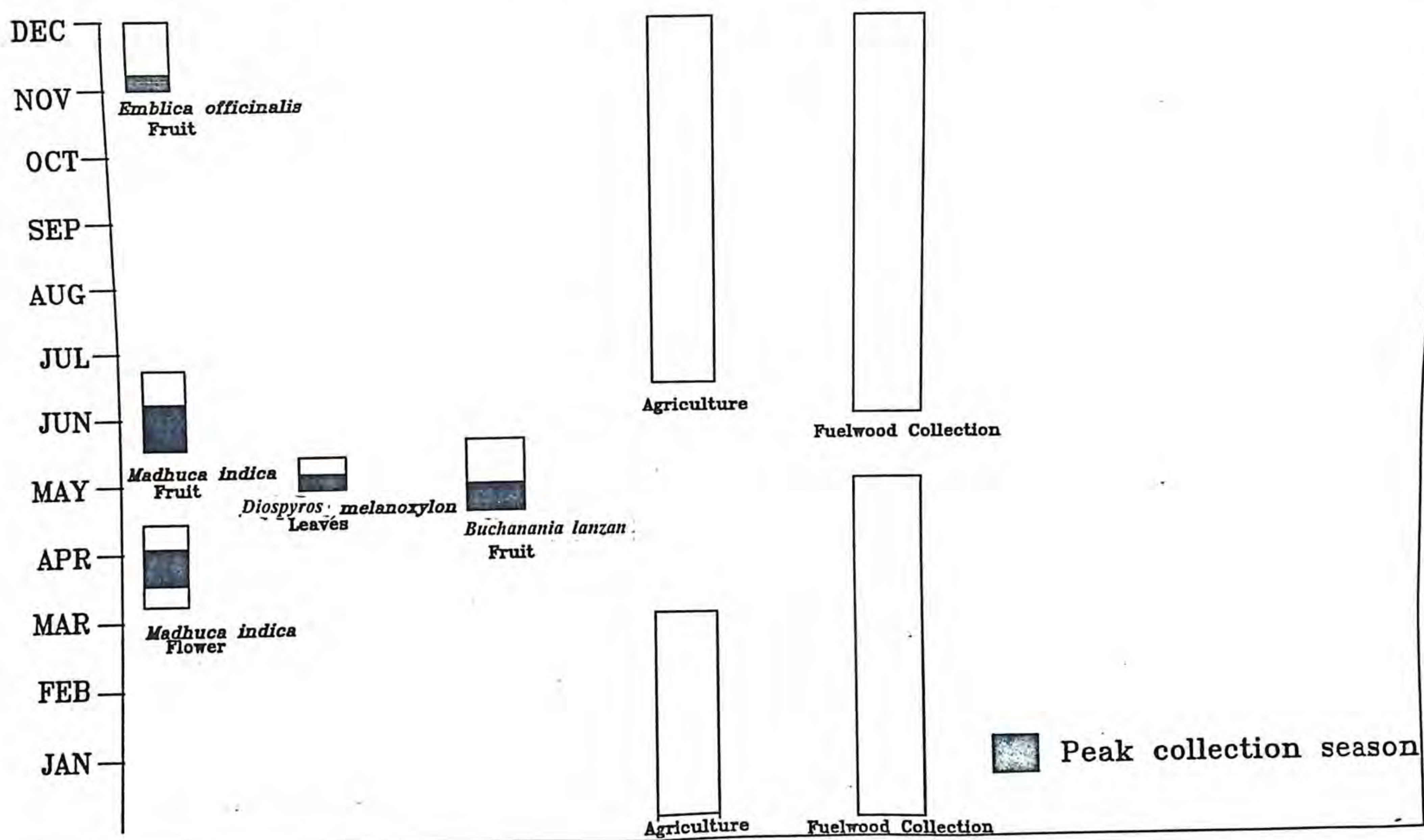
Gulli, fallen fruits of Mahua are picked up from the ground and the kernels are removed from the smooth chestnut coloured pericarp. Then these kernels have economic value (information gathered by interviewing the villagers). The interviews also revealed the following pattern of activity in different months of the year (Fig.4.7).

1. Agricultural activities is from the month of June to mid March.
2. NTFP collection mainly starts from the month of March, and lasts till the month of May. The fuel wood collection is throughout the year except for rainy season.

Table 11 Damage to NTFP tree species during extraction at Site 1 (NDBF), documented between Nov.'96 to May '97.

SPECIES	LOPPED	FELLED	NO DAMAGE
Emblica officinalis	31.7%	2.4%	65.8%
Buchanania lanzan	53.3%	13%	33.3%
Madhuca indica	nil	nil	nil

Figure 4.7 : Seasonal activity calendar



4.6 Results of Socio-economic survey

NTFPs form 34.9% of total mean annual income when both communities i.e tribals and *Goalies*, were taken together (Table 12).

Mann Whitney U test showed that there is no significant difference in the annual income of two communities (Z= 1.75, P=0.08, n1=12 n2=49, at α=0.05).

Table 12 Proportion of income generated by NTFP to the total mean annual income across all communities in Site 1 (NDBF), documented between Nov.'96 to May'97.

Total Mean Annual Income (Rs)	Total Mean NTFPs Income (Rs)	% Of NTFP Income To Mean Tot.Income
4960.65 ± 2935.2	1736.62 ± 896.40	34.9

The income generated by the NTFPs showed significant differences across two communities (Mann Whitney U test, Z= 2.11, P=0.035, n1=12 n2=49 at α=0.05). *Goalies* fetch higher income from the NTFPs than the "tribals". NTFP contributes 44.25% of total income in case of Goalies and 23.5% of total income of tribals. Among NTFPs maximum contribution to the total income is from Tendu leaves, then Mahua flowers, least is from Gulli (Table 13).

Table 13: Proportion of income generated by different NTFPs in two communities in Site 1 (NBFD), documented between Nov.'96 to May '97.

NTFP source of income	Income of *Goalies* (%)	Income of Tribals (%)
Achar (*B.lanzan)*	4.9	7.7
Amla (*E.officinalis*)	5.5	19.0
Mahua flower (*M.indica)*	44.1	26.3
Tendu (*D. melanoxylon*) leaves	42.61	45.8
Gulli (Mahua fruits)	2.1	1.2

The Spearman rank correlation showed that there is a positive correlation between perception of people towards the source of income and income generated by that particular source (r_s=0.61 P=0.92 n=8). But when mean of the ranks given by the people to different sources of income was compared with mean annual income generated by that particular sources showed that there was a difference in perception and annual income generation (Table 14). As shown in table 14 agriculture is ranked highest by the people but it is only the third highest source of income.

Table 14: Perception and mean income from various sources for respondents in Site1, documented between Nov '96 May '97.

*SOURCES OF INCOME	MEAN PERCEPTION	RANK PERCEPTION	MEAN INCOME (Rs)	RANK INCOME
1	8.0	8	846	6
2	5.45	6	1088.52	7
3	2.21	2	39.39	1
4	4.35	4	1288.52	8
5	3.46	3	95.27	2
6	1.82	1	283.54	3
7	4.50	5	537.13	4
8	6.22	7	781.27	5

*1=Agriculture *2= Labour *3=Gulli *4=Others (animal husbandary, going out as labourer) *5=*B.lanzan* *6=*E.officinalis* *7=M.indica flowers *8=*D.melanoxylon* leaves.

5 DISCUSSION

The structure and composition of an ecosystem depends on its ecological and management history, as well as its current usage pattern. Populations in a dynamic and complex ecosystem are interlinked, such that the removal of any given product from a forest could upset delicate natural equations, which would then pass on throughout the ecosystem (Gilbert 1980; Terborgh 1988). Therefore, extraction of fruits, which are the sources of potential propagules (seeds), is likely to impact the population structure of the extracted species.

NTFPs have been exploited for centuries in NBFD (Site 1) by indigenous people. Timber harvest has also been a regular feature of this area since 1862. Satpura NP, which was the unharvested Site (Site 2), was not under current biotic pressure, but prior to its declaration as a National Park in 1981, the area was subject to similar activities of commercial logging, grazing and NTFP collection.

5.1 Findings On Selected NTFPs, Their Population Structure, Production and Extraction methods:

5.1.1 Density and disturbance index

Significant differences in tree densities at both sites could be explained by differences in microclimate, edaphic factors, pest attack and the history of fire in the area. But results of this study clearly indicates that biotic interferences in Site 1 have played an important role in lowering tree density in the area. Marked differences in values of disturbance index (Table 4), i.e., number of cut, lopped and dead trees, amply indicates that due to current usage pattern there were more damaged trees in the harvested site. Dung evidence also confirms grazing pressure at Site 1. Thus, in the present case, grazing pressure and high tree mortality may be responsible for low tree density at Site 1. Findings of Murali *et al.* (1996) confirm that disturbed sites have more damaged trees than less disturbed ones.

5.1.2 Population Structure

A forest system which has a higher proportion of individuals in the recruitment class, points to the potential of the area, for sustaining more trees in the future. An age/size distribution which decays nearly exponentially reflects a population with many more juveniles than adults, and may be assumed to be self-replacing and in stable density (Hall and Bawa, 1993). Comparisons of size class distributions of the selected NTFP and TFP species, across the two sites, shows a significant difference in the population structure. As stated in the results, the difference can not be attributed to the sapling class alone. Proportion of saplings for NTFP tree species was found to be very high at Site 2 as compared to Site 1, but for TFP species it was the same. Fig. 4.1 to 4.6 however, clearly shows that there were more saplings of all tree species in Site 2 than in the harvested one. Overall, there was better regeneration at Site 2.

For *T. grandis*, *C. swietenia* and *Bauhinia racemosa*, plant parts other than seeds/fruits were harvested, and these species had good regeneration at the disturbed Site 1. On the other hand, species exploited for NTFP, mainly fruits, showed poor recruitment at the disturbed Site 1. Thus, it is evident that the harvest of seeds and fruits, which form the seed bank for future trees, affect the population of harvested tree species. Poor recruitment of NTFP species could be the outcome of fire, grazing or compaction of soil, but these factors were also operating on the

TFP species. Another argument could be that TFP species might have adapted themselves to the disturbed conditions for a longer period. For example *Bauhinia* sp. can withstand heavy lopping (Deb Roy *et al.*, 1980). Teak regeneration could be high due to thinning and tending operations carried by the Forest Department to increase timber yield, but these factors do not explain the good regeneration of these species in the unharvested site which is free from anthropogenic pressure. This explanation should also hold true for NTFP species which have been exploited for decades. Seeds of all selected NTFP species and *B.racemosa* (TFP) are dispersed by animals. Species, *viz. T.grandis* seeds fall on the ground and are dispersed by wind or water (*pers comm* V.B Sawarkar) and *C.sweitenia* is largely wind dispersed (*pers. comm.* Dr. G.S. Rawat). According to Janzen (1971), 99% of the crop can be lost to pre- and post-dispersal seed predators. The low recruitment of younger age classes of NTFPs at Site 1 may be due to seed dispersers acting as seed predators. But again, at Site 2, the presence of seed predators should be higher, as it is a protected area but still there is good recruitment.

Low regeneration at the harvested site may have been due to a fewer number of dispersers. However, observations made in the field site do not support this possibility.

Results showed that distribution of girth size classes of the same tree species at two sites were different. This difference in the girth size class distribution is not only due to the sapling class, as was the case in the study conducted by Murali *et al.* 1996, but the differences persisted even after the sapling data was excluded from the comparison. Differences in the population structure distribution of the same species in two sites could be attributed to many factors, like past forest management history of the area and biotic factors *viz.* fire, cattle grazing, etc.

One reason for the differential distribution of size classes could be that there were more trees with higher girth at the harvested Site (Fig.4.1 to 4.6b) especially in the case of *Madhuca indica* (fig 4.3a and 4.3b). Some parts of the Site 2 included areas where clear-felling was carried out 27 years ago. Thus, higher age classes were lesser in Site 2. On the other hand older Mahua trees with higher girth class are being protected in the crop fields, which form part of the broad valley stratum of Site 1.

Although the proportion of saplings was more in the Site 2 (Fig.4.1 to 4.3), the size class distribution is not showing ideal reverse J-shaped curve. This indicates that forests have not yet fully recovered, but with the control of anthropogenic pressure in the recent past, recruitment is definitely better . In the Site 1, girth size-class distribution was not exactly reverse J-shaped. It shows a sudden dip in certain size classes for example, size class of 20 to 30 cm shows dip in the frequency of *B.lanzan*, *C. sweitenia*, and *T.grandis* and size class of 60 to 70 cm shows a dip in case of *M.indica*. The sudden decrease in the frequency of these size classes may be due to natural pest attack, drought, or manmade (selective felling, fire) factors that might have occurred in the past .

5.1.3 Methods of extraction, production, and extraction level

Production and extraction were estimated on the basis of data collected during the study period. Amla production this year was poor compared to previous years. Data shows 93.6% of fruits per tree were collected while only 63% of fruiting trees were harvested. It is speculated that fruit extraction per tree was higher due to lower fruit production, as collectors might have collected more to maximise the effort of collection. It was also observed that 37% trees that were left unharvested had very little fruit. In *E.officinalis* on an average 83.6% of production per tree was harvested. To examine whether such levels of collection interfere with regeneration is beyond the scope of this short study.

It was observed that the density of the recruitment class at Site 1 for 'Amla' and 'Achar' was almost negligible. A seed before germination has to pass through several stages during which it is susceptible to predation and to natural mortality. Apart from all these natural factors, man-induced pressures like extraction of seeds, can push seed banks below the threshold level required to maintain the population. So even the above mentioned high level of harvest taking place in the study area can cause low levels of regeneration. This fact is also supported by the findings of Uma Shaankar *et al.* (1996) in their study done in the Biligiri Rangan hills.

Extractive activities are most likely to be unsustainable if they result in killing and damaging the target species (Salfasky, 1992). 'Amla' and 'Achar' trees were both felled and lopped at Site 1 during collection (Table 12 & Plate 5). The practice of felling trees would spell disaster not only in terms of regeneration of that species, but also in terms of irreplaceable loss of future income source for the native population. Panwar and Mishra (1994), based on their study on fodder trees in Rajaji N.P indicate that trees which are lopped, cease to flower and show total absence of regeneration. Lopping results in sap loss, attracts insect attacks, and ultimately results in plant mortality (Khati,1994).

Though the local people seem to be aware of the adverse consequences of their faulty practices, yet it continues due to several reasons. The season of amla harvest coincides with the period of agricultural activities, during which the people are hard-pressed for time. Thus, in order to gain maximum yield of amla in the least possible time, they tend to opt for the easiest means of fruit harvest, i.e., by lopping/felling which requires less time and is also less labour intensive when compared to climbing the tree and plucking/beating. Achar is very valuable commercially, and is harvested when the fruit is still unripe, as ripe fruits are eaten by animals. The unripe fruit is difficult to harvest by the alternative methods of beating/plucking, and hence felling is the easier option for the people who aim to maximise their harvest.

5.2 Socio-economics

Collectors of NTFP belong to several social groups of different hierarchy. The two main classes are the *Goalies* (the socially upper class) and the tribals (the socially lower class). *Goalies* did not involve themselves much in collection of Amla and Achar as the act of climbing trees in order to obtain fruits was deemed below their status. Another reason for their non-participation of collecting Amla was that the collection season of this two NTFP species coincides with the period of agricultural activities and so these people being primarily pastoralists, were more occupied with preventing their cattle from straying into others' crop fields.

Results clearly show that the annual income of both the tribal and *Goalies* are approximately the same (Table 12), i.e. ca. Rs.5000/-, which is about 38% lesser than the income of Soligas tribals (Hegde *et al.* 1996) in Biligiri Rangan hills and tribals in the state of West Bengal (Malhotra *et al.* 1991).

Overall, including both communities 34.9% of income was generated from NTFPs which was 60% to 48% and 22% in the study conducted by Hegde *et al* (1996) and Malhotra *et al* (1991) respectively. The *Goalies* derive 44% of their income from NTFPs, while NTFP forms 23.5% of the income of the tribals.

Mahua flowers alone contribute 44.17% of the total income from NTFPs for Goalies. The opportunity cost for collection of common species should be less than those of uncommon species (Godoy and Bawa 1993). So Mahua being a common species and present close at hand, demands less physical labour for its harvest, and therefore is expected to be harvested more intensively. Secondly, by the start of the Mahua season, agricultural activities are already over, and so there is 100% involvement in Mahua collection.

Although the situation is the same for the tribals too, Mahua contributes only 26.3 percent of the total income generated by the NTFPs. Tribals in contrast to "Goalies" use the collected Mahua to distil liquor which they use largely for their own consumption, due to which they may fetch less income from the Mahua flower.

The leaves of tendu (*Diospyros melanoxylon)* are collected and used to wrap tobacco to produce bidis. They contribute 42.61% of the total income generated by NTFPs for the "Goalies", and 45.8% for the tribal communities. The native population is more involved in the collection of tendu leaves because of following reasons:

1. During the collection period there are no other income generating activities.
2. Density of Tendu is very high in this area. So opportunity cost of collection is comparatively less.
3. It doesn't involve processing.

4. The payment for the product is made instantly and rates are fixed by the state Government. There is no investment for transportation of the product as collection centres ("*Phadi*") are set up at every village.

In case of tribals, *Amla* and *Achar* form 19.0% and 7.7% of total income produced by the NTFPs respectively, which is very less in the case of *Goalies* (Table 13).

Several discrepancies were recorded between the income generated by, and the preference value given to, the different sources of income (Table 14). Hegde *et al* 1996, have also detected similar trends in Biligiri Rangan hills. Though it may be expected that preference for activities would be graded according to economic returns, this was often not seen to be the case. The greatest difference was seen for the category "other", which included daily-wage labour (outside the village) and animal husbandry. Though this activity scored the highest in terms of economic gain, it was low on the list of preference scores. This was due to the fact that the local people did not prefer going out of the village to work, and would opt for other occupation types, closer home. Also, cattle rearing involved a lot of investment by the people, in terms of fodder, and did not fetch as much in return, especially as the breed of cattle reared in Central India is poor in terms of milk-yield. Agriculture was a much preferred activity, the perception index (Table 14) shows that even though agriculture did not generate as much income as other resources still it is preferred by the people; it is the subsistence farming that leads to such sub-optimal prioritisation. It provides the families the security of a source of food all the year round. Amla collection scored lower on the preference list than its score for income generated, because harvest of this fruit is very labour intensive, and not in proportion with the economic returns it fetches. Collection of tendu leaves was a preferred activity, as the product was easily available, it fetched instant monetary returns, and did not involve the need for processing, unlike amla. Achar collection was preferred as an occupation even though it did not translate into high economic benefits, because during the season of its collection, people were not involved in any other activity, and were thus free to devote their time to the collection of this fruit. Gulli (the fruit of mahua), was collected mainly for subsistence, and did not serve as a product of commerce. However, the people confirmed that in past years, when its availability/production was higher, the surplus crop used to be sold. Due to lower production in recent years, this was no longer the case, and this activity scored low both on the scale of preference as well as that of income generated.

CONCLUSION:

The results of this study clearly indicate that the extraction of NTFPs has a detrimental affect on the plant community in the area. Densities of adult trees, and as well those of the recruitment class (i.e., saplings), were lower in the sites of extraction when compared with those in the undisturbed site. The disturbance index was also higher in Site 1 than in Site 2.

The collection of NTFPs has serious repercussions for both humans and for the survival of the species they exploit. Though the proximate outcome of this activity translates into direct economic gain for the people involved in it, the ultimate consequences would benefit neither man nor his environment. This situation is obvious to the people concerned with the activity, but they still persist in doing it, for lack of better alternatives. For them it is not a question of what is better or worse, but quite simply, what is available for their livelihood. Given a chance of an alternative means to a livelihood, most would be willing to take it. Interviews with people revealed that the collection of NTFPs was not a preferred activity, because it is labour intensive, and seasonal, thus not assuring the people of a steady source of income all the year round. However, their present circumstances compel them to eke out a livelihood from whatever means available to them, and the forest is the easiest alternative. It is difficult, in such an instance, to pass judgement on the nature of this activity. The adverse effects it would have on the survival and reproduction/regeneration of the harvested species would ultimately, adversely affect the people, who would have less to harvest each year. For the people, however, it is a question of their survival, as much as it is a question of the survival of the exploited species.

In India, the problem of biotic pressures on natural areas is not an uncommon one. The collection of non-timber forest products from protected areas is a problem faced in most PAs in the country. The results of this study present a picture which is difficult to interpret. As is always the case where humans are concerned, answers to the problem are never easy. Activities such as the collection of NTFPs, impose a pressure that our protected areas can ill-afford. However, it is important that the management authorities handle the issue sensitively, keeping in mind the needs and compulsions of the people, when suggesting remedies to the problem.

Plate 1 Hilly undulating stratum (Teak mixed forest) harvested site

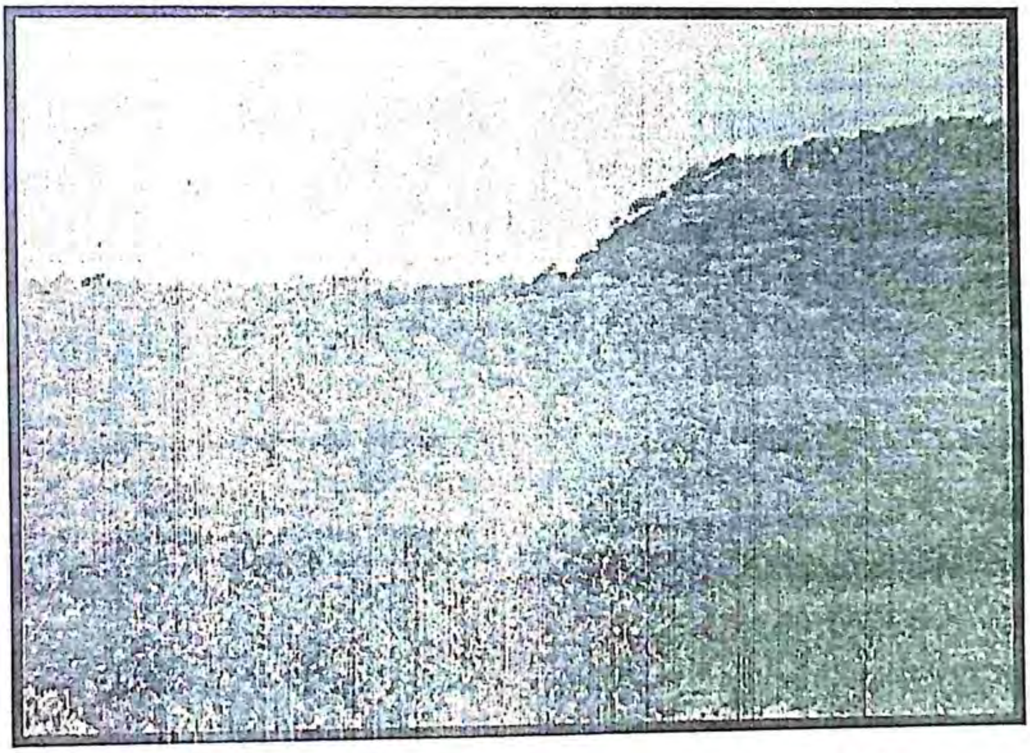


Plate 2 Hill stratum (Mixed forest) harvested site

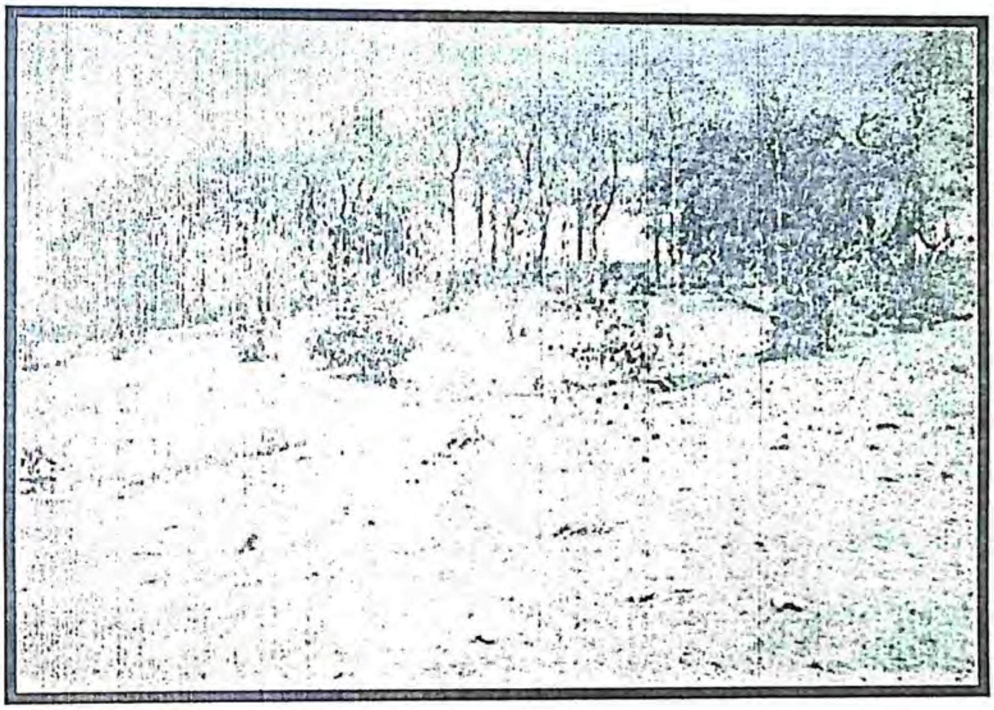


Plate 3 Broad valley (Modified land) at harvested site

Plate 4 *Emblica officinalis* (Amla) fruits

Plate 5 Stumps of *Emblica officinalis* (Amla)

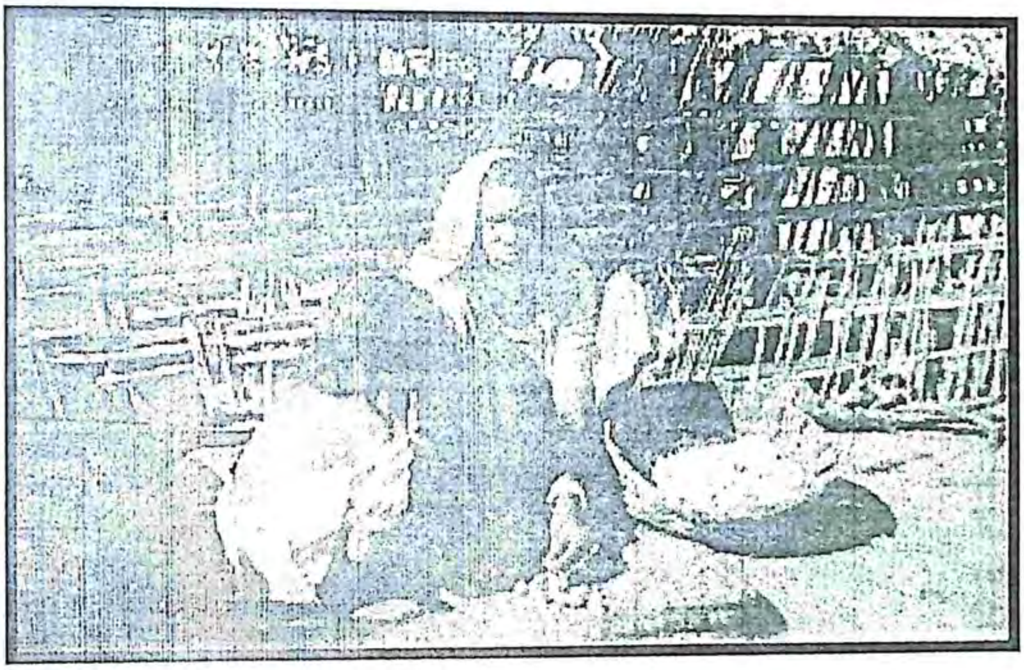


Plate 6 Pulping of boiled Amla fruits

Plate 7 Fruits of *Buchanania lanzan* (Achar)

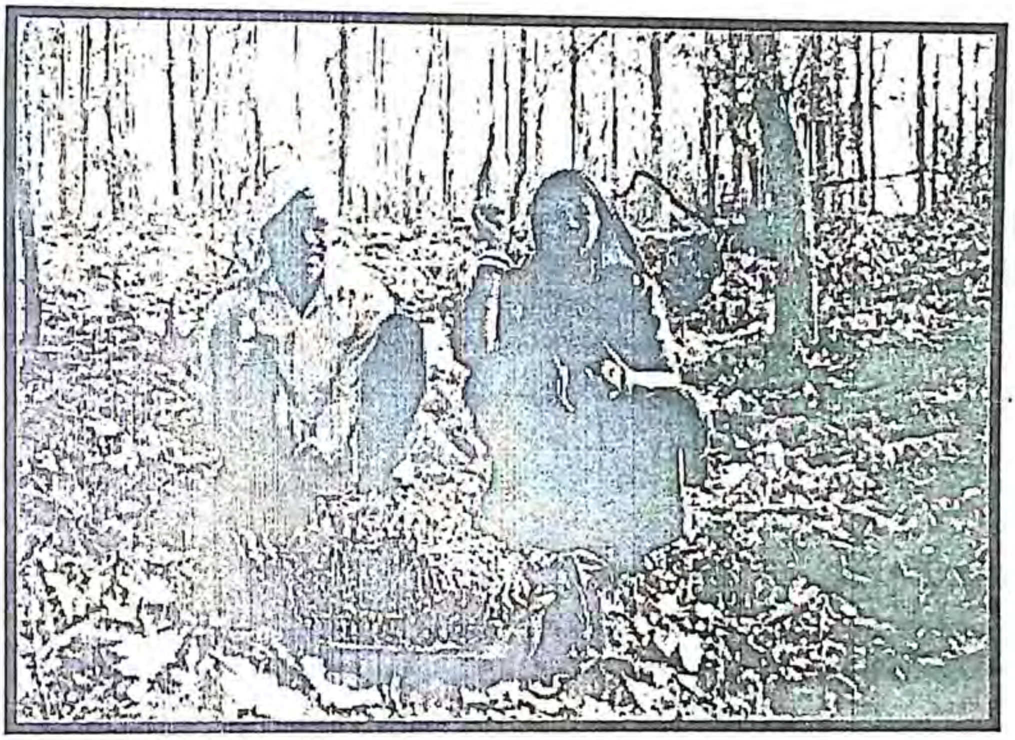


Plate 8 Collectors (Korku tribe) of *Buchanania lanzan* fruits

Plate 9 *Madhuca indica* (Mahua) tree

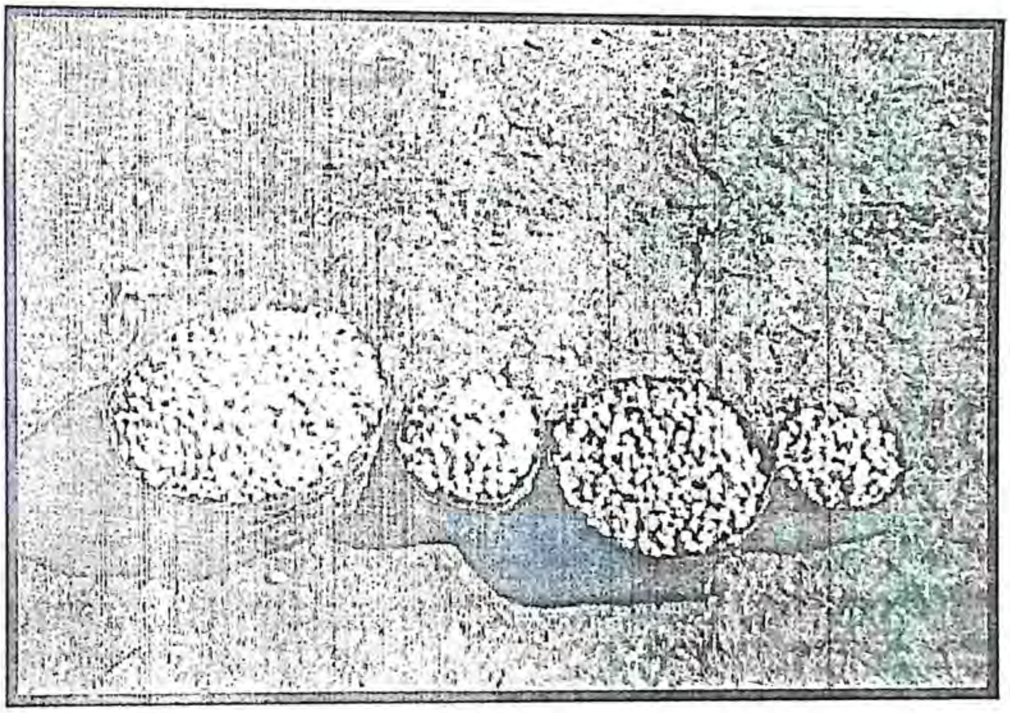


Plate 10 *Madhuca indica* (Mahua) flowers

Plate 11 Collectors of Mahua flowers

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