

# Forest Product Use, Conservation and Livelihoods: The Case of *Uppage* Fruit Harvest in the Western Ghats, India

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Nitin D. Rai and Christopher F. Uhl

*The harvest and sale of non-timber forest products (NTFP) by local communities has been suggested as a possible solution to the often observed conflict between forest use and forest conservation. Recent studies have, however, suggested that the economic rewards might not be constant, and that ecological effects of harvest might be higher than previously believed. In India trade in NTFP has a long history, but few studies have explored both the ecological and socio-economic aspects of harvest. We report here the results of a socio-economic and ecological study on the harvest of fruits from the rainforest tree uppage (Garcinia gummi-gutta), which occurs in the tropical forests of the Western Ghats. We studied the characteristics of uppage fruit harvest, socio-economic factors that influence harvest, and the ecological effect of fruit harvest under differing tenurial regimes. Our findings suggest that dependence on NTFP harvest by local communities might be problematic due to market instability, patchy resource distribution, inequitable access to forest resources within the village and lack of security of tenure.*

## INTRODUCTION

HUMANS HAVE HISTORICALLY depended on tropical forests for a variety of plant and animal products (Deneven 1992; Posey 1982). However, recent demand for timber and the expansion of agricultural activities have increased the rate of tropical forest loss. Following an influential study on the potential high economic value of tropical forest to indigenous communities (Peters et al. 1989; see Sheil and

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**Nitin D. Rai** is at the Ashoka Trust for Research in Ecology and the Environment (ATREE), 659 5th A Main Road, Hebbal, Bangalore 560 024, India. E-mail: [nitinrai@vsnl.com](mailto:nitinrai@vsnl.com).

**Christopher F. Uhl** is at the Department of Biology, Pennsylvania State University, 208 Mueller Lab, University Park, PA 16802, USA. E-mail: [cful@psu.edu](mailto:cful@psu.edu).

Wunder 2002 for a critique), the extraction of non-timber forest products (NTFPs) by local communities was widely proposed as a strategy to stem the rate of deforestation while enhancing livelihoods (Nepstad and Schwartzman 1992; Panayatou and Ashton 1992). As a result, this 'good extractivism' approach, one that 'preserves natural resources while enhancing income' (Almeida 1996), has spawned much research on the role of NTFPs in forest conservation (Peters 1996) and livelihoods (Godoy et al. 1995).

Recent studies on NTFP harvest and trade suggest that an emphasis on NTFP as a major source of income for forest communities might be problematic for several reasons: markets are frequently unstable (Padoch 1992); trade is often controlled by the elite, both locally and regionally (Ribot 2000); access to NTFPs is socially mediated and inequitable (Kumar 2002); most NTFPs occur at low densities (LaFrankie 1994); and the potential for trade is usually low, with only few species being traded (Saw et al. 1991). Furthermore, the lack of security of tenure, a situation commonly encountered in state-controlled forests, often results in such adverse ecological impacts as damage during harvest (Momberg et al. 2000) and suppressed regeneration. Ecological effects have been shown to be higher than expected (Padoch 1992) and economic returns are low (Godoy et al. 2000). There is, therefore, increasing evidence that NTFP harvest in practice often does not follow the concept of 'good extractivism'.

Few studies have simultaneously addressed the ecological and socio-economic aspects of NTFP harvest and trade. In order to fill this gap, we attempted such a study using the case of *uppage* (*Garcinia gummi-gutta*), a rainforest tree valued for its fruit. The dried rind of *uppage* fruit rapidly increased in value in the mid-1990s due to the discovery of international markets, thus encouraging members of several Western Ghats village communities to engage in the collection and trade of the product. The village communities in the study area, which are heavily depended on the state-controlled forests for their resource needs, are socially hierarchical. This presented a suitable case to examine the role of NTFP harvest in livelihood enhancement and the ecological impacts of NTFP harvest. The *uppage* harvest scenario is complicated by a transition from domestic to international markets, the pervasive state control of forests and social stratification within village communities. To gain an integrated understanding of the socio-economic and ecological aspects of *uppage* harvest, we asked the following questions: Are low-income households more dependent on *uppage* than high-income ones? Does the social position of a household determine access to *uppage* trees and income from *uppage* rind? What impact does fluctuating *uppage* market price have on household incomes? What is the pattern of distribution and structure of *uppage* populations in the village forests? Does the lack of security of tenure influence harvest and affect species ecology?

#### NATURAL HISTORY AND USE OF *UPPAGE*

*Uppage* is the Kannada name for *Garcinia gummi-gutta* (L.) Robson (Family Guttiferae), an understory rainforest tree, restricted to the moist forests of the

Western Ghats and Sri Lanka (Ramesh and Pascal 1997). *Uppage* is dioecious, with separate male and female trees occurring in a ratio of 1:1 (Rai 2003). Trees of both the sexes usually commence flower production when they are about 14 cm in diameter. Male and female trees produce flowers from February to April and fist-sized fruits that weigh about 80 g, ripen from July to September during the rainy season. *Uppage* flowers are pollinated by weevils. Fruits on an *uppage* tree do not all ripen at the same time. The staggered fruiting ensures that most fruits are eaten by animals, thus ensuring that a large proportion of the seeds are dispersed (Lee 1988). While unripe fruits are green, the ripe fruit is bright yellow, a colour associated with many monkey-dispersed fruits (Janson 1983; Terborgh 1986). *Uppage* is an important food resource for the common langur (*Presbytus entellus*), Bonnet macaque (*Macaca radiata*), common palm civet (*Paradoxorus hermaproditus*) and the endangered brown palm civet (*P. jerdonii*), all of which feed on the pulp. These animals play an important role in the ecology of *uppage* by dispersing seeds away from parent trees, thereby increasing the probability of survival of seeds and seedlings (Rai 2003). Animals discard *uppage* rind to the ground after eating the pulp. Collection of fallen rind, after it has been thus discarded, has no overt adverse impact on the ecology of *uppage*. The seeds of *uppage* are consumed by two species of arboreal squirrels (*Ratufa indica* and *Funambulus palmaram*).

The fruit of the tree is harvested by villagers, who after removing the seeds and pulp, sell the dried rind to traders. The rind of the *uppage* fruit has been traditionally used in the state of Kerala in India and in Sri Lanka as a culinary additive and fish preservative (Samarajeewa and Shanmugapirabu 1983). The long history of use has resulted in the species being domesticated in home gardens in Kerala for centuries.

The domestic demand for the rind in Kerala kept the price at a steady but low level until the early 1990s. In the late 1980s some studies showed that hydroxy citric acid (HCA), a secondary compound present in the rind of *uppage* fruit, might be effective in weight loss (Sergio 1988). This finding interested drug manufacturers in the United States of America who touted the drug as a natural solution to obesity (Majeed et al. 1994). Drugs such as Citrin and Citrimax were widely sold over the counter. These nutraceuticals, as drugs derived from natural products came to be called, were aggressively advertised despite a lack of rigorous studies on their efficacy. As a result of the increased demand for these products in Western markets, the price of *uppage* rind increased rapidly in India.

However, in 1998, the results of a randomised clinical trial showed that a control group, which was given a placebo, lost more weight than the treatment group that was given HCA (Heymsfield et al. 1998). As the results of this study were disseminated widely, primarily on the Internet, the demand for the product declined. The effect on the price of rind in India was dramatic. The price fell from an average of Rs 60/kg (\$1.43/kg) in 1999 to Rs 28/kg (\$0.66/kg) in 2000, and the price of HCA exported to the US fell from \$30/kg in 1999 to \$8.50/kg in 2000. Subsequent warnings by various other agencies regarding side effects from the continued

usage of the drug have further debilitated demand (Columbia.edu 2000). Exporters also attribute the drop in price to a steep increase in the number of HCA processors and a subsequent spurt in supply. Other reasons cited for the drop in prices are low rind quality due to the harvest of unripe fruit, and the import of *uppage* fruit from Sri Lanka at lower prices (Suresh Kumar, Sami Chemicals, Bangalore; personal communication).

## STUDY AREA

The Western Ghats in southern India are a 1,600 km long north–south hill range, traversing the states of Maharashtra, Karnataka, Tamil Nadu and Kerala. The Western Ghats have been identified by Myers (1990) as one of eighteen hot-spots of global biological diversity and more recently as one of eight global ‘hottest’ hot-spots (Myers et al. 2000). This study was conducted in an area of approximately 49 sq. km in the environs of Kelaginkeri village, Uttara Kannada district, Karnataka (Figures 1 and 2). Kelaginkeri village is situated at an altitude of 620 m. The average precipitation of about 3,600 mm is largely restricted to the monsoon months of June to October. The tropical wet forests along the crestline and the western slopes, have high levels of endemism: 12 per cent for birds and 60 per cent for amphibians (Daniels 1991, 1996). The proportion of the area under forest in the district is 79 per cent, which is remarkably high for any district in India.

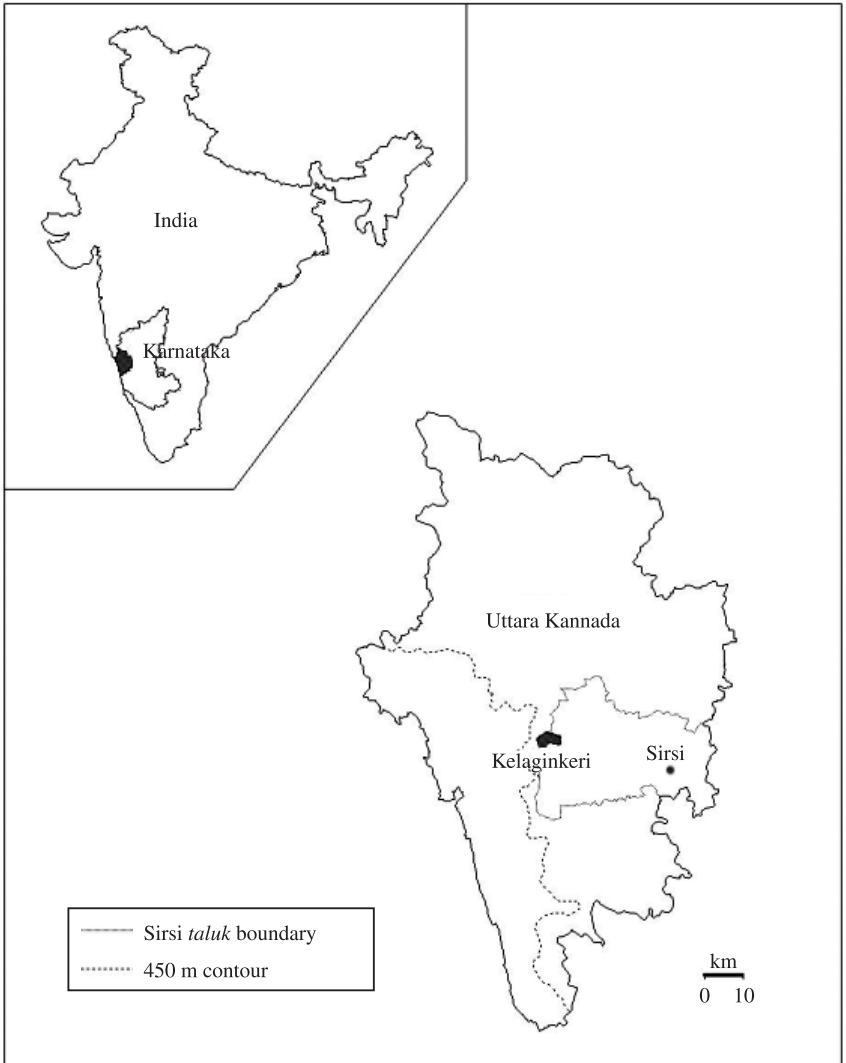
Areca palm plantations, rice paddies and human habitations occur in the valleys, thus restricting forests to the slopes and hilltops. The valleys, with their perennial streams and shade, offer the best sites for areca plantations, which is the major cash crop in the area. Forest canopy openness depends on use, which ranges from fuel wood collection and green leaf harvest for use as green manure to fruit and honey collection.

The area of Kelaginkeri village, which includes forests within the village boundary, is 15 sq. km. Ninety-three per cent of the area is forest land, including *sop-pinabetta* (Census of India 1991).<sup>1</sup> The 1991 national census lists fifty households in the village with a total population of 316 (169 males, 147 females). However, a survey of households in 1999 showed that the number had increased to eighty-two households as a result of division of land among male siblings and recent settlers.

One hundred and thirty species of NTFP are used to varying extents by villagers in Uttara Kannada district (Hegde et al. 2000). The extent of dependence on the forest among households varies. Farmers growing areca, the major crop of the region, use leaves obtained from the forest as mulch; meat-eating non-Brahmins obtain wild game and mushrooms; Brahmins harvest herbs and other plant products for food; and low-income households trade various NTFP even if only marginally lucrative. However, high-value NTFP such as *uppage* are attractive to all segments of the community. The seed has high oil content of 50 per cent (Mannan et al. 1986). In Uttara Kannada district the oil extracted from seeds of the *uppage* fruit has been used traditionally in cooking. Though the oil is no longer used as much

**Figure 1**

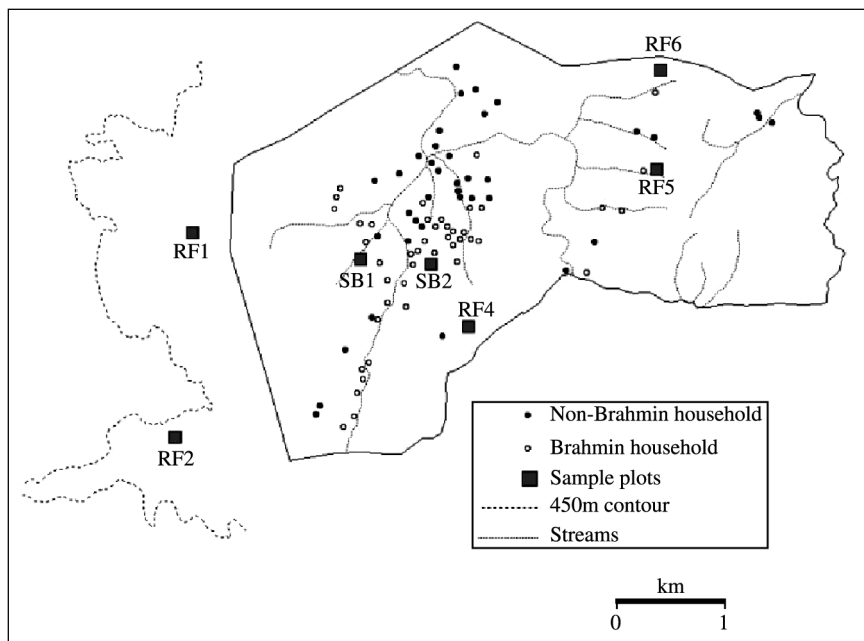
*Map of India Showing Karnataka State and Uttara Kannada District with Location of Sirsi Taluk, Kelaginkeri Village and the 450 m Contour of the Western Ghats*



as in the past, it has ensured that *uppage* trees in *soppinabetta* were maintained, and thus available to be harvested by *soppinabetta* owners when the market for the rind developed in the mid-1990s.

The human population density of 54 per sq. km in Uttara Kannada district is among the lowest in the country (Census of India 1991). The average annual household cash income in the district (Rs 38,745) (Hegde et al. 2000) is 1.2 times

**Figure 2**  
**Map of Kelaginkeri Showing Location of Households and Sample Plots**



**Note:** Plot RF3 not shown due to its distance from the village.

the national average (Rs 30,915) (Bhandare and Mukhopadhyay 1998). The higher average income in the district is due largely to the cultivation of areca nut. In the last fifteen years areca has experienced a steep increase in value as a result of the aggressive marketing of *ghutka*, a tobacco-coated areca product, to which a large number of people, especially youth, have become addicted.

### THE STRUCTURE OF THE VILLAGE COMMUNITY

The social structure of the Kelaginkeri village community is strongly hierarchical. At the top of this traditional hierarchy is the Havyaka Brahmin community, which is the richest and most politically influential. Havyakas constitute 54 per cent of the eighty-two households in the village. The non-Brahmins in the village are lower in the social order and are to varying degrees considered by the Brahmins to be 'untouchable' depending on their caste. These castes are Kare-vokkaliga (15 per cent of the households in Kelaginkeri), Naik (15 per cent), Siddi (8 per cent), Marathi (7 per cent) and Mahalaya (1 per cent). Brahmins, in the role of the clergy, have for centuries controlled the affairs of the village, effectively stifling participation of other communities in village-level decision making. The practice of social discrimination (untouchability and caste-based discrimination) continues here as it does in the rest of the country, despite the state having declared it

unconstitutional and illegal. Brahmins in Kelaginkeri discriminate against non-Brahmins by, amongst other things, preventing their entry into Brahmin houses.

The majority of areca plantations are owned by Brahmins. Non-Brahmins who do not own areca plantations usually work in the plantations of the Brahmins as labourers, and cultivate their (often small) rice paddies in the monsoon when water is available. Areca plantations are the most resource intensive and economically profitable land use in the district. The increased earnings from areca in the mid-1980s further concentrated power in the hands of the Brahmins. The lure of greater earnings from areca resulted in many poorer farmers and plantation workers establishing areca plantations by illegally cutting down state-controlled forests. Havyaka Brahmins increased their areca holdings by expanding into adjacent valleys. Farmers with recently established areca plantations, however, continued to work in the plantations of the richer farmers, as areca palms take eight to ten years to yield. Recent converts to areca plantations do not have access rights to the forest for the collection of green mulch, as the practice of granting *soppinabetta* to areca farmers was abolished in 1975 (Nadkarni et al. 1989). This has resulted in illegal expansion into reserve forests by farmers who have recently established plantations, and the intensification of use of existing *soppinabetta*.

### FOREST ACCESS LAWS AND PROPERTY RIGHTS REGIMES

There are as yet no clear policies governing NTFP harvest, although steps are being taken towards the formulation of a NTFP harvest policy. In a recent report the Forest Department of Karnataka state outlined a set of objectives for an NTFP use and management strategy (Karnataka Forest Department 1999), which is yet to be instituted. Much of the current extraction occurs rampantly with little monitoring of the impact of harvest. The absence of local institutions has hobbled attempts at achieving resource sustainability.

The rights regimes (*sensu* Srinidhi and Lélé 2000) that exist in the forests of the study area are reserve forest, *soppinabetta* and minor forest. Though all forest is owned by the state, each category has different usufruct rights. In reserve forests silvicultural operations and extraction of dead wood for subsequent sale as fuel wood are conducted by the state. Limited collection of fuel wood and fodder is granted to local communities, but the granting of these rights is at the discretion of forest officials. The Forest Department auctions the rights to extraction and trade of NTFPs to private contractors. The absence of usufruct rights in the reserve forest results in an 'open access' situation for NTFP collection, where NTFPs can be harvested by anyone as and when they are available.

*Soppinabetta* is private access forest that occurs only in the three hill *talukas*<sup>2</sup> of the district: Sirsi, Siddapur and Yellapur. In the 1890s the then British administration leased 9 ha of surrounding forest for every hectare of orchard owned (Buchy 1996; Nadkarni et al. 1989). This was to allow farmers to harvest leaves to use as mulch for areca palm trees. Farmers have complete control over the extraction of fuel wood, fodder, soil and green leaves. NTFP can, however, only be sold to the

contractor appointed by the Forest Department. In terms of NTFP harvest, *soppinabetta* ensures security of tenure to farmers in contrast to open access in reserve forests.

Minor forest is forest land given to the entire village in the ratio of 1 ha of land for every head of cattle. This enables local communities to meet their subsistence needs of fuel wood, fodder and leaf mulch. The harvesting of resources, including NTFP, for commercial purposes is not allowed. After decades of intense use, the vegetation in minor forest is mostly scrub and stunted trees. In the range in which Kelaginkeri village is located, 56 per cent of the forest area is reserve forest and 23 per cent is *soppinabetta* and 21 per cent is minor forest (Karnataka Forest Department 1999).

### HARVEST AND TRADE SCENARIO

The Forest Department auctions the rights to the harvest and trade of NTFPs biannually. Trade rights for major NTFPs like *G. gummy-gutta* are auctioned separately, while the auctioning of cheaper and less abundant NTFPs are combined. Rights are auctioned for each forest range, which is the basic administrative unit of forest, measuring about 250 sq. km.

Fifty-seven per cent of the total revenue earned by the Karnataka Forest Department from all NTFP auctions in 1995–97 was from *uppage* alone, illustrating its prominence in the NTFP trade scenario of the region at that time. However, revenue earned by the Karnataka Forest Department from NTFP in the district is less than 1 per cent of their total revenue (Gaonkar et al. 1998). The meagre revenue accounts for the general lack of interest in NTFP trade. Not surprisingly, the Department has raised concerns about the harvest from the reserve forest of fuel wood used to dry *uppage* rind, and argued that the revenue earned from auctioning trade rights is not commensurate with the loss of biomass (Saibaba et al. 1996).

The winning bidder assumes complete control of the trade of *uppage* for the range. These contracts, usually won by affluent business people from outside the area, give individuals, henceforth called contractors, marketing rights to all extracted *uppage* fruit. The harvest of the fruit itself is done by local people. The short lease period of two years gives contractors little incentive to ensure that NTFP harvest is conducted with minimum impact to the resource base.

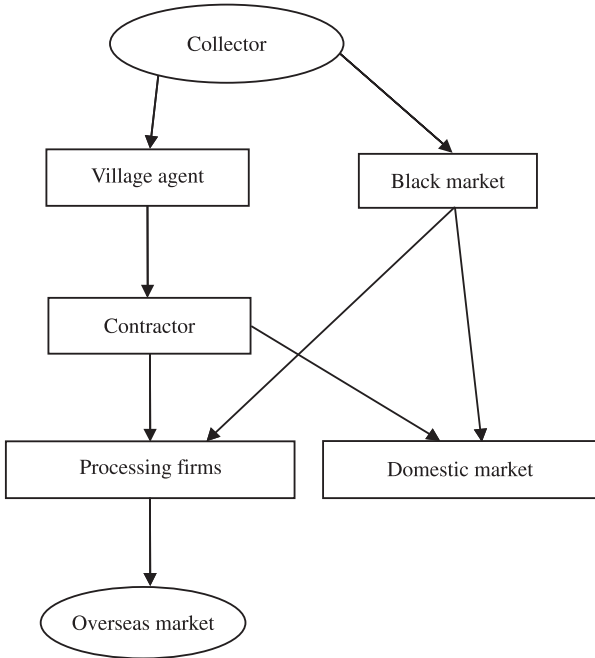
*Uppage* is harvested from reserve forests and from *soppinabetta*. Fruits are brought to the homes of the collectors where they are de-seeded and the rind is dried in a wood-fired oven, which usually comprises a metal mesh suspended over burning logs. The rind has to be dried within a day of harvest as it tends to spoil quickly in the humid climate.

Harvesters sell the dried rind to a contractor-appointed agent at a price determined by the contractor. The agent gets a commission for each kilogram bought. The contractor collects the rind from the agent at regular intervals. Apart from the agent, there are other buyers who acquire and sell small quantities of rind. These village traders sell *uppage* to either the legal contractor or to other traders who



operate on the black market (Figure 3). The occurrence of a black market ensures that prices are higher than if the contractor were the sole buyer of the rind. The contractor attempts to curtail this illegal trade by recruiting people to patrol the borders of the range to ensure that *uppage* is not purloined to a neighbouring range, the jurisdiction of different contractor, where prices may be higher, even if marginally. There is, however, little support for such monitoring either from villagers, who stand to benefit from the higher prices and greater options, or from the Forest Department, who, having auctioned off the contract, does not interest itself in the operational details of harvest and trade. Tensions between traders, and between collectors and the contractor, therefore, run high during the harvest season.

**Figure 3**  
**The Uppage Trade Network**



Using data from studies on fruiting and tree densities, we calculated the annual *uppage* production for Sirsi division to be 3,020,673 kg per year. The official estimate provided by the Forest Department for the period 1997–99 is 1,631,500 kg per year, or 54 per cent the estimated quantity. This disparity in estimates might be due to *uppage* rind being traded on the black market and under-reporting by contractors.

The contractor stores the dried rind in large sheds in the nearby town of Sirsi, where it is sorted, graded and sometimes adulterated with common salt and charcoal to increase weight. The rind is then sold to HCA processing firms, which are

usually located in cities, and are capital-intensive industrial units with the necessary technological expertise to extract HCA from rind for subsequent export. There are about thirty-five processing firms involved in the extraction of HCA in India.

## METHODS

### *Socio-economic Profile of Kelaginkeri Village*

How important is *uppage* to the household economy of Kelaginkeri village? We determined the effect of participation in *uppage* harvest on the income of rich and poor, Brahmin and non-Brahmin households, and the level of dependence of households on *uppage* collection. Information on the socio-economic characteristics of households in Kelaginkeri village was obtained from interviews in May and June 2001. Interviews were conducted at the end of a three-year stay in the village. Fifty-one of the eighty-two households in the village were interviewed. Households were selected to ensure that all castes and income classes were represented. During the interviews we gathered information on:

1. Household structure and income: Number of people in the household; income from agriculture, NTFPs and wage labour; size of landholding and land use.
2. NTFP collection: Number of species collected; quantity collected in 1999 and 2000.
3. *Uppage* harvest: Number of kilograms of *uppage* collected in 1999 and 2000; number of years of *uppage* collection; number of household members involved in *uppage* collection; time spent on *uppage* collection and processing; amount of fuel wood used per day in drying *uppage*.
4. Trade and access: Amount of *uppage* sold to contractor and on the black market; presence of informal tenurial arrangements; barriers to involvement in *uppage* harvest.
5. Harvest practice: Preference of harvest mode—climb and harvest or collection of fallen rind; proportion of *uppage* obtained from *soppinabetta*, proportion of fruits left on the trees.

### *Resource Access and Trade*

To obtain a description of the policy governing forest resource access and NTFP trade we interviewed forest officials, traders and conservation activists in the town of Sirsi, Uttara Kannada district. Two contractors in Sirsi and Siddapur were interviewed for their perceptions on NTFP trade, quantity of *uppage* obtained, final markets and profit margins. For an estimate of the significance of the black market, a trader operating on the black market was interviewed. In 1988, prior to the establishment of overseas markets, and the boom in *uppage* prices, the Bakkala village cooperative located about 25 km from the town of Sirsi, held the contract

for trade in *uppage* rind. We talked to the secretary of the Bakkala village cooperative to evaluate the potential for such village cooperatives being involved in NTFP trade. We interviewed representatives of five HCA extraction firms in Bangalore and Ankola to obtain information on the quantity of rind acquired per year, the price of *uppage*, the sources of *uppage*, the price of the finished product, size of the export market and fluctuations in demand.

### Ecology

To determine the density and distribution of *uppage* in the study area, trees greater than 10 cm diameter at breast height were enumerated in sample plots established in the forests of Kelaginkeri village. The total area sampled was 30.5 ha. The pattern of distribution of *uppage* in Kelaginkeri was determined by sampling along a 20 m wide, 11.8 km long transect. To determine if the occurrence of *uppage* along the 11.8 km transect was random or clumped, the transect was subdivided into 50 m continuous sections and the presence or absence of *uppage* trees in each section was recorded. A non-parametric Runs test was then used to test for randomness.

To determine if the impact of harvest practices varies between the two regimes, reserve forest and *soppinabetta*, we laid two 1 ha plots in *soppinabetta* (S1 and S2) and six 1 ha plots in reserve forest (Figure 2). In the reserve forest two plots (R1 and R2) were in sites harvested by migrant collectors and hence assumed to experience a high intensity of fruit harvest. Two reserve forest plots (R3 and R4) were considered medium-intensity sites due to their close proximity to many households. Two other reserve forest plots (R5 and R6) were considered low-intensity sites as each was harvested by one household as a result of an informal tenurial agreement.

Plots S1, S2, R1 to R5 consisted of three to five parallel sub-plots of size 20×100 m, separated from each other by 100 m. Within each sub-plot the diameter of all *G. gummi-gutta* trees (>10 cm diameter) was measured. Within each 20×100 sub-plot, we sampled saplings (0.5–2.0 m height) in a nested 5×100 m plot and seedlings (< 0.5 m height) in a nested 2×100 m plot. Plot R6 was a 100×100 m plot within which all *uppage* individuals greater than 0.5 m height were enumerated. All seedlings (< 0.5 m height) were also enumerated within a 40×100 m sub-plot.

The greater security of tenure in *soppinabetta* helps ensure that harvesters allow fruits to ripen on trees, increasing the probability of seeds being locally dispersed by primates. In the reserve forest, however, fruits are picked when unripe before seeds are fully developed and fruits along with seeds are taken to the households of collectors for processing and drying. We tested the hypothesis that a higher number of seeds are dispersed in *soppinabetta* than in reserve forest where seeds are removed along with fruits during harvest by comparing the ratio of seedlings (less than 0.5 m height) to trees greater than 20 cm diameter at breast height. A higher ratio would suggest that more seeds are germinating per adult tree.

We used only seedling number as we observed that saplings (plants greater than 0.5 m in height) were periodically cut in *soppinabetta* during biomass harvest.

Damage caused to trees during harvest was assessed in the six forest plots. If damage to trees was observed, we selected additional trees outside the plots along transects of variable lengths to ensure adequate sample size and recorded per cent damage for each tree encountered along the transect. Damage was observed in the high-intensity reserve forest sites RF1 and RF2 where 187 female trees were assessed for damage. The proportion of branches cut was recorded as per cent damage. Stumps of felled *uppage* trees were enumerated in the plots and along the transect.

## RESULTS

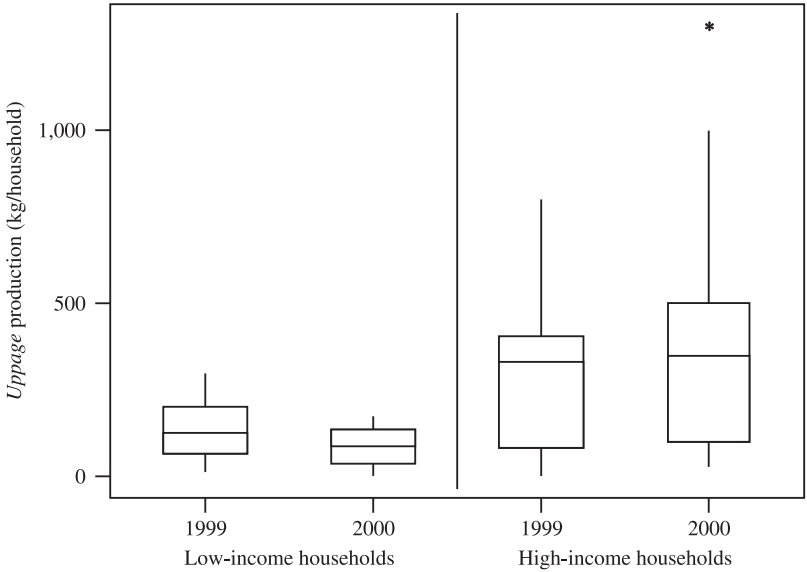
### *Role of Uppage in Income Generation*

The average annual household income of the fifty-one households was Rs 104,229 (US\$ 2,316), which is higher than the average annual household income of Uttara Kannada district (Rs 38,745 [Hegde et al. 2000]) or the country (Rs 30,915 [Bhandare and Mukhopadhyay 1998]). A comparison of Brahmin and non-Brahmin household incomes shows a significant difference indicating that the distribution of income within the village is not equitable (t-test,  $p < 0.001$ ; average Brahmin US\$ 3,218,  $n = 26$ ; average non-Brahmin Rs 1,347,  $n = 25$ ). The income disparity between Brahmin and non-Brahmin households does not, however, result in differential dependence on *uppage*, as the relative contribution of *uppage* to Brahmin (7.7 per cent of household income from *uppage*) and non-Brahmin (11.6 per cent) households is not significantly differently (Mann-Whitney U,  $p = 0.39$ ).

We tested the hypothesis that low-income households collect more *uppage* than high-income households. Households were divided into those with incomes less than Rs 50,000 ( $n = 16$ ) and greater than Rs 100,000 ( $n = 16$ ). In 2000 low-income households collected 85–124 kg, which is significantly lower than rind collected by high-income households, who collected 398–432 kg (t-test,  $p = 0.01$ ). Moreover, the average *uppage* harvest by low-income households decreased from 122 kg/household in 1999 to 85 kg/household in 2000, while that of high-income households increased from 277 kg/household to 398 kg/household over the same period (Figure 4). In 2000 households with access to *soppinabetta* collected 62 per cent of their *uppage* from it.

It has been hypothesised that with increase in income, households extract fewer NTFP (Godoy et al. 1995). We compared the number of NTFP used by households with incomes greater than Rs 100,000 ( $n = 16$ ) with the number of NTFPs used by households with incomes less than Rs 50,000 ( $n = 16$ ). There was no significant difference in the number of products extracted by these two groups (Mann-Whitney U,  $p = 0.28$ ). Contrary to expectations, richer households harvested, on the average, a higher number of products (2.4 products) than poorer households (1.9 products), but not significantly so. *Uppage* constituted 83 per

**Figure 4**  
**Uppage Rind Produced by High- and Low-income**  
**Households in 1999 and 2000 in Kelaginkeri**



**Note:** For low-income households,  $n = 12$ ; for high-income households,  $n = 15$ . The line within the box indicates the median value, and the edges are the first and the third quartiles. The whiskers extend to the adjacent values outside the box. Asterisk indicates an outlier.

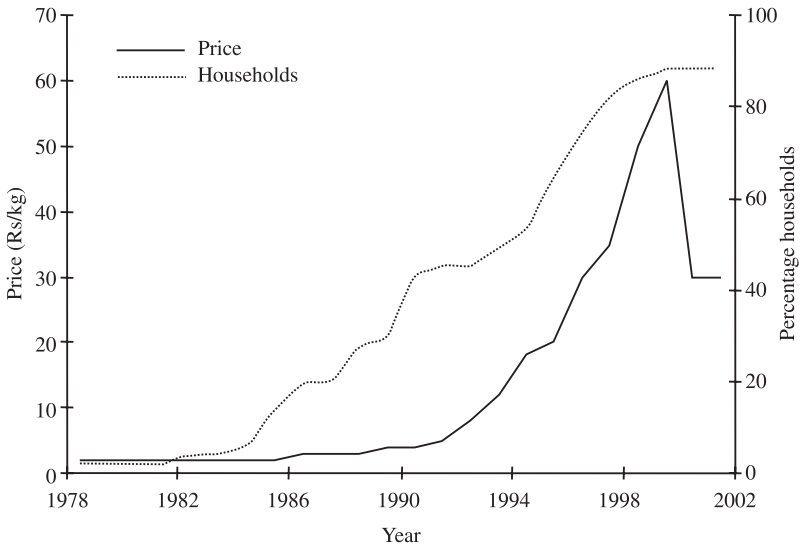
cent of the total household income in 2000 obtained from NTFPs by fifty-one households, suggesting that households depend on one, or few, high-value products as and when they become attractive (Table 1).

**Table 1**  
**NTFP Traded and Income Earned by Fifty-one**  
**Households in 2000 in Kelaginkeri Village, India**

NTFP	Value in 2000 (Rs/kg)	Number of households involved	Quantity collected (kg)	Income (Rs) (% of total)
<i>Uppage (G. gummi-gutta)</i>	31	42	14,622	454,320 (82.6)
<i>Wante (Artocarpus locucha)</i>	27	17	1,150	30,825 (5.6)
<i>Rampathre (Myristica malabaricum)</i>	140	11	148	20,655 (3.8)
<i>Muruglu (G. indica)</i>	27	16	725	19,845 (3.5)
<i>Lavanga (Cinnamomum zeylanicum)</i> (flower)	123	2	67	8,280 (1.5)
<i>Dalchini (Cinnamomum zeylanicum)</i> (bark)	161	1	35	5,625 (1.0)
<i>Anilekai (Terminalia chebula)</i>	5	2	825	4,410 (0.8)
Honey	48	2	75	3,600 (0.7)
<i>Suragi (Ochrocarpus longifolius)</i>	182	1	15	2,745 (0.5)

The drop in demand for HCA in overseas markets resulted in a steep decrease in price of *uppage* rind (Figure 5). To illustrate the effect of the fickle price regime on income generation, we compared income from *uppage* for the years 1999 and 2000, during which time prices fell from Rs 62 per kg to Rs 28 per kg. Though the quantity of *uppage* collected by the households increased marginally from 1999 to 2000 (12,611 kg to 14,622 kg), the reduction in price resulted in the total earnings from it dropping from Rs 800,969 in 1999 to Rs 436,233 in 2000. The vagaries of external markets and demand could thus be debilitating to the economy of harvester households.

**Figure 5**  
*The Trend in Price Paid to Uppage Collectors and in Household Participation in Uppage Trade from 1978 to 2002 in Kelaginkeri*



## *Impact of Harvest*

**Harvest Behaviour** Due to open access in reserve forests, collectors are driven by necessity to harvest *uppage* before others. The early harvest results in low quality *uppage* rind as fruits are not fully developed and rind obtained from unripe fruit weighs less than rind from ripe fruit. Reserve forest patches, in some cases having as many as 100 *uppage* trees per ha, attract collectors from distant villages. There is, therefore, a conflict of interest between migrant harvesters and local villagers who are also involved in *uppage* collection. Under the current rights regime, local villagers are unable to prevent migrant harvesters from collecting in the reserve forests surrounding their village. Surveys in forests frequented by migrant harvesters have shown that branches were cut in over 50 per cent of adult

fruiting *uppage* trees. The cutting of branches makes the harvest of fruits easier than picking individual fruits from the tree. Often the largest branches are cut, as fruits at the tips of these branches are the most inaccessible. In addition, most harvest occurs early in the season, and as unripe fruits are more difficult to dislodge, it encourages the cutting of branches to the ground where they are then picked clean. The harvest practice in *soppinabetta* is different. *Soppinabetta* owners wait for *uppage* fruits to ripen before harvesting. They usually harvest fruit that has fallen to the ground after ripening or after primates have eaten the pulp and discarded the rind. This results in better quality rind.

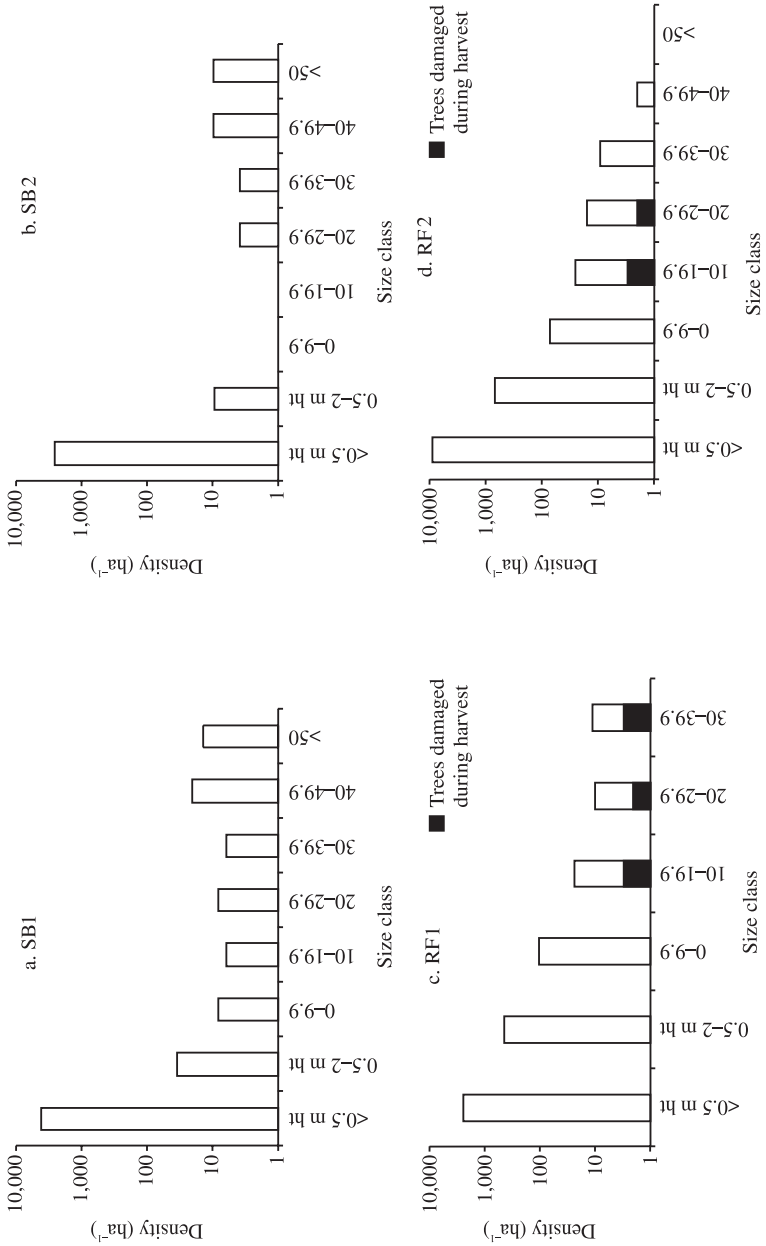
Thus, collectors pick rind from the ground only in forests that have secure tenurial arrangements. Picking rind might be more time-consuming than climbing and harvesting trees. This is because not all fruits ripen synchronously and the number of fruits fallen under a tree at any given time is few, necessitating frequent visits to the same trees. However, economic returns from picking fallen fruits are higher as only ripe fruits are obtained when harvested in this fashion in contrast to a mixture of ripe and unripe fruits that are obtained when the entire tree is harvested at once. Rind from ripe fruit weighs more than unripe fruit and sells for about Rs 5 to 10 more per kg than rind from unripe fruit.

Sixty-seven per cent of the forty-two harvesters interviewed preferred to pick fallen fruit than climb trees. They offered such reasons as lesser effort, less dangerous harvest practice, measured pace of work, decreased processing time as ripe fruits are easier to deseed and better quality rind for their decision. Only 26 per cent of the households preferred to climb trees, as that allowed the harvest of fruits from trees in remote areas that might not be possible to be visited on a regular basis or in areas that are harvested by several people.

**Population Structure** The density of *uppage* trees ranged from 4 trees/ha to 123 trees/ha, with an average of 29 trees/ha. The result of the Runs test was significant at  $p < 0.001$ , showing that *uppage* trees are not evenly distributed in the forests of Kelaginkeri. Data from the belt transect suggests that *uppage* trees occur in clumps.

A comparison of the *soppinabetta* and reserve forest sites shows that there are few juveniles (0.5–2.0 m height) and young adults (1–20 cm dbh) in *soppinabetta* (Figure 6), due to the clearing of undergrowth periodically for fodder and mulch collection. There is, however, an adequate number of seedlings for adult populations to establish if the existing young trees are allowed to grow. The ratio of seedlings to mature trees is higher in *soppinabetta* than in the reserve forest with the exception of the reserve forest site RF2 (Figure 7). The generally high proportion of seedlings in *soppinabetta* suggests that the practice of collecting fallen rind results in greater seedling to adult ratios. This suggests that picking rind is a more ecologically sustainable harvest behaviour than harvesting fruits directly from the tree. However, such factors as greater mortality of seedlings in intact forest and high rates of seed predation in diverse forest (Rai 2003) might also be responsible for the lower seedling ratios in the reserve forest.

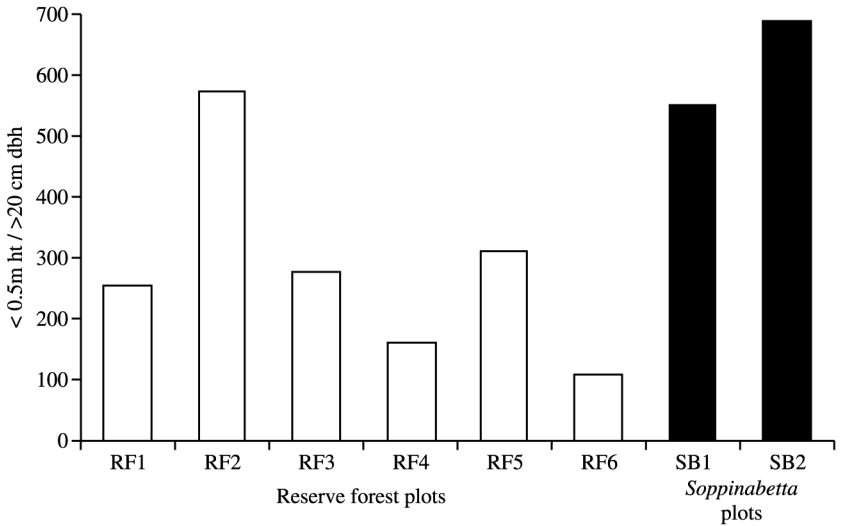
**Figure 6**  
**Size Class Distribution of Uppage in Soppinabetta and Reserve Forest Plots Near Kelaginkeri**



**Note:** Size classes are height (in m) and diameter (in cm). SB1 and SB2 are *soppinabetta* plots; RF1 and RF2 are reserve forest plots.



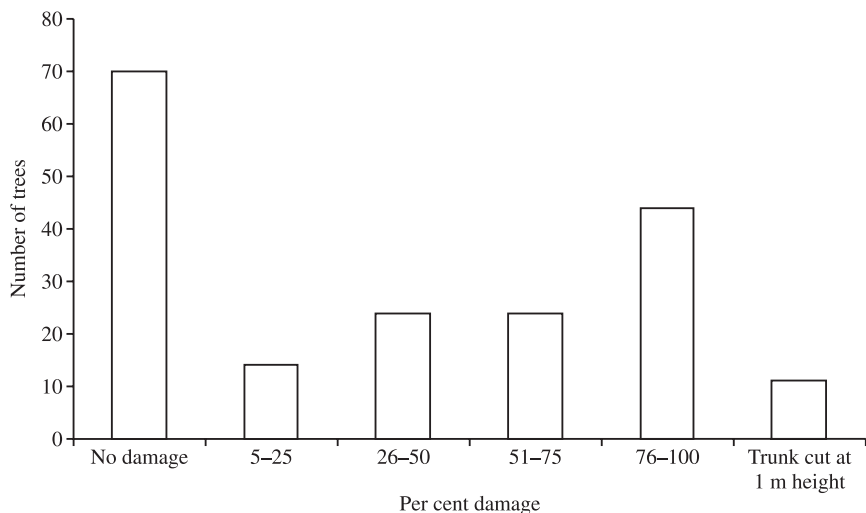
**Figure 7**  
**Ratio of Uppage Seedlings (<0.5 m in Height) to Trees (>20 cm Diameter)**  
**in Soppinabetta and Reserve Forest in Kelaginkeri**



**Note:** RF1–RF6 are reserve forest plots; SB1 and SB2 are *soppinabetta* plots.

**Damage Due to Harvest** The cutting of lateral limbs of *uppage* trees during harvest was observed in areas that are heavily used. In sites RF1 and RF2, branches were cut on 57 per cent of trees, all branches on 8 per cent of the trees were cut, and 11 trees (6 per cent) were cut at the trunk at a height of 1 m with the bole of the tree lying near the stump (Figure 8). Due to the short history of fruit harvest, extreme impacts such as the cutting of branches and trees are currently confined to the forest patches that are close to high-density villages situated below the Western Ghats from where migrant harvesters originate. An increase in the price of *uppage* could result in these impacts rapidly spreading to larger areas if local villagers are not given more control and access rights to *uppage* trees.

**Impact of Fuel Wood Collection** The drying of *uppage* rind requires fuel wood, which is collected from the forest. The Karnataka Forest Department estimated that 25 kg of wood is required to obtain 1 kg of dried rind (Saibaba et al. 1996). We estimated the amount of fuel wood used, by weighing the wood required to dry known amounts of rind. We estimated that 10.5 kg of wood is used to obtain 1 kg of dried rind. This was within the range of values provided by harvesters during the interviews. Lélé (1993) estimated the total above-ground wood production in the area to be 1,100 to 3,100 kg ha<sup>-1</sup>yr<sup>-1</sup>. The estimate of dry rind produced per ha in the study area is 37.9 kg. Thus, the estimated fuel wood consumption is 398 kg ha<sup>-1</sup>yr<sup>-1</sup>, which is less than half the lower range of the estimated above-ground wood production in these forests. Although less wood is extracted than

**Figure 8****Per Cent Damage to Uppage Trees in the Reserve Forest Surrounding Kelaginkeri**

**Note:** Damage is expressed as per cent of branches cut.

total production, it is removed from a smaller area of forest, often close to the harvester household. This might result in a high level of impact on smaller areas of forest.

## DISCUSSION

*There is significant disparity in the income of upper-class (Brahmin) and lower-class (non-Brahmin) households in Kelaginkeri.* This variability in household incomes within the village and income distribution is related to the social stratification. It has been shown that most village communities are highly stratified (Agrawal and Gibson 1999). Under the existing social structure, access to resources is biased towards the upper-class households. To ensure equitable resource access 'negotiations that can modify the effects of alienation, hierarchy, and domination' (Agrawal 1999) are necessary.

*Higher-income households collect significantly more uppage and a marginally higher number of NTFP species than poor households.* High-income households increased the quantity of uppage collected from 1999 to 2000, while low-income households either ceased or reduced collection. This finding contradicts studies that have shown that households with low income are more dependent on NTFPs than high-income households (Gunatilleke et al. 1993). However, Kumar (2002) has shown that in the dry forest of central India high-income households benefit more from the extraction of NTFP than low-income households. Godoy et al. (1995) have also shown that in a Nicaraguan village an increase in household income does not encourage households to specialise on fewer forest products or

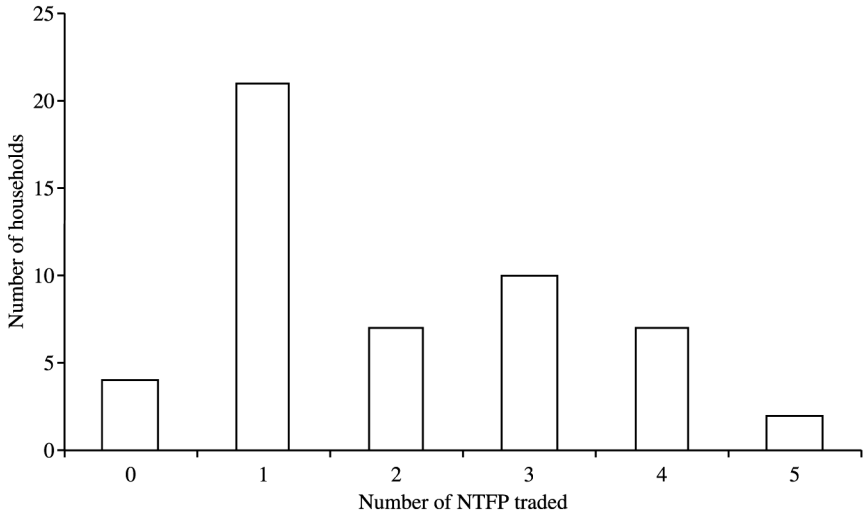
reduce their dependence on forests. The significantly higher quantities of *uppage* collected by high-income households is probably a result of the greater access to trees in *soppinabetta*. In addition, their greater wealth enables them to employ people from Kelaginkeri and from faraway villages to collect rind from the reserve forest. Trees growing in the open canopy *soppinabetta*, due to their larger size, produce more fruit than those growing in the dense canopy forest (Rai 2003). The greater tenurial security enjoyed by *soppinabetta* owners enables them to collect ripe fruits, resulting in greater economic returns as ripe fruits fetch higher prices. The lower quantities collected by poorer households might be due to their being involved in labour duties in areca plantations or in their own rice fields whose cultivation only in the monsoons when water is available coincides with the peak *uppage* fruiting season.

*Price of uppage rind fell sharply, resulting in a large decrease in household income.* NTFP often show boom–bust scenarios, with significant effects on local incomes. Collectors make the decision to harvest based on limited market information, and often suffer the consequences of market collapse. Padoch (1992) describes a boom and bust scenario in the extraction of aguaje fruit (*Mauritia flexuosa*) in the Amazon. Prices in local markets showed a six-fold price increase in a week, which then spurred a massive increase in palm fruit harvest, causing a subsequent crash in the price to, or below, the pre-boom value. If local communities are to rely on NTFP, there has to be greater market stability, a scenario that is complicated by an increasingly global trade regime as illustrated in this case study. There is, however, a stable, albeit less lucrative, domestic market for *uppage* rind in the state of Kerala. Interviews with traders suggest that about 20 per cent of the rind from Sirsi district, even during peak international export, was being directed to markets in Kerala state. The existence of multiple uses and markets for the rind is encouraging for the continued marketability of *uppage*.

*Households in Kelaginkeri specialise on a few high-value NTFP.* Despite the diversity of NTFP in the forest (Hegde et al. 2000), households engage in the collection and trade of only a few NTFP (Figure 9), which constitutes 14 per cent of the average total household income, a large portion of which (83 per cent, Table 1) is from *uppage* rind alone. Most NTFP that occur in the forests around Kelaginkeri are either financially unattractive (Table 1) or are at low densities (N. Rai, unpublished data). Similarly, Saw et al. (1991) have shown that only one species (*Parkia speciosa*) out of seventy-six edible fruit-bearing species (9 per cent of total tree species) in a 50 ha forest plot in Malaysia was harvested for sale. Thus, an emphasis on forest products as a major source of income, as many conservation and development agencies have suggested, might not improve the economic situation of forest-dependent communities. This, therefore, casts doubts over the role of NTFP as a primary income source for forest-dwelling communities.

*Seedling regeneration is higher in soppinabetta, indicating that security of tenure might result in stable populations of uppage.* Security of tenure rights has been cited as an important factor that ensures sustainable harvest of forest resources (Momberg et al. 2000). The practice of delayed harvest of *uppage* fruits is seen

**Figure 9**  
**Number of NTFP Traded by Households in 2000 in Kelaginkeri**



**Note:** Including *uppage*, which was sold by forty-two of the fifty-one households interviewed.

often in *soppinabetta*, a more secure tenurial regime, and rarely in reserve forest. Harvesters who lack secure rights of access are tempted to harvest fruits before other collectors, resulting in seeds not being dispersed and a probable reduction in seedling regeneration. Greater security of tenure will ensure that fruits are harvested later in the season, and picked from the ground instead of being plucked from the tree. Collectors who use this mode of harvest cannot, however, harvest over large areas, as *uppage* fruits can lie on the ground for only one to two days before rotting in the heavy rain that falls during the fruiting season, thus requiring frequent visits to fruiting trees. Lack of tenure security has also resulted in a high incidence of damage to trees during collection. More than half the number of *uppage* trees in the intense harvest sites was intentionally damaged during harvest. Local control of resources by villagers and ecological monitoring of the *uppage* population might ensure that damage to trees, usually caused by migrant harvesters, is minimised and that seedling regeneration is adequate.

There have been precedents for the local control of forests in India through the granting of rights of forest use to the entire village, and regulation through a village council (Kothari et al. 1998). In Karnataka, Village Forest Councils (VFC) exist in several villages, but at present their scope is limited to the management of degraded forest and rarely extends to reserved forest. Increasing the authority of VFCs and granting rights of NTFP harvest within prescribed village boundaries will greatly enhance the access rights of local communities.

*Uppage trees are not evenly distributed in the forest.* How then are resources to be divided amongst the members of a heterogeneous community? Important and

empowering as securing rights of tenure is, some questions regarding the process of granting tenure remain. As many NTFP are patchily distributed, drawing boundaries around households might not result in an equitable distribution of forest products. Nor can it be assumed that granting property rights alone will ensure that the larger issues of access to markets, involvement in policy decisions and effective resource management will be addressed (Zerner 2000). Such issues of resource sharing are best addressed by community members and stakeholders themselves, through negotiations facilitated by the establishment of local institutions (Martin and Lemon 2001).

*Middle traders are important to NTFP product trade.* Gaonkar et al. (1998) have suggested that the current contractual system be replaced by a village-level NTFP cooperative that undertakes the trade of the product directly, eschewing the contractor and other middle traders. The current system is unfavourable to collectors as the price is set by the contractor, and harvesters get a proportionally small share of the final profits. However, due to their experience and contacts with the external markets, traders are more adept at finding markets and absorbing the risk of market collapse. This was corroborated by the experience of a village sales cooperative that had won the contract for *uppage* trade in 1988 (S. M. Hegde, personal communication). As a result of their inability to effectively market the rind, they lost money over the two years that they had the contract.

We found that the reported estimates of *uppage* rind bought and traded by contractors might have been underestimated. Contractors might under-report quantities in order to drive down auction prices, and deflate profit estimates in order to offer lower prices to collectors. This has been possible due to the lack of monitoring by the Forest Department and the lack of transparency in trade. Information on actual quantities will enable a better understanding of the impact of NTFP harvest on village household income, size of the trade and the impact on the ecosystem of fuel wood collection. Our results show that the amount of fuel wood required for drying rind is lower than previously published estimates (Saibaba et al. 1996). However, the impact of biomass removal on forest patches might be high, as wood is extracted from areas close to households, thus focusing fuel wood extraction on small areas.

In a review of the *uppage* marketing regime in the district, Saxena et al. (1997) have argued that although monopolistic NTFP trade regimes may not be conducive to local income augmentation, the ecological effects of such a trade regime are benign due to depressed prices and a quasi-regulated harvest regime. There is, however, little information on the impact of the trade regime on the ecology of NTFP species. The case of nutmeg (*Myristica malabaricum*) is illustrative of an NTFP that, despite being traded under the contractual system, was over-exploited to the point where harvest and trade were banned by the Karnataka Forest Department (Saibaba et al. 1996) due to extensive tree damage. There is, therefore, little evidence to suggest that changes in the trade regime will result in more benign harvest.

## CONCLUSION

Our study shows that greater local control over forest resources will increase the probability of sustainable *uppage* harvest, mainly through the harvest of ripe fruits and decreased tree damage during harvest. Transparency in trade and decision making at all levels (state, contractor and harvester) will ensure faster response by all stakeholders to variability in market demand and resource condition. We found a large disparity in access to forest resource within the village. This heterogeneity can be reduced through the representation of non-Brahmins in local institutions, thus giving them a greater voice in resource use decisions. In cases where these structures have been initiated, it has been largely through the efforts of local non-governmental agencies (Jeffrey and Sundar 1999), suggesting that the role of external agencies is critical in ensuring sustainable harvest and equitable distribution of rewards. If communities are to become more dependent on NTFP, a greater involvement by the state and by non-governmental agencies is necessary.

The *uppage* case shows that NTFP use is dependent on more than just the direct interaction of markets, forests and livelihoods. The paradigm of 'good extractivism' that has fuelled much of the interest in NTFP needs to be re-evaluated in the light of increasing evidence that a complex interplay of factors such as regulation of forest access, social dynamics within the community, unstable trade due to fluctuating market demand, and local and global economic scenarios influence NTFP use. Although strategies evolved for one area can seldom be used in other areas due to differences in the prevailing economic, social and ecological scenarios (Sheil and Wunder 2002), basic aspects such as greater local control, ecological monitoring and transparency in trade appear to be important for NTFP harvest to be sustainable. The skewed distribution of natural resources and opportunities such as land, income and social status are characteristic of most villages in India (Kumar 2002), and possibly many other countries. It is, therefore, critical that the basic issue of social justice be addressed in order for biodiversity conservation and poverty alleviation programmes to succeed.

## Notes

1. *Soppinabetta*, a Kannada word, translates as 'leaf forest'. These forest patches, are adjacent to plantations and have been leased to areca farmers for the harvest of leaves that are applied to the base of areca trees as mulch.
2. A *taluka* is an administrative subdivision of a district. Uttarra Kannada district has a total of nine *talukas*.

## References

- Agrawal, A. (1999), 'Community-in-Conservation: Tracing the Outlines of an Enchanting Concept', in R. Jeffrey and N. Sundar (eds), *A New Moral Economy for India's Forests?* p. 304. New Delhi: Sage Publications.

- Agrawal, A. and C.C. Gibson (1999), 'Enchantment and Disenchantment: The Role of Community in Natural Resource Conservation', *World Development*, 27: 629–49.
- Almeida, M.W.B. (1996), 'Household Extractive Economies', in M. Ruiz Perez and J.E.M. Arnold (eds), *Current Issues in Non-Timber Forest Products Research: Proceedings of the Workshop 'Research on NTFP' Hot Springs, Zimbabwe*, pp. 119–42. Bogor, Indonesia: Center for International Forestry Research.
- Bhandare, S.S. and J.K. Mukhopadhyay (1998), *Statistical Outline of India 1998–99*. Mumbai: Tata Services Limited.
- Buchy, M. (1996), *Teak and Arecanut: Colonial State, Forest, and People in the Western Ghats (South India), 1800–1947*. Pondicherry: Institut Français de Pondicherry, Indira Gandhi National Centre for the Arts.
- Census of India (1991), *District Profile 1991: Karnataka*. New Delhi: Office of the Registrar General and Census Commissioner.
- Columbia. edu (2000), 'Weight Loss Products Containing Hydroxy Citric Acid: Safe?', 15 September, available at <http://www.goaskalice.columbia.edu/1763.html>.
- Daniels, R.J.R. (1991), 'The Problem of Conserving Amphibians in the Western Ghats, India', *Current Science*, 60: 630–32.
- . (1996), 'Landscape Ecology and Conservation of Birds in the Western Ghats, South India', *Ibis*, 138: 64–69.
- Denevan, W.M. (1992), 'The Pristine Myth: The Landscape of the Americas in 1492', *Annals of the Association of American Geographers*, 82: 369–85.
- Gaonkar, D.S., S. Shivanagowda and M. Harrison (1998), *A Review of NTFP Management in Kanara Circle: Policy and Institutional Changes to Improve Resource Management and Rural Livelihoods*. Bangalore: Western Ghats Forestry Project, Karnataka Forest Department.
- Godoy, R., N. Brokaw and D. Wilkie (1995), 'The Effect of Income on the Extraction of Non-Timber Tropical Forest Products: Model, Hypotheses, and Preliminary Findings from the Sumu Indians of Nicaragua', *Human Ecology*, 23: 29–52.
- Godoy, R., D. Wilkie, H. Overman, A. Cubas, G. Cubas, J. Demmer, K. McSweeney and N. Brokaw (2000), 'Valuation of Consumption and Sale of Forest Goods from a Central American Rain Forest', *Nature*, 406: 62–63.
- Gunatilleke, H.M., A.H. Senaratne and P. Abeygunawardena (1993), 'Role of Non-Timber Forest Products in the Economy of Peripheral Communities of Knuckles National Wilderness Area in Sri Lanka: A Farming Systems Approach', *Economic Botany*, 47: 275–81.
- Hegde, P., B. Hegde and N.R. Hegde (2000), 'Non-Timber Forest Products in Uttara Kannada District', report submitted to International Union for the Conservation of Nature and Natural Resources. Gland, Switzerland: IUCN.
- Heysfield, S.B., D.B. Allison, J.R. Vasselli, A. Pietrobelli, D. Greenfield and C. Nunez (1998), 'Garcinia cambogia (Hydroxycitric Acid) as a Potential Antiobesity Agent: A Randomized Controlled Trial', *Journal of the American Medical Association*, 280: 1596–1600.
- Janson, C.H. (1983), 'Adaptation of Fruit Morphology to Dispersal Agents in a Neotropical Forest', *Science*, 219: 187–89.
- Jeffrey, R. and N. Sundar (1999), *A New Moral Economy for India's Forests?* New Delhi: Sage Publications.
- Karnataka Forest Department (1999), *Guidelines on Policies and Procedures to be Applied to all Working Plans: Version 2.0*. Bangalore: Office of the Chief Conservator of Forests (Working Plans, Research and Training).
- Kothari, A., R.V. Anuradha and N. Pathak (1998), 'Community-based Conservation: Issues and Prospects', in A. Kothari, R.V. Anuradha, N. Pathak and B. Taneja (eds), *Communities and Conservation: Natural Resource Management in South and Central Asia*, pp. 25–57. New Delhi: Sage Publications.
- Kumar, S. (2002), 'Does "Participation" in Common Pool Resource Management Help the Poor? A Social Cost-Benefit Analysis of Joint Forest Management in Jharkhand, India', *World Development*, 30: 763–82.

- LaFrankie, J.V. (1994), 'Population Dynamics of Some Tropical Trees that Yield Non-Timber Forest Products', *Economic Botany*, 48: 301–9.
- Lee, T.D. (1988), 'Patterns of Fruit and Seed Production', in J. Lovett Doust and L. Lovett Doust (eds), *Plant Reproductive Ecology*, pp. 179–202. New York: Oxford University Press.
- Lélé, S.M. (1993), 'Degradation, Sustainability, or Transformation? A Case Study of Villagers' Use of Forest Lands in the Malnaad Region off Uttara Kannada District, India', Ph.D. thesis. Berkeley: University of California.
- Majeed, M., R. Rosen, M. McCarty, A. Conte, D. Patil and E. Butrym (1994), *Citrin: A Revolutionary Herbal Approach to Weight Management*. Burlingame, CA: New Editions Publishing.
- Mannan, A., J.A. Farooqi, I. Ahmad and M. Asif (1986), 'Studies on Minor Seed Oils: VII', *Fette Seifen Anstrichmittel*, 88: 301–2.
- Martin, A. and M. Lemon (2001), 'Challenges for Participatory Institutions: The Case of Village Forest Councils in Karnataka, South India', *Society and Natural Resources*, 14: 585–97.
- Momberg, F., R. Puri and T. Jessup (2000), 'Exploitation of Gaharu, and Forest Conservation Efforts in the Keyan Mentarang National Park, East Kalimantan, Indonesia', in C. Zerner (ed.), *People, Plants, and Justice: The Politics of Nature Conservation*, pp. 259–84. New York: Columbia University Press.
- Myers, N. (1990), 'The Biodiversity Challenge: Expanded Hot-spot Analysis', *Environmentalist*, 10: 243–56.
- Myers, N., R.A. Mittermeir, C.G. Mittermeir, G.A.B. da Fonseca and J. Kent (2000), 'Biodiversity Hotspots for Conservation Priorities', *Nature*, 403: 853–58.
- Nadkarni, M.V., S.A. Pasha and L.S. Prabhakar (1989), *The Political Economy of Forest Use and Management*. New Delhi: Sage Publications.
- Nepstad, D.C. and S. Schwartzman (eds) (1992), *Non-Timber Products from Tropical Forests: Evaluation of a Conservation and Development Strategy*. New York: New York Botanical Garden.
- Padoch, C. (1992), 'Marketing of Non-Timber Forest Products in Western Amazonia: General Observations and Research Priorities', *Advances in Economic Botany*, 9: 43–50.
- Panayatou, T. and P.S. Ashton (1992), *Not by Timber Alone: Economics and Ecology for Sustaining Tropical Forests*. Washington, DC: Island Press.
- Peters, C. (1996), 'The Ecology and Management of Non-Timber Forest Resources', World Bank Technical Paper 322. Washington, DC: World Bank.
- Peters, C., A. Gentry and R. Mendelsohn (1989), 'Valuation of an Amazonian Rainforest', *Nature*, 339: 655–56.
- Posey, D. (1982), 'Keepers of the Forest', *Garden*, 6: 18–24.
- Rai, N.D. (2003), 'Human Use, Reproductive Ecology, and Life History of *Garcinia gummi-gutta*, a Non-Timber Forest Product, in the Western Ghats, India', Ph.D. thesis. University Park: Pennsylvania State University.
- Ramesh, B.R. and J.P. Pascal (1997), *Atlas of Endemics of the Western Ghats (India)*. Pondicherry: French Institute.
- Ribot, J.C. (2000), 'Rebellion, Representation, and Enfranchisement in the Forest Villages of Makacoulibantang, Eastern Senegal', in C. Zerner (ed.), *People, Plants, and Justice: The Politics of Nature Conservation*, pp. 134–58. New York: Columbia University Press.
- Saibaba, K.S., I.M. Nagaraj and K.G. Satyanarayana (1996), *A Case Study of Issues Related to the Collection of Garcinia cambogia (Uppage) in a few VFCs of the Janmane Range*, JFPM Case Studies 4. Bangalore: Western Ghats Forestry Project, Karnataka Forest Department.
- Samarajeewa, U. and N. Shanmugapirabu (1983), 'A Cheap Method for Preservation of Fish', *Proceedings of the 6th International Congress of Food Science and Technology*, 1: 80–81.
- Saw, L.G., J.V. LaFrankie, K.M. Kochummen and S.K. Yap (1991), 'Fruit Trees in a Malaysian Rain Forest', *Economic Botany*, 45: 120–36.
- Saxena, N.C., M. Sarin, R.V. Singh and T. Shah (1997), *Western Ghats Forestry Project: Independent Study of Implementation Experience in Kanara Circle*. Bangalore: Karnataka Forest Department.



- Sergio, W. (1988), 'A Natural Food, the Malabar Tamarind, May Be Effective in the Treatment of Obesity', *Medical Hypotheses*, 27: 39–40.
- Sheil, D. and S. Wunder (2002), 'The Value of Tropical Forest to Local Communities: Complications, Caveats, and Cautions', *Conservation Ecology*, 6, available at <http://www.consecol.org/vol6/iss2/art9>.
- Srinidhi, A.S. and S.M. Lélé (2000), 'Forest Tenure Regimes in the Karnataka Western Ghats: A Compendium', technical report. Bangalore: Institute of Social and Economic Change.
- Terborgh, J. (1986), 'Community Aspects of Frugivory in Tropical Forests', in A. Estrada and T.H. Fleming (eds), *Frugivory and Seed Dispersal*, pp. 371–84. Boston: Dr W. Junk.
- Zerner, C. (ed.) (2000), *People, Plants, and Justice: The Politics of Nature Conservation*. New York: Columbia University Press.