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Non-timber forest product dependence among the *Jah Hut* subgroup of Peninsular Malaysia's Orang Asli

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Abstract Non-timber forest products (NTFP) represent key sources of cash and subsistence income for millions of rural and indigenous peoples living in tropical developing countries throughout the world. The current study investigates the use and significance of NTFP within a sample of Peninsular Malaysia's Orang Asli (indigenous people). Data collected via household surveys across three sampling phases reveals that more than 75% of the population is actively engaged in NTFP collection. Household responses indicate diversity in both the types and uses of products collected. NTFP collection participation, frequency of collection, and collection reliance are found to be significantly negatively related to village proximity to the market, as well as to income level relative to the Malaysian poverty line. When collection variables are examined by different product categories, relationships with market access and income group are variable. Implications for different approaches to forest conservation and rural development are discussed.

Keywords *Jah Hut* · Malaysia · Non-timber forest products · NTFP · Orang Asli · Poverty

1 Introduction

Each year roughly 13 million hectares of tropical forests worldwide are cleared for timber, agriculture, ranching, and development (FAO 2005). Consequently, services associated with forest preservation are either severely impacted or lost completely. These services

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include watershed protection, soil nutrient retention and erosion control, habitat for threatened and endangered species, biodiversity, climate regulation, carbon sequestration, and recreation. Whereas society as a whole bears the costs of losing *global* forest services, local populations suffer the loss of *local* forest services, which often directly impacts the physical, economic, and cultural well being of rural households (Byron and Arnold 1999; Cavendish 2000; Vedeld et al. 2004).

As knowledge of forest benefits (to all levels of society) improves, alternative forest management strategies suggest differing degrees of protectionism relative to use and access (Kramer et al. 1997; Oates 1999). On one end of this continuum, logging and other forest clearing activities are not permitted, yet NTFP collection by local people is allowed; at the other extreme, neither forest clearing activities nor access by local populations is allowed. Given that roughly 80% of the developing world including nearly 60 million indigenous peoples depend on non-timber forest products (NTFP) such as fruits, legumes, construction materials, and medicinal plants to meet subsistence and supplemental income needs (FAO 2005), the outcome of this debate will have serious ramifications for local populations as well as for conservation efforts.

On a local level, NTFP may help households cope with poverty, insufficient agricultural yields, catastrophic weather events, or other unfavorable conditions associated with high-risk rural environments (Pattanayak and Sills 2001; Shackleton and Shackleton 2004; Takasaki et al. 2004; Paumgarten 2005). For indigenous populations—which often lack property rights, human and physical capital, financial resources, and political advocacy (Nicholas 1997; FAO 2005)—NTFP may provide a form of natural insurance to buffer against the effects of rapid rural development or political climates that have displaced them from fertile lands to marginal areas with poor soils and low productivity (Cavendish 2000).

Without careful planning and accurate information, the outcome of any given forest policy might unintentionally impair conservation efforts and/or the well being of forest-fringe communities—specifically during periods of economic hardship (Byron and Arnold 1999). For instance, a policy of no protection would likely result in reduced forest coverage, leading to decreased availability of NTFP and causing a loss of NTFP benefits to local communities. Alternatively, restricting forest access completely would protect forest species and services, but would cost local people whose livelihoods depend on the ability to freely appropriate NTFP. Finally, if clearing activities are restricted yet access for hunting and gathering is allowed, then NTFP services will continue in as long as the products themselves are not over-harvested.

In the interest of adding to the growing base of information framing this debate, the objectives of this research are to (a) identify the types of NTFP collected by an indigenous forest-fringe community in Peninsular Malaysia, (b) illustrate the extent to which this community relies on these products, and (c) improve our understanding of how this population's resource draw and reliance might evolve with changes in particular economic factors. From a conservation perspective, cataloging the types of products collected may more quickly identify the products that are threatened with overharvesting and, thus, aid in more expeditious conservation efforts. From a development perspective, knowledge of forest reliance by poor forest-fringe communities may further our grasp of the full range of consequences associated with forest-clearing on one extreme, or restricted access on the other (Musters et al. 2000; Paumgarten 2005), including the distributional and equity impacts that are neglected in discussions about how to allocate these resources efficiently. Finally, awareness of how resource draw and income reliance may be influenced by market access and income may prove useful to policymakers' efforts to design both efficient forest management and effective poverty alleviation programs in rural areas.

2 Background

The need to balance forest conversion, conservation, and rural development is particularly important within the forested regions inhabited by Peninsular Malaysia's Orang Asli[1] (original people; Nicholas 1997). Since 1970, aggressive economic development across Malaysia has led to a quadrupling of per-capita growth domestic product (GDP; United Nations Country Team 2005). Yet, the benefits and costs associated with this growth have not been distributed equally. While Malay, Chinese, and Indian populations in Malaysia have seen poverty rates drop from over 65%, 25%, and 35%, respectively in 1970, to <5% in 2005 (United Nations Country Team 2005), nearly 77% of the Orang Asli continue to live below the poverty line (Nicholas 1997; United States Department of State 2006). Further, much of the nation's economic prosperity has benefited urban populations. Rural groups, especially those in forested regions, have experienced less growth and many have faced declining forest resource bases. Since 1970, more than 30% of the standing forests in Peninsular Malaysia have been converted to cash crop plantations or other commercial uses (Repetto and Gillis 1988; Malaysian Timber Council 2005). The opportunity costs of this forest conversion have been borne disproportionately by the local peoples, particularly the Orang Asli, who traditionally have benefited economically, physiologically, and culturally from forest services (Couillard 1980; Nicholas 1997).

Most Orang Asli in Peninsular Malaysia live as subsistence farmers and cash crop smallholders within remote rural settlements, and roughly 40% reside in or near forested areas (Nicholas 1997). Their economic productivity is limited by imperfect markets, as well as low levels of education, poor health, and few wage-income opportunities (Nicholas 1997). These conditions are exacerbated by the absence of property rights, limited land, poor soil quality, and diminishing forests (Nicholas 1997; FAO 2005; Howell et al. 2005). For Malaysia, little quantitative information exists (for an exception see Lim and Noor 1995) on the prevalence of NTFP collection, the types of products collected, the contribution of NTFP to total income, or the socioeconomic conditions that may influence collection (FAO 2005).

The current project investigates the nature of NTFP collection among the *Jah Hut* subgroup of Orang Asli. Most *Jah Hut* live near the Krau Forest and Wildlife Reserves, and NTFP collection is a common activity. We assess how NTFP collection and reliance might vary with economic conditions and development by examining collection variables across levels of market access and non-forest income. Market access may influence collection of product types differently depending on whether they are collected for sale or as substitutes for market goods (Robinson et al. 2002; Marshall and Newton 2003). Distance to the market is generally correlated negatively with opportunity costs of time in NTFP collection because households residing closer to markets can typically obtain better returns to labor time as well as acquire affordable substitutes for NTFP (Wunder 2001; Vedeld et al. 2004). Households that reside far from the market may have fewer employment opportunities as well as fewer options for obtaining market substitutes.

Household income is presumed to reflect household opportunity costs, which are generally correlated negatively with NTFP collection activities. However, several studies have observed NTFP collection and income to rise with total household income (Godoy et al. 1995; Mahapatra et al. 2005), suggesting that relatively wealthier collector households may be better poised to collect specialized and high-value NTFP due to the availability of capital investments and technology (Cavendish 2000; Arnold and Ruiz Pérez 2001;

[1] The Orang Asli are the indigenous people of Peninsular Malaysia (pop. 105,000).

Coomes et al. 2004). For low-value non-market products (e.g., fuelwood) income is generally negatively correlated with collection as market substitutes become more appealing and wealthier households have higher opportunity costs of time in collection (Köhlin and Parks 2001). Due to its arduous nature and low rate of return, NTFP collection may be readily abandoned if other more lucrative income opportunities become available (Byron and Arnold 1999). Thus, households with secure employment and, consequently, higher opportunity costs of time, tend to be the least likely to collect low-return NTFP (Sills et al. 2003; Takasaki et al. 2004).

3 Method

3.1 Study area, data collection, and sample characteristics

The *Jah Hut* (pop. approx. 2,600) reside among a dozen small villages within Aboriginal Areas or Aboriginal Reserves on the fringes of the Krau Wildlife and Forest Reserves in the state of Pahang, Malaysia (Fig. 1). Household-level data were collected across nine geographically distinct villages by means of oral interviews across three survey phases in March 2003, October 2003, and March 2004. In eight of the nine villages surveyed, all the *Jah Hut* households with adult decision-makers present were interviewed. For the largest and most homogeneous village (Menkuang), budgetary restrictions allowed for just a probability sampling method involving every other household. Interviewers (bilingual students from the University of Malaya) generally addressed the male head of household, although it was encouraged that one adult female household member also be present to answer questions. This format allowed for information to be gained about certain household production practices of which only the women may have had knowledge (Wollenberg 2000). In the event that the head of household was unavailable, an adult household member with sufficient knowledge of household income and activities was questioned.

The current analyses reflect responses from the 259 households that were present for all three surveys. From this balanced sample, a cross-seasonal income dataset was generated by averaging and aggregating each income and production variable across the three sampling phases within each household.[2] This procedure was intended to reduce measurement error due to respondent recall or interviewer bias.[3] The cross-seasonal dataset is assumed to represent general *Jah Hut* characteristics, activities, and income across the main planting and harvest periods over the course of a year.

The mean age of sampled *Jah Hut* heads of household (primary respondents) was 43.6 years (range = 20–86 years) and most primary respondents had less than a grade school education. The mean number of household members was 6.7 (range = 1–19). It was common for multiple generations and extended family to reside together and pool resources. Several cash and subsistence-generating activities were pursued to varying degrees by the *Jah Hut* sample. These activities included agriculture (e.g., rubber, rice, banana, tapioca, durian), wage jobs (e.g., factory, school, government, shop, plantation), contract work (timber harvesting, house construction), odd jobs (clearing land, spraying herbicides, tapping rubber, collecting oil palm), sharecropping (e.g., rubber, banana, rice,

[2] Details of the variable formation process are described in Howell (2006).

[3] Compared with household income survey research that relies on single sampling time-points, this averaged dataset may be less prone to over- or underemphasizing seasonal or anomalous productivity or behaviors.

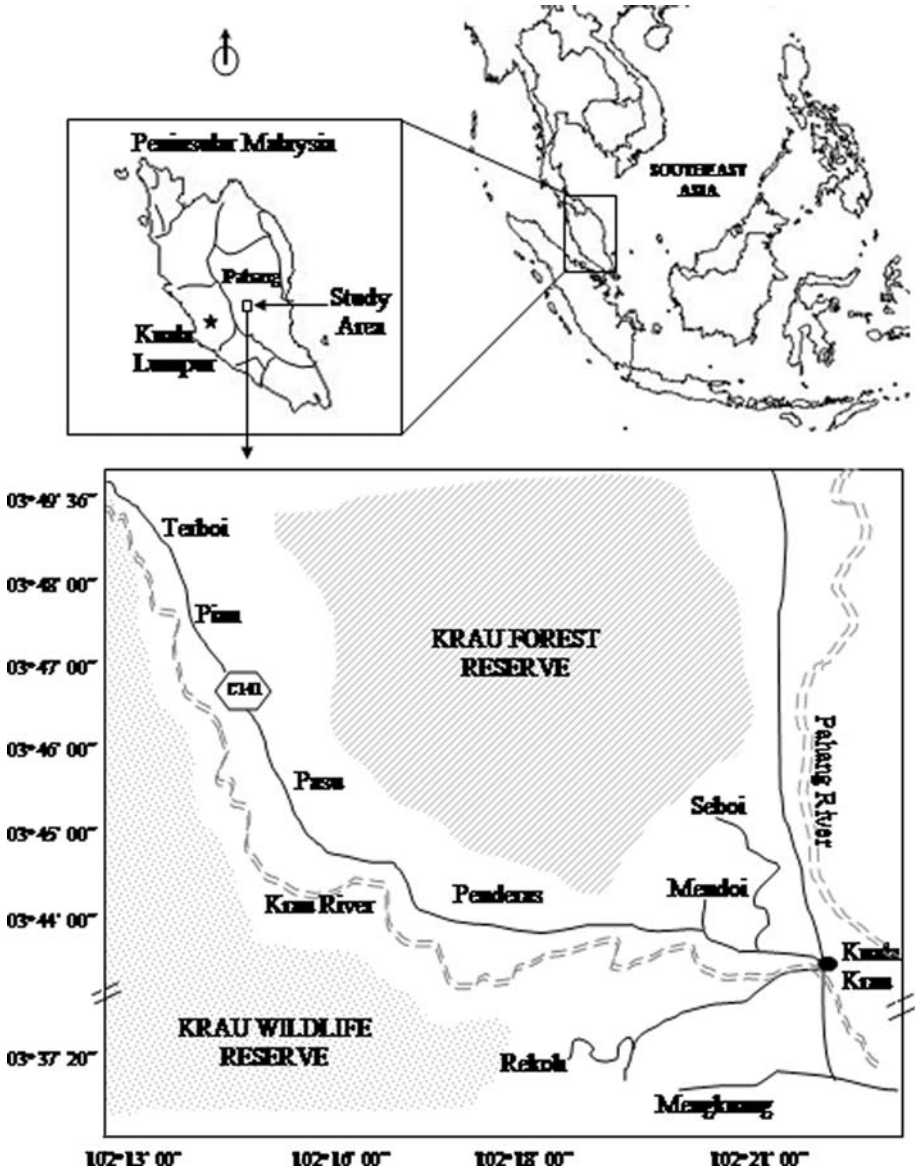

Fig. 1 Location of *Jah Hut* study area in Pahang, Peninsular Malaysia, approximately 150 miles northeast of Kuala Lumpur. Most study villages are located along route C141, which follows the Krau River and is bordered by the Krau Forest and Wildlife Reserves to the north and south respectively. (Map not to scale)

oil palm), and NTFP collection (hunting and gathering). Respondents were asked to indicate the types of NTFP collected (for sale or home consumption) and then were asked to estimate the quantity collected. NTFP included all types of leaves, fruits, flowers, seeds, nuts, legumes, reptiles, frogs, and mammals collected from publicly held forested areas. Fuelwood collection was not included in these analyses. There was no minimum quantity criterion for inclusion of a specific NTFP resource in the analysis. Data were aggregated

across the three sampling phases for each household to help smooth any error resulting from respondents' potential difficulty recalling NTFP quantities.

3.2 Variables: NTFP collection, market access, non-forest income

NTFP collection *participation*, a measure of the prevalence of collection activities across the sample, was defined as the percentage of households that reported NTFP collection (hunting or gathering) at least once across the three sampling phases. Collection *regularity*, a proxy for assessing the temporary or long-term nature of NTFP dependence, was defined as the count of surveys (0–3) in which households reported collection. NTFP *income reliance*, generally used to gauge the economic importance of NTFP, was defined as the contribution of NTFP income (cash plus subsistence) to total income (NTFP income plus non-forest cash and subsistence income).

Market access was represented as an ordinal variable that ranked villages—from 1 (least market access) to 9 (most market access)—based on road quality and median distance to the nearest market where goods were bought and sold. During the first sampling phase it was observed that access to the villages of Rekoh and Seboi required traversing steep and poor quality unpaved roads. These two villages were deemed least accessible and were assigned market access rankings of 1 and 2 respectively. The market access rankings of the other villages were as follows: Terboi (17 km), Pian (16 km), Lubok Wong (15 km), Pasu (12 km), Penderas (11 km), Mendoi (5 km). Mengkuang (2 km) was the most market-integrated village and, thus, was assigned a market access ranking of 9. In general, market access correlated negatively with distance to the forest.[4]

Mean per-capita non-forest monthly income was calculated for each household by dividing total monthly household income from non-forest sources (e.g., agriculture, wage, contract, share-cropping, odd-jobs, government assistance, remittances, etc.) by the total number of household members. As with NTFP income, non-forest income includes the sum of cash revenues as well as the market values of in-kind payments or subsistence production.[5] Of specific interest was the nature of NTFP collection and reliance across income groups formed relative to Malaysia's poverty thresholds. Income groups were formed from per-capita non-forest household income (as opposed to total income, which includes NTFP income) in order to gauge potential *Jah Hut* poverty rates in the absence of NTFP income.

It is possible that if NTFP collection were not available, households would allocate more labor to other income-generating activities. However, given the theory that NTFP are generally 'last resort' sources of income (Byron and Arnold 1999; Coomes and Barham 1997; Takasaki et al. 2004; Wunder 2001), it seems reasonable to assume that NTFP are chosen in the absence of more lucrative opportunities, and that the poorest households would fall deeper into poverty if NTFP could not be collected to smooth consumption or cope with emergencies.

Based on the 2002 Malaysian poverty threshold of RM 529 (USD 139) per month for a household of 4.6 (United Nations Country Team 2005), the per-capita poverty line was

[4] From a general definition, forests are located near all of these villages. In this sense, distance to market is not inversely related to distance to the forest. However, the abundance of forested land within a particular radius increases with increasing distance from the market, and as area devoted to plantations and development decreases. In this sense, distance to the market varies inversely with level of access to less depleted forested land.

[5] The costs of inputs were not computed or included in this calculation, as accurate information on inputs was not available. Most inputs involved household labor and little capital.

computed to be RM 115 (USD 30) per month. Absolute poverty, defined as living on an income of less than half the poverty line, was estimated at RM 57.50 (USD 15) per person per month. Under these poverty line definitions, 37% of the *Jah Hut* households lived in absolute poverty, 37% lived below the poverty line (moderate poverty group), and 26% lived above the poverty line (least-poor group). The poverty rate for Malaysia at the time of sampling was <5%.

4 Results

Table 1 presents the percentage of the sample reporting income (cash or subsistence) from different activities at least once across the three sampling phases, the median monthly income (cash plus subsistence) earned from each source, and the mean share of total household income attributable to each source.[6] After agriculture, gathering forest flora was the most prevalent economic activity and comprised 20% of collectors' total income. This estimate, defined as NTFP reliance, resembles the estimate of 22% calculated by Vedeld et al. (2004) in a meta-analysis of 54 NTFP studies. For the *Jah Hut* households that reported forest hunting activities, hunting income supplied 23% of total income. Wage income was the least prevalent activity, barring contract labor, yet generated substantially larger returns than any other activity.

4.1 Nature of NTFP collection: sample characteristics

In all, 188 households (73%) reported collection of NTFP during at least one of the three sampling phases, and many households reported collecting multiple types of products. These 188 collector households represented 1,294 individuals that were dependent on NTFP to some extent for their livelihoods. Of the collector households, 121 reported using NTFP for subsistence, indicating that at least 877 *Jah Hut* individuals may have used the forest as a source of food.

The various NTFP collected by the sample are specified in Table 2, along with their uses, the number of households that reported collection and sale over the course of the three sampling phases, and the median price received per unit sold. Collection rates were the highest for frogs, of which nearly all were sold. Other products generally sold were terrapin, large rattan, *gaharu*, and resin. Fruits and legumes were both sold and consumed, whereas mammals primarily were hunted for home consumption. Fruits and legumes garnered the lowest unit prices, followed by construction materials and small mammals. The more lucrative products included frogs and terrapin. The high-priced specialty products were tree resins, medicinal herbs, and *gaharu*. Based on additional analyses, this price pattern was also reflected in the average value returns to labor.[7]

[6] The mean monthly income share supplied by each source for each household was computed as: Mean aggregated monthly income from source/Mean aggregated total monthly income.

[7] Respondent approximations of the length of average collection trips were used to estimate total person-hours devoted by each household to collecting each product. A rough estimate of the NTFP average value product of labor was computed by dividing total income (cash plus subsistence) from each product by the total number of hours spent collecting that product. These average value products of labor were the lowest for construction materials, mammals, and fruits, and were the highest for frogs, reptiles, herbs and resins.

Table 1 Economic activities reported by *Jah Hut* households (March 2003-March 2004)

	Agriculture		Off-farm employment			NTFP	
	Agriculture	Share cropping	Wage	Contract labor	Odd jobs	Gathering	Hunting
Participation rate (%)	84.6	52.1	45.6	40.2	50.2	60.2	50.6
Median monthly income (RM)	163	220	505	156	68	72	91
Mean income share (Participants of given activity only)	0.40	0.43	0.61	0.29	0.21	0.20	0.23
Mean income share (All households)	0.34	0.23	0.28	0.18	0.10	0.12	0.12

Note. Approximate currency conversion: 1 USD = 3.8 Ringgit Malaysia (RM). Median monthly income and mean income share (percentage of total income derived from each activity) are based on mean aggregated income across the three surveys

To facilitate analyses, NTFP were grouped into five categories[8] based on shared characteristics. Table 3 summarizes collection participation, the mean number of annual trips, median income, and mean income share from each category for the entire sample. The participation rate and mean number of trips were the highest for construction materials, followed by frogs and reptiles, which generated the highest median monthly income of any category and accounted for the highest income share. Consistent with their roles as subsistence goods, fruits and mammals accounted for very small portions of the households' total income (approx. 2%).

4.2 Market distance and NTFP collection characteristics

Figure 2 shows the nine sampled *Jah Hut* villages ordered according to market access and the percentage of households in each village reporting NTFP collection during one, two, or all three sampling phases. As market access improved, collection participation gradually diminished, as did the percentage of households reporting collection in two or more surveys. A chi-square test revealed a statistically significant linear relationship between the ordinal market access variable and the percentage of households reporting NTFP collection ($\chi^2(1, N = 259) = 27.67, p < 0.001$). An ANOVA test for linearity revealed a statistically significant negative relationship between market access and collection regularity (0–3 ordinal variable; $N = 259$, $r = -0.44$, $p < 0.001$).

For product categories, the percentage that reported fruit collection generally increased as market access decreased (χ^2 (1, $n = 188$) = 18.28, $p < 0.001$), as did the percentage that collected construction materials, (χ^2 (1, $n = 188$) = 11.97, $p = 0.001$), and frogs and reptiles, (χ^2 (1, $n = 188$) = 15.35, $p < 0.001$). Collection regularity for these categories was also negatively correlated with market access ($r = -0.34$, $p < 0.001$ for fruits; $r = -0.30$, $p < 0.001$ for construction materials; $r = -0.28$, $p < 0.001$ for frogs and reptiles).

[8] The fruits category combined fruits, vegetables, and legumes. These products were used for both cash and subsistence, and were collected seasonally. The construction materials category included rattans, bamboo, and palm branches collected for building dwellings and making crafts. Specialty plant products such as resins, *gaharu*, medicinal herbs, and spices were combined to form the herbs and resins category. Amphibians, terrapin, tortoises, snakes, and monitor lizards were collected for sale and were grouped into a frogs and reptiles category. All other hunting comprised the mammals category, which tended to be hunted for home consumption.

Table 2 Characteristics of non-timber forest flora and fauna collected by *Jah Hut* sample households

Common name	Scientific name[a]	Part used	Uses	N collecting (selling)	Median price (RM)[b]
Fruits					
Tampoi	*Baccaurea* sp.	Fruits, bark, rinds	Food, income, medicine	56 (15)	1.50/kg
Salak	*Salacca zalacca*	Fruits; fronds	Food, income; handicrafts	52 (23)	6.00/kg
Starfruit	*Averrhoa* sp.	Fruits	Food; income, medicine	26 (1)	0.10/piece
Durian	*Durio* sp.	Fruits	Food, income, medicine	1 (1)	0.54/piece
Rambutan	*Nephilium* sp.	Fruits	Food, medicine	2 (0)	1.00/kg
Kundang	*Bouea macrophylla*	Fruits	Food, medicine	1 (0)	1.00/kg
Jackfruit	*Artocarpus heterophyllus*	Fruits	Food	1 (0)	1.00/kg
Legumes/vegetables					
Jering	*Pithecellobium jiringa*	Seeds (legume)	Food, dye, medicine	46 (12)	0.65/kg
Petai	*Parkia speciosa*	Pods (legume)	Income, food, medicine	78 (42)	5.00/kg
Kerdas	*Pithecellobium bubalium*	Seeds, shoots	Food, income, medicine	74 (27)	2.30/kg
Tapioca	*Manihot esculenta*	Young leaves	Food, income	2 (2)	1.00/bundle
Ferns	Varied	Young leaves	Food, income	4 (3)	5.00/sack
Banana buds	*Musa sp.*	Flowers	Food, income	2 (2)	0.35/piece
Mushrooms	Varied	Mushrooms	Food, medicine, income	1 (1)	3.00/piece
Herbs, spices, resin					
Ubi jaga	*Eurycoma longifolia*	Leaves	Medicine, income	3 (3)	50.00/packet
Agarwood/ *gaharu*	*Aquilaria* sp. *Dipterocarpus* sp.	Aromatic diseased wood exudate	Income, incense, medicine	26 (26)	1000/kg
Resin (damar)	*Balanocarpus* sp.	Exudates	Income, medicine	23 (22)	15.00/piece
Construction materials					
Small rattan	*Calamus* sp.	Woody vine	Income, handicrafts	48 (34)	3.00/bundle
Medium rattan	*Calamus* sp.	Woody vine	Income, furniture	28 (14)	0.15/piece
Larger Rattan	*Calamus* sp.	Woody vine	Income, construction	53 (50)	3.00/piece
Bemban	*Donax* sp.	Stems	Income, handicrafts	23 (10)	1.00/lg. piece
Bamboo	*Bambusa* sp.	Shoots	Construction, handicrafts	42 (9)	1.68/piece
Cucuh	*Calamus castaneu*	Palm fronds	Roof thatching, handicrafts	32 (23)	0.60/kg

Table 2 continued

Common name	Scientific name[a]	Part used	Uses	N collecting (selling)	Median price (RM)[b]
Gutta-percha	*Palaquium gutta*	Latex	Income	4 (1)	0.25/piece
Animals					
Frogs	Varied	Meat	Income, food	106 (103)	18.00/kg
Tortoise	*Testudo* sp.	Shell, meat	Income, food	8 (5)	5.00/kg
Terrapin	*Batagur baska*	Shell, meat	Income, food	22 (20)	13.00/kg
Monitor lizard	*Varanus* sp.	Skin, meat	Income, food	15 (0)	30.00/each
Wild boar	*Sus scrota*	Meat	Food, income	26 (2)	120.00/each
Squirrel	*Callosiurus* sp.	Meat	Food	1 (0)	2.00/each
Mouse deer	*Trangulus* sp.	Meat	Food	15 (0)	4.00/each
Pangolin	*Manis javanica*	Skin, scales, meat	Income, food, medicine	1 (1)	38.00/each
Monkey	*Macaca* sp.	Meat; live animal	Food; pet	13 (0)	10.00/each
Porcupine	*Hystrix* sp.	Meat	Food	2 (0)	30.00/each
Barking deer	*Muntiacus* sp.	Meat	Food	9 (0)	250.00/each
Total	–	–	–	188 (163)	–

[a] Nair et al. (1998)

[b] Median price across all three surveys for households selling product. Price fluctuation across surveys was minimal. Standard shadow price of RM 4/kg for animal products used to compute average price per unit for mammals (Gomes 1986)

Note. $N = 259$

Table 3 Household participation in NTFP collection, mean number of annual collection trips, median monthly income, and income share (percentage of total income derived from each collection activity) by NTFP category

	Forest product category					
	Fruits	Construction materials	Herbs and resins	Frogs and reptiles	Mammals	Total NTFP
Participation rate (%)	40.2	44.8	18.1	44.4	16.6	72.5
Mean number of annual trips per collector household	12	29	10	14	7	25
Median monthly income (RM)	26	46	82	95	19	65
Mean income share (Collectors of given product only)	0.02	0.10	0.11	0.16	0.02	0.20
Mean income share (All households)	0.01	0.04	0.02	0.07	0.004	0.15

Note. $N = 259$; Approximate currency conversion: 1 USD = 3.8 Ringgit Malaysia (RM). Median monthly income and mean income shares based on mean aggregated income across the three surveys for households that participated in each collection activity

No statistically significant linear relationship was identified between market access and either collection participation or collection regularity for herbs and resins or mammals, both of which also required more knowledge and skill than other categories.

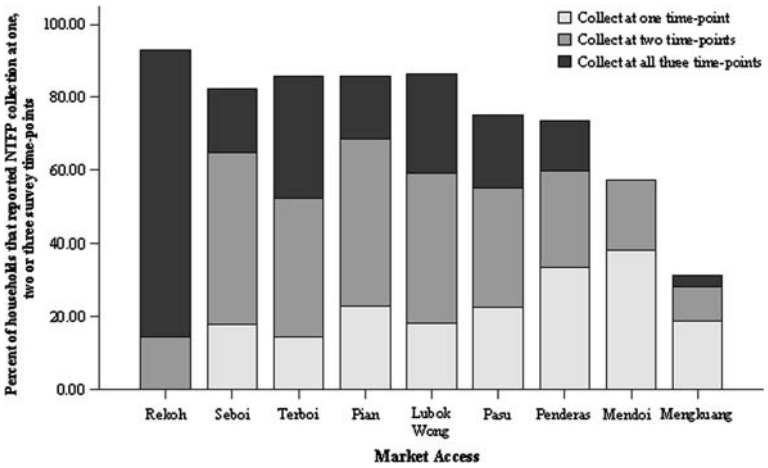

Fig. 2 Percentage of households that reported NTFP collection at one, two or all three survey time-points between March 2003 and March 2004 ($N = 259$). Villages are ordered from least market access (Rekoh = 1) to most market access (Mengkuang = 9)

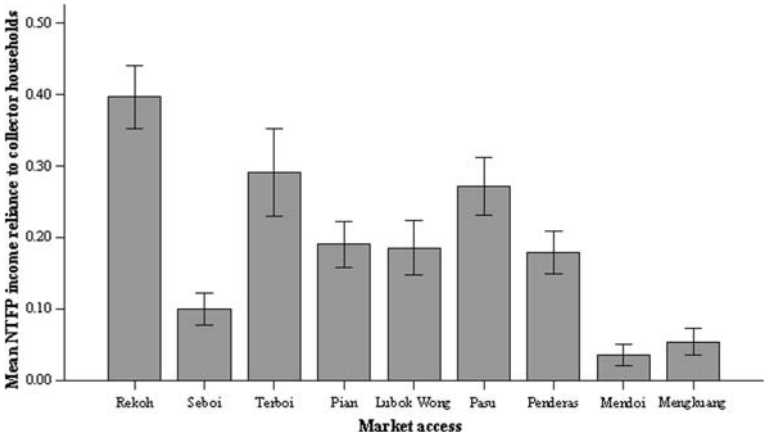

Fig. 3 Mean monthly NTFP income reliance for collector households in each village. Villages are ordered from least market access (Rekoh = 1) to most market access (Mengkuang = 9). Error bars represent ± 1 standard error

Mean monthly NTFP income (cash and subsistence) was computed for each village using NTFP income estimates from collector households only ($n = 188$). ANOVA tests revealed significant negative linear trends between market access and both forest cash ($r = -0.29$, $p < 0.001$) and subsistence income ($r = -0.16$, $p = 0.028$). Across all the villages mean monthly cash income was the highest for frogs and reptiles and herbs and resins, and was the lowest for fruits and mammals. Significant negative relationships were found between market access and cash income for construction materials ($n = 116$, $r = -0.18$, $p = 0.038$) and frogs and reptiles ($n = 115$, $r = -0.19$, $p < 0.037$), and a positive relationship was found for herbs and resins ($n = 47$, $r = 0.30$, $p = 0.052$).

Figure 3 shows that NTFP income reliance (the fraction of total income derived from NTFP) was the highest for Rekoh (40%) and tended to decline as market access improved.

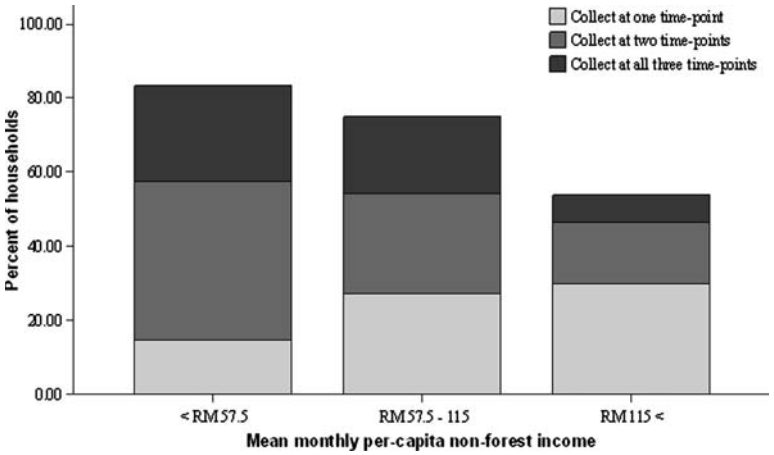

Fig. 4 Percentage of households in each per capita income group reporting gathering or hunting NTFP in one, two or all the three surveys between March 2003 and March 2004. Income groups represent absolute poverty ($n = 96$), moderate poverty ($n = 96$), and above the poverty threshold ($n = 67$). Malaysian poverty line = RM 115 per capita per month

NTFP income shares for households in Seboi were relatively lower than what might be expected given their poor market access because most of these households received high revenues from a government-subsidized rubber program. An ANOVA test for linearity between market access and income reliance was negative and significant ($n = 188$, $r = -0.25$, $p < 0.001$). Across most villages, collector households were reliant on frogs and reptiles, herbs and resins, and construction materials. Overall, collectors were least reliant on fruits and mammals, which generally supplied <5% of total income to collectors.[9] Market access was significantly negatively related to income reliance for frogs and reptiles ($n = 115$, $r = -0.15$, $p = 0.098$), and positively correlated with income reliance for herbs and resins ($n = 47$, $r = 0.32$, $p = 0.033$).

4.3 Income and NTFP collection characteristics

Figure 4 shows the percentage of households in each non-forest income group that participated in NTFP collection. Among households living in absolute poverty, moderate poverty, and above the per-capita Malaysian poverty threshold (based on non-forest income only) NTFP collection participation was, respectively, 83%, 75%, and 54%. A chi-square test revealed a statistically significant negative relationship between the household collection decision (collect or not collect) and the ordinal income group variable ($\chi^2(1, N = 259) = 16.51$, $p < 0.001$). The percentage of households that reported collection at all three time periods was the highest at 26% for the absolute poverty group, decreased slightly to 21% for the moderate poverty group, and decreased substantially to 7.5% for the least-poor group ($\chi^2(1, N = 259) = 8.30$, $p = 0.004$), indicating that the poorest households were more likely to engage in NTFP collection on a routine basis, whereas the wealthier households tended to collect infrequently.

[9] Given the proximity of the sampled households to the Krau Wildlife Preserve the relatively sparse data on hunting may have been due to a reluctance to declare animal species under protection status (e.g., pangolin).

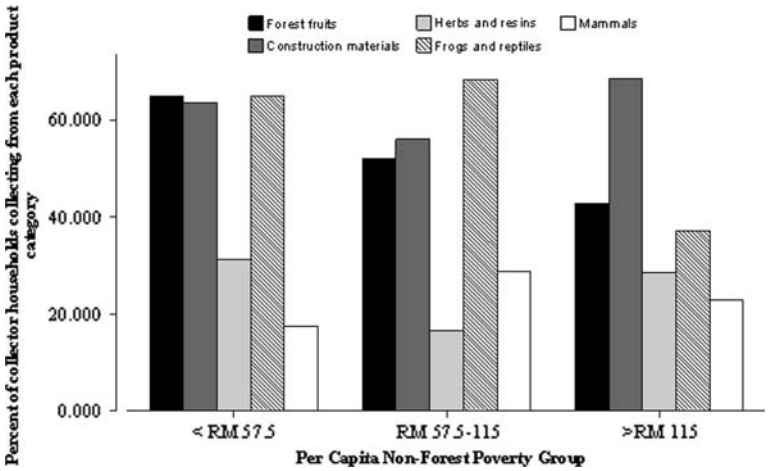

Fig. 5 Percentage of collector households in each per capita non-forest income group that reported collecting various NTFP types. Income groups represent non-forest incomes below the absolute poverty line ($n = 80$ collector households), non-forest incomes below the poverty line ($n = 72$ collector households), and non-forest incomes above the poverty line ($n = 36$ collector households)

The percentage of collector households in each non-forest income group that reported collection from each of the five NTFP categories is shown in Fig. 5. Collection participation for fruits was the highest in the absolute poverty group and decreased as non-forest income increased (χ^2 (1, $n = 188$) $= 5.89$, $p = 0.01$). For frogs and reptiles, collection participation was the highest for the two poverty groups and substantially lower for the group above the poverty line (χ^2 (1, $n = 188$) $= 4.87$, $p = 0.027$). Relationships between non-forest income group and collection regularity for collectors were statistically significant for fruits ($r = -0.15$, $p = 0.046$), herbs and resins ($r = -0.12$, $p = 0.096$) and frogs and reptiles ($r = -0.21$, $p = 0.004$) only.

Mean monthly household NTFP cash and subsistence income was computed for collector households within each income group. The group considered as living in absolute poverty (based on non-forest income) generated the highest mean monthly NTFP cash income (RM 118, USD 31), with this reliance decreasing as monthly per-capita non-forest income increased. An ANOVA test for linearity revealed a significant negative relationship between non-forest income group and NTFP cash income ($n = 188$, $r = -.26$, $p < .001$). Mean monthly subsistence income from NTFP was rather low and invariable across income groups. For individual NTFP categories, mean monthly cash income estimates for construction materials, herbs and resins, and frogs and reptiles were the highest for the absolute poverty group. For the least-poor group, fruits generated the highest mean monthly cash income. Cash from mammals was negligible across all the income groups as most hunting households consumed their harvest. Only cash income from frogs and reptiles was statistically significantly related to non-forest income group ($n = 115$, $r = -0.23$, $p = 0.017$), reflecting the good commercial value of this product.

For NTFP income reliance, our results indicated that collector households living in absolute poverty relied on NTFP to supply, on average, 31% of total monthly income. This reliance dropped to 14% for households in the moderate poverty group, and fell to 8% for the least-poor group. The relationship between income reliance and non-forest income was highly significant ($n = 188$, $r = -0.48$, $p < 0.001$). Figure 6 displays the relationship

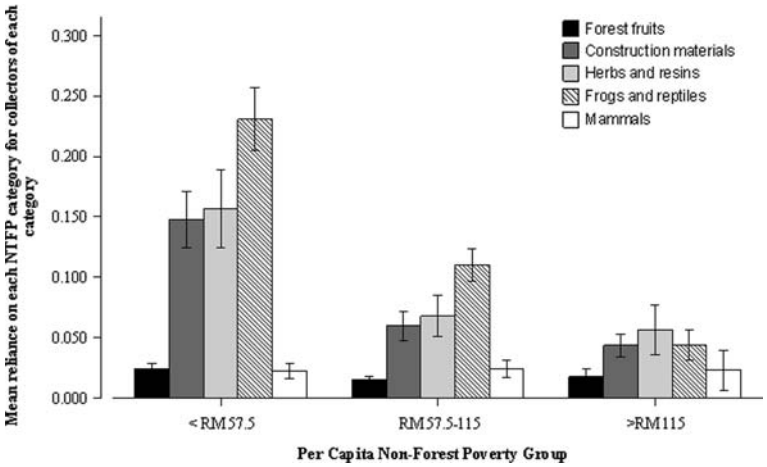

Fig. 6 Mean monthly product income reliance for collectors of each product within each per capita income group. Error bars represent ± 1 standard error

between NTFP reliance on individual NTFP categories and income level. Reliance on fruits and mammals was low and showed little variance within or between income groups. Reliance on construction materials, herbs and resins, and frogs and reptiles was the highest for the absolute poverty group and decreased for the moderate poverty and least-poor groups. Significant relationships were found between non-forest income group and reliance for construction materials ($n = 116$, $r = -0.34$, $p < 0.001$), herbs and resins ($n = 47$, $r = -0.34$, $p = 0.021$), and frogs and reptiles ($n = 115$, $r = -0.43$, $p < 0.001$).

5 Discussion

Most *Jah Hut* households participated in more than one income-generating activity, indicating that diversification may have been an important livelihood strategy to smooth consumption and income over time or to prevent households from falling deeper into poverty. Both the prevalence of collection and the range of NTFP collected support the claim that forest resource abundance and diversity are important to the livelihoods of *Jah Hut* households. Consistent with findings from past research, the average annual income earned from NTFP was low relative to income from other on- and off-farm sources. Yet at 20%, NTFP income certainly was a sizable portion of total income and likely supplied supplemental cash and subsistence when other sources failed to meet household needs. Further, results from group-level analyses support the assertion that NTFP are most important to the most remote and poorest households within these forest-fringe communities—households that may be most vulnerable to fluctuations in economic, political, and environmental conditions. Understanding the behaviors and needs of such groups is essential to designing efficient and equitable forest protection plans.

Households in remote villages and with lower non-forest incomes were most likely to collect NTFP and tended to engage in NTFP collection most regularly. Because these households presumably had fewer non-forest income sources and, thus, lower opportunity costs of time in collection, NTFP may have been used to supplement non-forest income, fill regular income gaps, or provide primary income when other employment was unavailable.

For households with better market access or higher non-forest incomes, NTFP collection was less prominent, and may have been pursued only when returns to collection would be the highest, in response to cash shortages, or because of preferences for seasonal forest products. Alternatives explaining wealthier households' reliance, albeit low, on NTFP include household preference as opposed to need (e.g., recreation, festival, hobby) and filling income gaps due to seasonal cash shortfalls.

The negative relationships observed with market access and income group for NTFP collection participation and regularity appeared to be driven by fruits and construction materials—products for which returns were low, physical labor requirements were high, and for which market substitutes were likely available to wealthier, more market-integrated households. Although frogs and reptiles tended to be collected for cash income and yielded relatively high returns compared with other NTFP, the requirements of collection (e.g., searching in remote forests throughout the night) were likely incompatible with regular daytime employment and, thus, not readily adopted by households near markets or with greater non-forest incomes.

Collection participation and regularity for herbs and resins and mammals were unrelated to market access and income group. Although herbs and resins tended to garner relatively high prices, their collection entailed extensive time commitments and a high risk of failure. Hunting, too, required significant time investments and potentially low success rates. The observation that participation in hunting tended to be relatively high for households with favorable market access and higher non-forest incomes may imply that hunting provided recreation or leisure for these households. Indeed, hunting expeditions usually required planning and were often pursued in response to specific market demands or festival needs. Hunting decisions by other collector households may have been influenced by their opportunity costs of purchasing meat from the market, the availability of livestock for consumption, or their perceived returns to hunting relative to those from products whose harvests entailed less uncertainty.

Similar to patterns observed for collection participation, NTFP reliance tended to be negatively related to market access and non-forest income. The exception was herbs and resins. The positive relationship between market access and herbs and resins reliance may have been due to NTFP specialization by households nearer to markets who, because herbs and resins promised high returns when extracted successfully, may have replaced non-forest income with income from this product category. The negative relationship observed between market access and income reliance on frogs and reptiles suggests that remote households may have collected this product to meet primary income needs, which were not supplied by other sources.

Collectors' non-forest income group membership was strongly negatively correlated with reliance on construction materials, herbs and resins, and frogs and reptiles. Income reliance from each of these product categories was significantly higher for the absolute poverty group than for either of the other two income groups. This finding suggests the importance of both NTFP abundance and diversity to the welfare of the poorest *Jah Hut* households, who presumably pursued NTFP collection in response to insufficient income from other sources (e.g., agriculture for households with smaller landholdings). For example, several *Jah Hut* households offered that NTFP were collected only when extra income was needed and odd-jobs were unavailable.

As a post hoc analysis, we examined the effect of NTFP income on poverty status for *Jah Hut* households at each of the three sampling phases as well as across the three surveys (Table 4). Although causality cannot be confirmed, these results support the possibility that NTFP income may have been important (as has been suggested by other studies) for

Table 4 Number of households by poverty status with and without NTFP income across three sampling phases. Values in cells are counts of households

	Survey 1 (March 2003)		Survey 2 (October 2003)		Survey 3 (March 2004)		All surveys (Aggregated)	
	Non-forest income	Non-forest plus NTFP income	Non-forest income	Non-forest plus NTFP income	Non-forest income	Non-forest plus NTFP income	Non-forest income	Non-forest plus NTFP income
Absolute poverty	117	86	103	82	103	76	96	65
Below poverty line	72	78	69	78	79	86	97	109
Above poverty line	70	95	87	99	77	97	66	85

Note. Poverty status categories are: Absolute poverty (<RM 57.5 per capita per month); Below poverty line (RM 57.5–RM 115 per capita per month); Above poverty line (>RM 115 per capita per month)

Survey 1: NTFP income resulted in 31 households moving out of the absolute poverty category and in 25 households moving above the poverty line

Survey 2: NTFP income resulted in 21 households moving out of the absolute poverty category and in 12 households moving above the poverty line

Survey 3: NTFP income resulted in 27 households moving out of the absolute poverty category and in 20 households moving above the poverty line

Aggregated Surveys: NTFP income resulted in 31 households moving out of the absolute poverty category and in 19 households moving above the poverty line

keeping households above the poverty line, or for keeping them from falling deeper into poverty. Indeed, given the numbers of households below the poverty thresholds in each of the three surveys compared to the numbers below those thresholds when the surveys were aggregated, there was a fair degree of household income fluctuation across the 18 months represented by the three sampling phases. NTFP may have served as an income stabilizer under such conditions.

Substantial variability with respect to NTFP collection participation, regularity, and income reliance was observed across the *Jah Hut* sample and by product type. Collection participation and NTFP reliance generally increased as market access and non-forest income decreased (Vedeld et al. 2004). The product-specific analyses highlighted the importance of disaggregating NTFP collection into product types when attempting to identify group- and household-level characteristics that may influence NTFP collection variables, as different products are used for different purposes and involve different levels of skill and effort. These results were consistent with those reported from other rural samples (e.g., Coomes et al. 2004; Takasaki et al. 2004) and, as has been suggested by recent research (Arnold and Ruiz Pérez 2001; Sills et al. 2003), warrant further investigation into the various factors that may motivate collection of different products.

6 Conclusion

Results from the current project confirm the importance of maintaining healthy and abundant forests in regions inhabited by *Jah Hut* villages and, in particular, the importance of NTFP to the poorest households in the sample. The identification of specific product

types for which collection participation and reliance may be high could provide insight into NTFP that may be susceptible to overharvesting or for which the development of more formal markets and well-defined property rights may be beneficial. Further, if households were seeking NTFP in response to poverty, as may have been the case, the alleviation of this poverty may reduce pressures on scarce forest resources, particularly those that were collected for cash income (e.g., construction materials, frogs and reptiles, herbs and resins). Such information could prove useful to forest managers or economic planners, as the well being of the poorest and least market-integrated *Jah Hut* households may hinge on their ability to harvest these forest products in a sustainable manner when other income-generating opportunities are unavailable. Indeed, impoverished households that rely heavily on NTFP income may be doing so because they have no alternatives (Byron and Arnold 1999). Thus, if forest access were to be denied, these households could lose the little income they may have—especially during lean times—and, thus, fall deeper into poverty.

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