NONTIMBER FOREST PRODUCT EXTRACTION, UTILIZATION AND VALUATION: A CASE STUDY FROM THE NILGIRI BIOSPHERE RESERVE, SOUTHERN INDIA[1]

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Narendran, Kodandapani, Indu K Murthy, H. S. Suresh, H. S. Dattaraja, N. H. Ravindranath, and R. Sukumar *(Centre for Ecological Sciences, Indian Institute of Science, Bangalore 560 012, India).* NONTIMBER FOREST PRODUCT EXTRACTION, UTILIZATION AND VALUATION: A CASE STUDY FROM THE NILGIRI BIOSPHERE RESERVE, SOUTHERN INDIA. *Economic Botany 55(4): 528–538. 2001. We evaluated the diversity, social, and economic aspects of nontimber forest product (NTFP) collection in the Nilgiri Biosphere Reserve (NBR), in southern India. The NBR is a region known for its floral and faunal diversity, as well as an area with increasing human pressure. Fifty to 75% of the households (HH) in rural areas gather a diversity of forest products. Dominant NTFPs contributed 25–60% of the average annual per capita household income from NTFPs. The mean annual per capita household income from NTFPs ranges between Rs. 134 and Rs. 4955. The mean annual income per hectare ranges from Rs. 93 in the montane zone to Rs. 3780 in the moist deciduous. NTFPs contribute 15–50% of the annual per capita income of rural households. Ethnicity plays an important role in the collection of NTFPs and ethnic tribes derive a large proportion of their annual per capita income from NTFPs.*

Key Words: forests; incomes; nontimber forest products (NTFPs); diversity; social; indigenous; communities; extraction; Nilgiri Biosphere Reserve (NBR).

Southern Asia has a long history of human use of forest products (Bawa and Godoy 1993). In India, for example, an estimated 50 million people live in and along the periphery of forests. A large number of these people rely upon nontimber forest products (NTFPs) for their subsistence and cash income (NCHSE 1987). As implicit in the term, NTFPs include all biological materials, except timber, extracted for human use. Some have even used the term to encompass service functions rendered by forestlands. The products include fuel wood, charcoal, honey, resin, spices, and raw materials for handicrafts from rattan, vines, bamboo, grasses, and wildlife products such as bones and skins for rituals and ornamental purposes. Service functions include grazing, watershed protection, provision and management of wildlife habitats, and tourism.

In recent years the collection of NTFPs is being increasingly driven by commercial demands from a much wider market. There has been much debate on the sustainability of this extraction for the long-term ecological integrity of forests. Sustainable harvest could be defined as the level of harvest that does not impair the ability of the harvested population to replace itself (Hall and Bawa 1993). Sustainable harvest of renewable natural resources such as NTFPs can, in principle, contribute to the economic well-being of the forest people and involve them in conservation of biodiversity (Uma Shankar et al. 1996). Decisions on whether or not to permit NTFP extraction would depend on a variety of considerations, including its importance to the local economy, possibility of alternative sources of income to the people, ecological impacts of NTFP extractions, and legal status of the forests (protected areas versus other categories).

As a first step towards understanding the above issues in the NBR, we have documented the following aspects of NTFP extraction: (1) the diversity of products extracted from the different forest types, (2) dependence by rural and indigenous communities on forests, (3) house-

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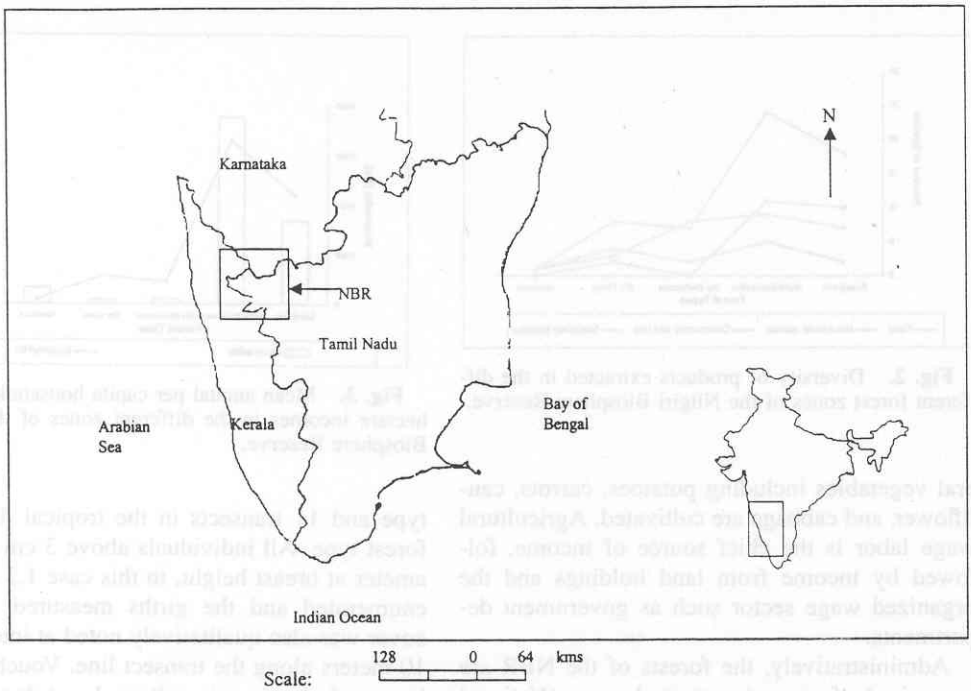


Fig. 1. Map showing the location of the Nilgiri Biosphere Reserve.

hold incomes accruing to these communities from NTFP extractions, and (4) amount of extractions of NTFPs and their financial values.

Material and Methods

Study Area and Features

The study was carried out in the Nilgiri Biosphere Reserve (NBR) spread over the states of Karnataka, Kerala, and Tamilnadu in southern India (Fig. 1). The geographical forested area of the reserve is 5520 km² (Sukumar et al. 1992). The topographical diversity of the NBR gives rise to much spatial variation in climate (von Lengerke 1977). The mean annual temperature varies with the altitude: about 26°C below 500 m, around 23°C in the 500–1000 m range, and below 20°C at higher altitudes. The western part of the biosphere receives over 3000 mm rainfall annually, and the sheltered Moyar valley in the east as little as 500 mm. There is thus a distinct west-east climatic gradient, which gives rise to a diversity of vegetation types.

The NBR supports all the major vegetation types of peninsular India (Champion and Seth 1968). These include tropical evergreen and semi-evergreen forest, tropical moist deciduous forest, tropical dry deciduous forest and tropical dry thorn forest. At higher altitudes (>1800 m) there is a characteristic association of two vegetation types namely, patches of tropical montane stunted evergreen forest (locally called *shola*) in the valleys and folds of the hills and extensive grassland on the hill slopes. More detailed descriptions of the vegetation are available elsewhere (Nair et al. 1977; Ravindranath, Sukumar, and Deshingkar 1997; Sukumar et al. 1992; von Lengerke and Blasco 1989).

The NBR is home to a diversity of peoples and cultures. There are several indigenous communities living in many parts of the reserve, including the Kurumbas, Irulas, Todas, Kothas, Paniyas, and Cholanayakas. The Todas are pastoralists; the Kurumbas, Irulas, Paniyas, and other tribes are hunters and food-gatherers (see papers in Hockings 1989, 1997). The land-use pattern changes with altitude from the plains of Coimbatore to the Upper Nilgiri plateau. The dominant crops cultivated in the different vegetation zones vary. In the tropical evergreen and tropical moist deciduous forest zones, paddy, banana, coffee, and tea dominate the landscape. In the tropical dry deciduous and tropical dry thorn forest zones, millets are the main cultivated crops. In the tropical montane zone, tea and sev-

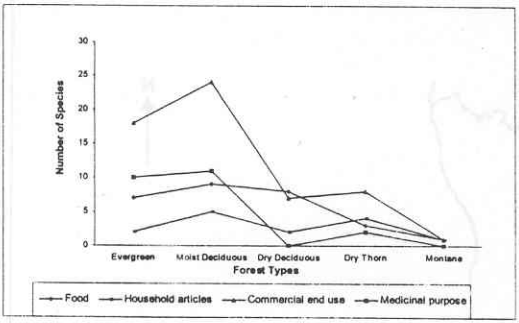


Fig. 2. Diversity of products extracted in the different forest zones of the Nilgiri Biosphere Reserve.

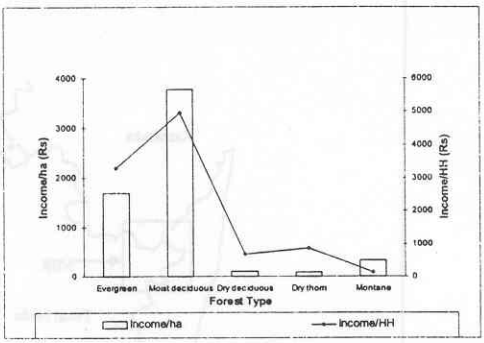


Fig. 3. Mean annual per capita household and per hectare incomes in the different zones of the Nilgiri Biosphere Reserve.

eral vegetables including potatoes, carrots, cauliflower, and cabbage are cultivated. Agricultural wage labor is the chief source of income, followed by income from land holdings and the organized wage sector such as government departments.

Administratively, the forests of the NBR are comprised of several protected areas (National Parks and Wildlife Sanctuaries) under the management of the wildlife wing of the state forest departments, territorial forest divisions under the control of the state forest departments as well as smaller areas of privately owned forests.

Vegetation Sampling

Belt transects of 0.1 ha were used to estimate plant diversity. Transects (250 meters × 4 meters) were randomly laid in strips of five units. Such transects were laid in all the different vegetation types of the NBR. Eight transects were laid in the tropical evergreen forest type, 12 transects each in the tropical moist deciduous and tropical montane/grassland forest types, 13 transects in the tropical dry deciduous forest type and 11 transects in the tropical dry thorn forest type. All individuals above 3 cm dbh (diameter at breast height, in this case 1.3 m) were enumerated and the girths measured. Canopy cover was also qualitatively noted at intervals of 10 meters along the transect line. Voucher specimens of plants were collected and deposited in the herbarium of the Centre for Ecological Sciences, Indian Institute of Science.

Sampling Methods of Village Households

Twenty-seven villages were randomly sampled from the five different vegetation zones: tropical evergreen forest, tropical moist deciduous forest, tropical dry deciduous forest, tropical dry thorn forest, and tropical montane forest/grassland. The number of villages sampled in each vegetation type depended on the size of the villages (thus only three villages were sampled in the dry deciduous zone and four villages in the dry thorn zone). The goal was to sample at least 100 households in each vegetation zone.

TABLE 1. NUMBER OF VILLAGES AND HOUSEHOLDS SAMPLED IN THE DIFFERENT FOREST TYPES IN THE NILGIRI BIOSPHERE RESERVE.

Forest type	No. of villages sampled	Total no. of households	No. of sample households			
			LL	SF	Others	Total
Dry deciduous	3	379	46	33	27	106
Moist deciduous	8	199	45	5	45	95
Dry thorn	4	453	91	32	22	145
Evergreen	6	106	20	2	20	42
Montane	6	307	19	24	49	92
Total	27	1444	221	96	163	480

TABLE 2. WOODY PLANT RICHNESS (0.1 HA) AND DIVERSITY FOR DIFFERENT FOREST TYPES IN THE NILGIRI BIOSPHERE RESERVE.

Vegetation type	No. of species Mean ± SD	Diversity index (H')
Evergreen forest	38 ± 7.9	3.10 ± 0.4
Moist deciduous forest	18 ± 6.6	2.45 ± 0.3
Dry deciduous forest	15 ± 5.3	2.11 ± 0.4
Dry thorn forest	14 ± 3.3	2.29 ± 0.3
Montane forest/grassland	31 ± 8.9	2.85 ± 0.3

The survey was carried out in two phases. During the first phase a questionnaire survey was carried out to assess the socioeconomic status of the households. The questionnaire included details on the family size, occupation, land holding, and livestock holding.

In the second phase, a detailed survey on the extraction of NTFPs was carried out. From the sampled households in the preliminary survey, 25% of the households drawn from the different occupational classes (the landless, the small farmers and others) were revisited for detailed study (Table 1). The NTFP survey provided information on the percentage of people involved in NTFP collection, the different NTFPs extracted, the time spent on gathering these products, the quantities extracted as well as the quantities consumed at home and those that were marketed. Estimates of the quantities and value of NTFPs extracted per hectare and at forest zone level were made. The per capita values obtained from the sample household surveys were projected to the rural population in each forest zone considering the total number of rural households. Further, the total quantity of NTFPs extracted and financial values estimated for each forest zone were divided by the total area under the respective forest types to obtain per hectare values. The limitations of extrapolation from sample survey to the whole forest zone have to be kept in mind while drawing inferences from the findings. The main purpose of obtaining forest zone level aggregate estimates of quantities and financial values is to assess the current aggregate value of forest products extracted and, in turn, the dependence of rural and indigenous communities on forests. The study was carried out between May 1995 and August 1996.

SEASONALITY AND ACCESS TO NTFPS

Collection of NTFPs takes place round the year. For example *Acacia sinuata* (Willd.) DC is extracted in the month of March, whereas *Emblica officinalis* Gaertner is extracted during the months of October and November. Some products like *Solanum indicum* L. and *Sida rhombifolia* L. are extracted as and when the demand arises. The forest department has evolved certain management practices over the years for the extraction of NTFPs. Although the extraction of certain products is permitted without any controls, e.g., fuel wood and fodder, there is limited access to other products. In the Mudumalai Wildlife Sanctuary, extraction of NTFPs is banned and so are fodder extractions and grazing with the exception of the eastern part of the sanctuary. Similarly in the Bandipur National Park the extraction of NTFPs is legally banned. However, in the Wyanad Wildlife Sanctuary extraction of NTFPs is permitted through the issue of permits. Access to forest products thus differs in the different forest administrative divisions.

RESULTS

VEGETATION OF NBR

Of the total forested area of 5520 km^2, the tropical dry deciduous and tropical dry thorn forest types are predominant, accounting for 29.7% and 38% of the area respectively. The tropical evergreen and tropical moist deciduous forest types account for 10.6% and 16.3% of the areas respectively, and the tropical montane sholas/grasslands account for the remaining 5.2% of the area. Diversity is highest in the tropical wet evergreen forests with an average of 38 species of woody plants (>3 cm dbh) recorded per 0.1 hectare. We do not have specific data for a one-hectare plot in this forest. The second most diverse forest type is the tropical montane shola forest with an average of 31 species per 0.1 ha or 67 species recorded in a single 1-ha plot at Thaishola. These are followed by tropical moist deciduous forest (18 species/0.1 ha; 55 species per hectare), tropical dry thorn forest (14 species/0.1 ha; 33 species/ha) and tropical dry deciduous forest (15 species/0.1 ha; 27 species/ha) (Table 2).

DIVERSITY OF PRODUCTS EXTRACTED

The analysis revealed that the diversity of products extracted differs from one forest zone

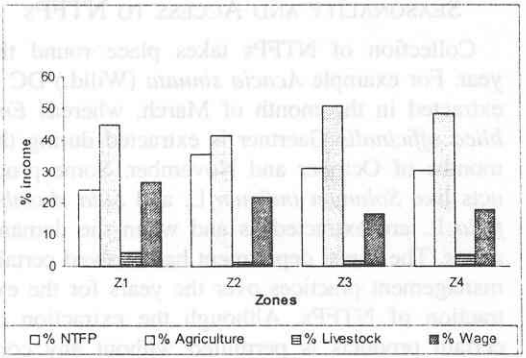


Fig. 4. Contribution of various income sources to the per capita income among non tribals in the Wyanad Wildlife Sanctuary.

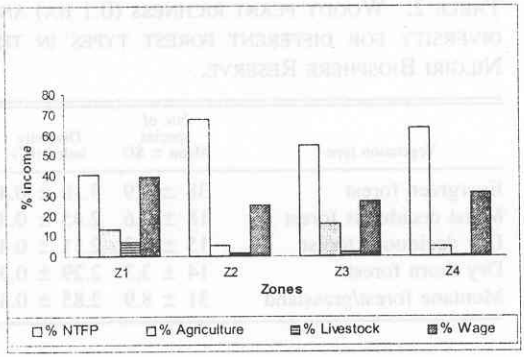


Fig. 5. Contribution of various income sources to the per capita income among tribals in the Wyanad Wildlife Sanctuary.

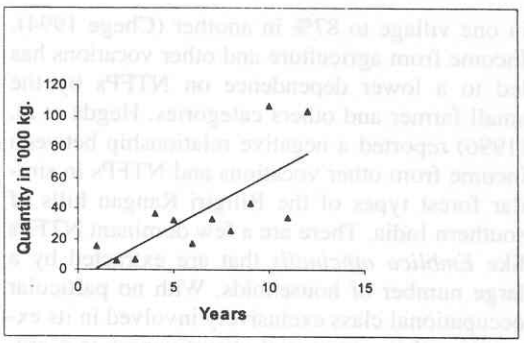
to another. In the moist deciduous forest zone, nine products are utilized for food, five for household articles, 24 for commercial products, and 11 for medicinal purposes (Fig. 2). In the dry thorn and dry deciduous zones combined, 17 products are extracted. In the montane zone three products are extracted of which one is for food, one for household articles, and the third for commercial uses. In the evergreen forest zone a total of 37 products were extracted; many of these products have significant commercial potential. The diversity of products collected depends on the type of forest, the diversity, species abundance, and economic viability of the products being extracted. Apart from the above factors, the indigenous knowledge of the people is an important factor in determining the diversity of products extracted from a given forest type. Appendix 1 gives a list of NTFPs extracted, their common names, the botanical names, the parts used, the end uses and the forest zones in which the NTFPs are extracted.

The tropical moist deciduous and tropical evergreen forest zones seem to be the most significant sources of medicinal plants as compared to other forest zones. Apart from the 21 products used for medicinal purposes, many other small herbs and shrubs are extracted from the forest. However, these products are extracted only at the time of need and not on a commercial basis, hence are not reflected in the results. About 50% of the products, which are listed in the commercial category also, have medicinal value.

Social and Economic Aspects of NTFP Extractions in the NBR

In the tropical evergreen forest zone over 90% of sampled households extract *Acacia sinuata*, *Emblica officinalis*, and *Bambusa arundinacea* (Retz.) Roxb. The dependence on fuel wood is high, with 97% of the people extracting wood from the forest. The households also extract a variety of fruits, greens, and tubers. Households that own agricultural land and livestock extract manure and fodder from the forests but their percentage is relatively low at 15% and 21% respectively. In the tropical moist deciduous forest zone more than 70% of the households interviewed gather *Emblica officinalis*, *Acacia sinuata*, and *Bambusa arundinacea*. Between 50 and 60% of the people are engaged in honey and *Solanum indicum* extractions. In the tropical dry deciduous forest zone, *Emblica officinalis* fruit is the only product gathered by more than 50% of the households, whereas 40% of the households gather honey and fewer people gather *Curcuma aromatica* (Salisb.) and *Phoenix sylvestris* (L.) Roxb. Apart from the abundance of species, the utility, the traditional knowledge, and commercial importance plays a significant role in the extraction of NTFPs. Ethnicity also plays an important role in the extraction of NTFPs. The Jenu Kurumbas are known for their skilled extraction of honey, though they also extract other common products.

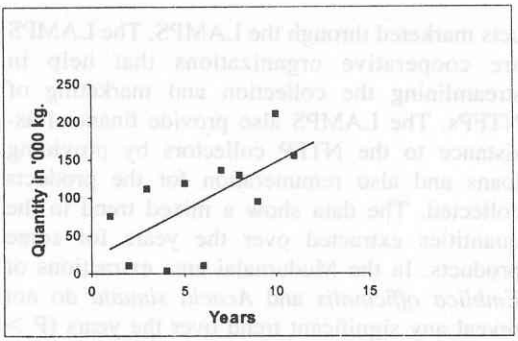
The contribution from NTFPs to the annual per capita household income varies across the different forest zones. The extraction of *Acacia sinuata* and *Emblica officinalis* in the tropical evergreen zone contribute US $21 (Rs. 703) and US $33 (Rs. 1117) respectively. In the tropical moist deciduous zone they contribute US $21 (Rs. 698) and US $41 (Rs. 1396) respectively. A few dominant NTFPs contribute to a large



y=6.7959x - 5.919; R^2 = 0.5458; p < 0.001

Base Year 1986

Fig. 6. Trends in the extraction of *Acacia sinuata* in the Wyanad Wildlife Sanctuary.



y=12.807x + 19.28; R^2 = 0.4128; p < 0.05

Base Year 1986

Fig. 7. Trends in the extraction of *Emblica officinalis* in the Wyanad Wildlife Sanctuary.

portion of the annual household income from NTFPs. *Emblica officinalis* and *Acacia sinuata* contribute 25–50% of the average household income from NTFPs in the tropical evergreen and tropical moist deciduous forest types. Similarly, in the tropical dry deciduous and tropical dry thorn forest types between 30% and 60% of the household income from NTFPs comes from *Emblica officinalis, Phoenix sylvestris, Tamarindus indica* L., honey, and *Mangifera indica* L. The annual per capita household income from NTFPs ranges between US $4 (Rs. 134) in the tropical dry thorn forest and US $147 (Rs. 4955) in the tropical moist deciduous forest (Fig. 3).

To understand the importance of ethnicity in the collection of NTFPs, we compared the contribution of the different sources of income to the annual per capita household income among tribals and non-tribals. The data from the Wyanad Wildlife Sanctuary have been used for this analysis. Among the non-tribes the percentage contribution of NTFPs to the per capita household income ranges from a minimum of 24% to a maximum of 35% (mean = 30%), whereas among the tribes this ranges from a minimum of 41% to a maximum of 68% (mean = 57%). The dominant source of income for the non-tribes is agriculture with a median value of 46% (Fig. 4, 5). The evergreen and moist deciduous forest zones generate the maximum number of days of employment in NTFPs extraction. This can be attributed to the availability, the proximity, the access regimes, and commercial value of products.

Quantum of NTFP Extractions from the NBR

The quantum of NTFP extractions varies among the different forest types of the NBR, with the highest levels of extraction from the tropical evergreen and tropical moist deciduous types. Two commonly and widely gathered products bring about the importance of NTFP extractions from the different forest types. In the case of *Acacia sinuata* 130 kg/ha/yr is extracted in the tropical moist deciduous zone, 49 kg/ha/yr in the tropical evergreen forest zone, whereas only 0.4 kg/ha/yr in the tropical dry thorn zone. A higher per hectare quantity is obtained for *Emblica officinalis*, 382 kg/ha/yr in the tropical moist deciduous zone, 119 kg/ha/yr from the tropical evergreen zone, 7 kg/ha/yr from the tropical dry deciduous zone, and 2 kg/ha/yr from dry thorn zone with no extraction in the tropical montane zone. The results have shown that the tropical moist deciduous zone has the highest per hectare extracted income of US $112 (Rs. 3780/ha/yr), for the entire type of forest and the tropical dry thorn has the least of US $3 (Rs. 92/ha/yr). The mean annual extractive value of one hectare of the reserve from NTFPs is US $36 (Rs. 1211), this being corroborated from the results of the per hectare calculations (Fig. 3).

Trends in the Extraction of NTFPs

Data regarding the quantities and financial values realized from the sale of NTFPs through LAMPS (Large-scale Adivasi Multipurpose Society) were obtained. The information thus obtained gives a picture of the quantity of the prod-

ucts marketed through the LAMPS. The LAMPS are cooperative organizations that help in streamlining the collection and marketing of NTFPs. The LAMPS also provide financial assistance to the NTFP collectors by providing loans and also remuneration for the products collected. The data show a mixed trend in the quantities extracted over the years for some products. In the Mudumalai area extractions of *Emblica officinalis* and *Acacia sinuata* do not reveal any significant trend over the years ($P > 0.05$ in both cases). However, in the Wyanad Wildlife Sanctuary (WWLS), there is a significant trend in the extraction of *Acacia sinuata*, ($F = 12.0$, $R^2 = 0.54$, $df = 10$, $P < 0.001$), and in the extraction of *Emblica officinalis*, ($F = 6.3$, $R^2 = 0.41$, $df = 10$, $P < 0.05$) (Fig. 6, 7).

Discussion

The diversity of products extracted from the NBR could be basically attributed to the high plant diversity of these forests. In India over 3000 plant species produce economically significant products (Tewari 1994). Apart from the biological diversity, the indigenous knowledge of the communities, the commercial viability of the extracted products, the abundance of NTFPs in the different zones, the proximity to forested areas all contribute to the diversity of products extracted in the different forest types of the NBR. The commercial viability of products in the tropical moist deciduous and tropical evergreen zones coupled with the medicinal value of many species of plants has led to the extraction of a large number of NTFPs in these two zones. A study in West Bengal showed that 72 plant species and three animal species were used extensively for fuel, fodder, medicine, household articles, rituals, ornaments, and recreation by the local people (Malhotra 1992). In another study carried out in the Knuckles National Wilderness area of Sri Lanka, villagers used 47 plant species for food, medicine, spices, and construction materials (Gunatilake, Senaratne, and Abeygunawardena 1993).

Between 50% and 75% of the households in rural areas gather a diversity of forest products. Landless and indigenous communities seem to have a larger involvement in the extraction of NTFPs, as compared to land-owning agriculturists and wage earners from the organized sectors in the NBR. A study of eight villages in Ghana found that the percentage of households earning income from sale of NTFPs ranged from 49% in one village to 87% in another (Chege 1994). Income from agriculture and other vocations has led to a lower dependence on NTFPs by the small farmer and others categories. Hegde et al. (1996) reported a negative relationship between income from other vocations and NTFPs in similar forest types of the Biligiri Rangan hills of southern India. There are a few dominant NTFPs like *Emblica officinalis* that are extracted by a large number of households. With no particular occupational class exclusively involved in its extraction, the commercial attractiveness is a crucial factor in such extractions. A study in the Biligiri Rangan hills found that 70% of the households extract on an average 1000 kg of *Emblica officinalis* fruits realizing US $45 (Rs. 1500) as cash income each year (Uma Shankar et al. 1996). Depending on the abundance of species in the different forest zones and the opportunity cost involved in their extraction, NTFP income from different products varies in the different forest zones of the NBR, with a few dominant NTFPs in each forest zone. Five NTFP species (*Sapindus emarginata*, tree moss, *Emblica officinalis*, *Tamarindus indica*, and *Acacia sinuata*) contributed almost 75% of the total NTFP revenues generated in 1991–1992 at Mudumalai (Ganesan 1993).

Ethnicity plays an important role in the extraction of NTFPs in the NBR, with tribes obtaining a larger proportion of their annual income from NTFPs as compared to the non-tribes. On an average, NTFPs provide up to US $59 (Rs. 2000) in cash per year per household. If one considers the family incomes of households residing in the Wyanad Wildlife Sanctuary as typical of households residing in the NBR, the average income from NTFPs contributes 12% of the total household income in the NBR. However if one considers the exclusive extracting population, in this case tribal communities of the NBR, as much as 57% of the average per capita household income of the tribal population comes from NTFPs. An economic analysis in West Bengal showed that the average household income per year from NTFPs was around US $74 (Rs. 2230), and the contribution of NTFPs to household income ranged between 13% and 22% (Malhotra 1992).

The results of the per hectare analysis show significant variation in the quantum of NTFPs extracted in the different zones. The quantum of extractions of *Emblica officinalis* and *Acacia sinuata* varies significantly in the different forest

zones and could be a function of the abundance of these two species in the forest zones. In the Biligiri Rangan hills the fruit (*Emblica officinalis*) yield per tree varies among forest types, with the deciduous and evergreen forests yielding significantly more fruits per tree than the thorn forests and montane forests of lower stature. Fruit yield per hectare, is a function of tree density/unit area and production potential of the average sized tree, is highest in deciduous forest and lowest in montane forest, the difference between the two being approximately 28 fold (Uma Shankar et al. 1996). Therefore extraction levels in NBR do not reflect only availability but access regimes in various forest types. A large area under dry deciduous forests and a part of the thorn forest are protected (Bandipur National Park and Mudumalai Wildlife Sanctuary). Bilagiri Rangan hills is one administrative division, whereas NBR includes 16 forest divisions, of these in 14 forest divisions NTFP extractions are regulated.

The mean annual extractive value of NTFPs per hectare in the NBR as a whole is US $36 (Rs. 1211). A comparison of the extractive values of NTFPs from other forests in South Asia reveals a more conservative extraction from the NBR. Extraction value of fuelwood, fodder, and honey collected annually from Kadavakurichi Reserve Forests located in the foothills of the Palni hills, an offshoot of the Western ghats was about US $70 (Rs. 2090) per hectare (Appasamy 1993). Similarly, estimations of the minimum and maximum values of the annual flow of NTFPs and services per hectare from tropical deciduous forests in India ranged between a minimum of US $219.80 (Rs. 6594) and a maximum of US $357.08 (Rs. 10712.5) (Chopra 1993). The study by Gunatilake, Senaratne, and Abeygunawardena (1993) in the Knuckles National Wilderness area of Sri Lanka showed that the value of NTFP per ha per year at prevailing rates of extractions was US $91.80. A recent study in a region of the tropical moist forest of eastern Honduras by Godoy et al. (2000) showed that the combined value of consumption and sale of forest goods from a Central American rain forest ranged from US $17.79 to US $23.72 per hectare per year.

The trends observed in the extraction of certain NTFPs could be an indication of the sustained ecological and economic value of these forests. The extraction of *Emblica officinalis* and *Acacia sinuata* in the Wyanad Wildlife Sanctuary shows a significant positive trend. Whether such a positive trend in the extraction of these NTFPs is an indication of sustainable harvests or not is difficult to answer at present, but certainly such long-term records give us an idea of the ecological cycles or patterns in seed production. Data on such aspects, combined with long-term monitoring of the demography of plant populations, are crucial in understanding the sustainability or otherwise in the extraction of these NTFPs.

Conclusions and a Policy for the Future

The study shows a significant dependence on forests by communities in the NBR. A variety of NTFPs are extracted from the region, apart from being used for food, household articles, many of the NTFPs have medicinal value. Apart from the biological diversity of the NBR, the commercial value of NTFPs is an important factor in the extraction of NTFPs, *Acacia sinuata* and *Emblica officinalis* are dominant NTFPs and are extracted by different social groups in large quantities in the NBR. The mean annual per capita household income from NTFPs in the NBR varies from a minimum of US $4 to a maximum of US $147. Tribals derive a larger proportion of their annual income from NTFPs than nontribal communities living in the NBR. The quantum of extractions of NTFPs varies across the different vegetation types in the NBR.

To assess the sustainability of harvesting a nontimber forest product, knowledge of the natural distribution, abundance, population structure and dynamics, and variation of these factors across a landscape is required for each species (Hall and Bawa 1996). We currently have little knowledge on many of these aspects of the NTFP species in the NBR. The sustainability or otherwise involved in the extraction of NTFPs is a complex issue which encompasses ecological as well as socioeconomic aspects involved in the collection of NTFP species. In this regard we suggest collection of long-term data on the ecology of the different NTFP species at the population, community and landscape levels. To harness the complete potential of NTFP species in the NBR there needs to be a thorough overhauling in the marketing strategies involved in the collection of NTFPs. In this direction we make the following recommendations:

1. Zonation with strict controls in protected areas and prioritizing areas for NTFP extraction,

as the study has revealed that the quantum of extractions differ in different zones, this would enable better organization thereby preventing losses during storage and transport.

2. A participatory approach in the extraction and marketing of these NTFPs would help in a more judicious use of these resources.

3. There is a need to strengthen the existing market mechanism, as it was found on many occasions that NTFPs, the common ones and of commercial importance were destroyed on account of poor marketing decisions. Rendering financial and marketing assistance would help increase incomes at all levels.

4. The problem of value addition is something that requires further research, especially pricing and valuation of NTFPs. This is important to alleviate the exploitation of NTFP collectors by intermediaries, thereby increasing extraction management efficiency.

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APPENDIX 1. NTFPs EXTRACTED BY THE COMMUNITIES IN THE NILGIRI BIOSPHERE RESERVE.

NTFP	Common name	End use	Parts used	Forest extracted	Access regimes
Acacia sinuata (Willd.) DC	Sekai	Washing, medicinal	Fruits, leaves	E, D, M, T	R
Bambusa arundinacea (Retz.) Roxb	Bamboo	Handicrafts	Stem	E, D, M, T, S	R
Callicarpa tomentosa (L.) Murr.		Medicinal	Root, bark	M	R
Canarium strictum Roxb.	Black Damer	Medicinal	Exudates	E, M	R
Capsicum frutescens L.	Chilly	Food, medicinal	Fruit	D	R
Cinnamom malabathrum (Burman) Blume	Country cinnamon	Medicinal	Bark, dried buds and seeds	M	R
Curcuma aromatica Salisb.	Wild Turmeric	Medicinal	Rhizome	E, M, D	R
Cyclea peltata Hk. & Th.		Medicinal	Root	E, M	R
Desmodium gangeticum (L.) DC.		Medicinal	Root	E, M	R
Elettaria cardamomum (L.) Maton	Cardamom	Medicinal	Fruits and seeds	M	R
Emblica officinalis Gaertn.	Indian Gooseberry	Food, medicinal	Bark, leaves, root, fruit, seeds	E, M, D, T	R
Fodder (Mixed species)		Domestic		E, M, D, T, S	F
Fuelwood (Mixed species)		Domestic		E, M, D, T, S	F
Garcinia indica (Thouars) Choisy	Red mango	Food, medicinal	Bark, leaves, fruit	E, M	R
Hemidesmus indicus (L.) R. Br.	Indian sarsaparilla	Medicinal	Root, bark	E	R
Holostemma annulare (Roxb.) Schum.		Medicinal	Root	E	R
Honey		Food, medicinal	Root	E, M, D, T, S	R
Kavadi #		Medicinal	Root	E	R
Mangifera indica L.	Mango	Food, medicinal	Fruit, kernal, leaves, bark, gum	E, M, D	R
Manure (Mixed species)		Domestic		E, M, D, T, S	F
Nilgirianthus ciliatus (Nees) Bremek.		Medicinal	Root	E	R
Ocimum sanctum L.	Holy basil	Medicinal	Leaves, seed, root	E	R
Phoenix sylvestris L. Roxb.	Wild date	Food, handicrafts	Fruits, leaves	M, D, T	R
Piper longum L.	Long-pepper	Food, medicinal	Fruits, stem	E, M	R
Piper nigrum L.	Black-pepper	Food, medicinal	Fruit	E, M	R
Pseudarthis viscida (L.) Wt. & Arn.		Medicinal	Root	E, M	R
Sapindus emarginata Vahl.	Soapnut tree	Medicinal, washing	Fruit	M, D	R
Sida rhombifolia L.	Country mallow	Medicinal	Root	E, M	R
Solanum indicum L.	Indian nightshade	Medicinal	Root, seed	E, M	R
Tamarindus indica L.	Tamarind tree	Food, Medicinal	Leaves, bark, flowers, fruit	E, M, D, T	R
Terminalia chebula (Gaertn.) Retz.	Indian gallnut	Medicinal	Fruits	E, M, T, D	R
Tree moss		Medicinal		M	R
Vateria indica L.	White damer tree	Household, medicinal	Exudates	E, M	R

APPENDIX 1. CONTINUED.

NTFP	Common name	End use	Parts used	Forest extracted	Access regimes
Yarakasinga #		Medicinal	Root	E	R
Zingiber zerumbet Smith.	Wild ginger	Medicinal	Rhizome	E, M, D, T	R

F: free access to NTFPs; R: regulated access to NTFPs.

# Indicates local name only.

E: evergreen; M: moist deciduous; D: dry deciduous; T: dry thorn; S: montane.