Sustainable of extraction of non-timber forest products (NTFP) in Dipterocarp-dominant lowland rain forests – a case study in southwestern lowland rain forest in Sri Lanka

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Abstract

A study was carried out in Sri Lankan southwestern lowland tropical rain forests to obtain background information to support decision-making in sustainable extraction of NTFP. The research sites were located in the Dipterocarp-dominant forests within Kanneliya and Sinharaja protected areas, where 36 plots of 10mx10m were surveyed with the objectives of documenting NTFP site data, high-priority species, abundance, pattern of distribution, seasonality, available harvestable quantities, manpower requirements for harvesting, activity timing, cost associated with operations and cash incomes. Field data were gathered in collaboration with the local communities and hence, the results are heavily based on community perception, observation and inference. The results showed that the most important NTFP species (19) are *Enicosanthus accuminata, Ochlandra stridula, Garcinia quaesita, Dipterocarpus glandulosus, Doona venulosa, Hopea discolor, Hopea jucunda, Shorea congestiflora , Shorea* sp., *Cinnamomum multiflora, Cinnamomum verum , Coscinium feneatratum, Calamus digitatus, Calamus ovoides, Calamus pseudotenuis , Calamus radiatus, Calamus thwaitesii, Caryota urens* and *Pandanus ceylanicus.* Density of priority NTFP species, which are harvestable individuals, ranged from 11 per ha to 242 per ha. On average cash income from NTFP, harvested in conservative manner, was Rs.7132 (USD 72) per ha per year with an input of manpower worth Rs.2000.00 (USD 21) per ha per year in 2004. January and December were identified as the peak NTFP harvesting months. For ecological and economic sustainability of the NTFP extractions in those forests, more action oriented research are required to shed light on the biological safe limits of NTFP extraction, low impact harvesting techniques, best harvesting time for different species, domestication of NTFP species and marketing of NTFP.

Key words: Sri Lanka, NTFP, dipterocarps.

Introduction

Rain forests in Sri Lanka located in the southwest part of the country are exceptionally rich in plant diversity. However, presently they existed as fragmented forest patches. Although 23.88% of Sri Lanka is covered with natural forests, only 2.14% is natural lowland wet evergreen forests (Legg and Jewlle1995) that are dominated by dipterocarps.

The major causes for rainforest loss in Sri Lanka are deforestation and forest degradation. Deforestation occurs mainly due to the collection of fuelwood from the forests, permanent agriculture, shifting cultivation, tree plantations, fire, illegal gem mining in forest land, urbanization and timber felling. The absence of well-defined forest reserve boundaries has exacerbated the problem. Rain forests are also adversely affected due to the over-collection of forest plants and animals for commercial uses such as fish for the aquaculture trade, plants for medicinal purposes, etc., that leads to the rapid depletion of forest resources. Therefore, sustainable management of Non-timber forest products (NTFP) extraction from forests has been gaining ground in forestry sector for the wellbeing of forest ecosystem as well as associated local people.

NTFP refers to all natural resources from forests apart from sawn timber (Secretariat of the Convention on Biological Diversity 2001). The recent advances in NTFP related activities in forestry sector in Sri Lanka are due to several factors:

- NTFP contributes in many ways to the livelihoods of people living in adjacent areas of forests, providing them with food, medicines, fibres, resins, rattan, bamboo and the like.
- Harvesting of NTFP is less destructive than timber felling and hence it is a better way of resource use.
- Economic values of NTFP of natural forests contribute to conserving the forests rather than converting them into other land uses.
- Sustainable harvesting of NTFP conserves the indigenous knowledge of the rural communities.

The main objective of this study was to obtain background information to support decision-making in sustainable extraction of NTFP in Dipterocarp-dominant forests in Kanneliya and Sinharaja protected areas of Sri Lanka. Attention was paid to gather information on the following aspects of the high-priority NTFP species:

- Demography of NTFP relevant plant species.
- Harvestable NTFP quantities and their seasonality.
- Cash income from NTFP.
- Manpower requirements for harvesting.
- Activity timing for sustainable NTFP harvesting operations.
- Ecological and economic sustainability of NTFP extraction.

Material and method

Site description

The study sites are located in two protected rain forest areas, Kanneliya ($6^0$10' N- $6^0$18 N' and $80^0$19' E - $80^0$26' E) and Sinharaja ($6^0$21'N-$6^0$26'N and $80^0$21' E - $80^0$34' E), in the southwestern part of Sri Lanka. The region receives about 2 500 mm to 5 000 mm of rainfall, with no drought months. The altitude extends from sea level to about 1 000 m. The area is under bioregion (4), classified as lowland wet zone, where tropical lowland wet evergreen forests are the climax formation, and are dominated by Dipterocarp

species. The forests are characterized by a dense canopy of tree species reaching 30 to 40 m in height, with emergent species rising to about 45 m, and woody lianas that form an intricate network (Gunetilleke and Gunetillke 1990).

Plot layout
Rectangular plots of the size 50m x100m were laid out in natural and buffer zone (slightly disturbed) forests at both sites:

Plot 1. Kanneliya - Natural forest
Plot 2. Kanneliya - Buffer zone forest
Plot 3. Sinharaja - Natural forest
Plot 4. Sinharaja - Buffer zone forest

Plots 1 and 2 were 1.5 km apart in the Kanneliya forest close to the Forest Department office ($80^0$20N $06^0$15E), while plots 3and 4 were 1 km apart in the Sinharaja forest in the vicinity of the Pitadeniya village ($80^0$30N $06^0$22E). The two main sites, Kanneliya and Sinharaja, were some 28 km apart, but both areas were covered with well-developed lowland rain forests.

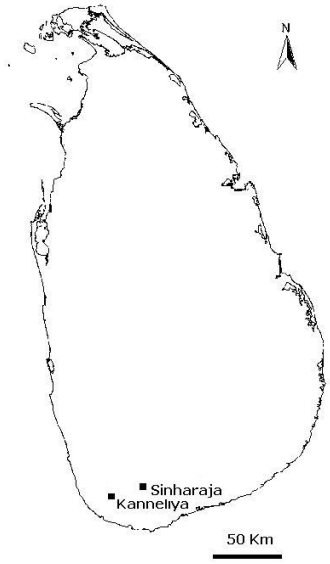

Figure 1. Line map of Sri Lanka showing the locations of study sites in South Western lowland rain forests.

Nine sub plots of size 10mx10m, were marked symmetrically in the main plot as shown in Figure 2, for collecting data on key NTFP plant species. Similar plot sizes have been used in studies elsewhere (Martin 1995).

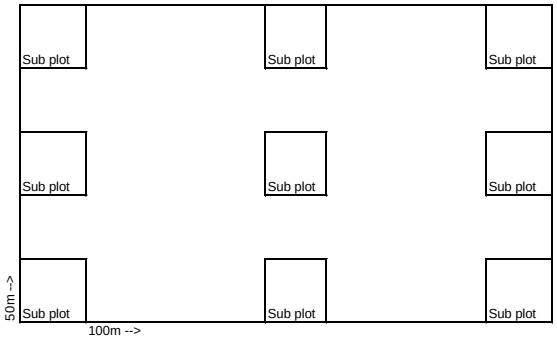

Figure 2. Layout of main plot (50mx100m) and its sub plots (10mx10m).

Data collection

Data collection was carried out in 2004, and the process was heavily depended on knowledge of the local communities; supplemented with semi-structured interviews, walks with key informants and direct observation (Jakson & Ingles 1998). As a primary survey, a general list of NTFP species in the localities were prepared through field works, discussions with local people and observations of plant materials. Discussions were tape recorded for further analysis. Details on high priority NTFP species (those with marketable NTFPs with significant cash income as per local perception), demography (density and pattern of distribution), seasonality, available NTFP harvest quantities, man power requirements for harvesting works, activity timing, cost associated with operations and cash income of products, were recorded in the field in consultation with local people. Occurrences of high priority NTFP species including seedlings, saplings or mature plants were also recorded for different sub plots. Botanical identification was done at the National Herbarium of Sri Lanka.

Results

Demography of high-income NTFP plant species

During the survey 19 plant species were recognized in sampling plots as high priority NTFP species They are *Calamus digitatus, Calamus ovoides, Calamus pseudotenuis, Calamus radiatus, Calamus thwaitesii, Caryota urens, Cinnamomum multiflora, Cinnamomum verum, Coscinium feneatratum, Dipterocarpus glandulosus, Doona venulosa, Enicosanthus accuminata,Garcinia quaesita, Hopea discolor, Hopea jucunda, Ochlandra stridula, Pandanus ceylanicus. Shorea congestiflora* and *Shorea* sp..Their details are given in Annex I. Their frequencies of occurrence in different forest sub plots are as shown in Table1. Annex II shows the density of mature plant individuals of those species that could provide NTFP income in the year 2004, when the field works were carried out.

Table 1. Frequencies of occurrence of high-income NTFP plant species in different forest plots.

Plant name	Frequency of occurrence in sub plots			
	Kanneliya forest site		Sinharaja forest site	
	Buffer zone forest plot	Natural forest plot	Buffer zone forest plot	Natural forest plot
1.Calamus digitatus	Absent	Absent	4	Absent
2.Calamus ovoides	Absent	Absent	Absent	2
3.Calamus pseudotenuis	Absent	1	1	3
4.Calamus radiatus	1	Absent	6	6
5.Calamus thwaitesii	2	Absent	Absent	Absent
6.Caryota urens	Absent	Absent	8	6
7.Cinnamomum multiflora	Absent	5	2	1
8.Cinnamomum verum,	Absent	1	2	Absent
9.Coscinium feneatratum,	1	5	4	3
10.Dipterocarpus glandulosus,	1	2	Absent	Absent
11.Doona venulosa	1	Absent	Absent	Absent
12.Enicosanthus accuminata	Absent	8	Absent	Absent
13.Garcinia quaesita,	Absent	2	3	Absent
14.Hopea discolor	Absent	2	2	Absent
15.Hopea jucunda	7	Absent	2	Absent
16.Ochlandra stridula	Absent	1	2	Absent
17.Pandanus ceylanicus	Absent	Absent	Absent	2
18.Shorea congestiflora,	Absent	4	4	1
19. Shorea sp.	1	Absent	Absent	Absent

Note: The numerical values indicate the number of sub plots per plot where the respective plant species (seedlings, saplings or mature plant) was present.

NTFP harvest and cash income

Estimates of different types of harvestable NTFP quantities, best harvesting time and the units of measurements have been summarized in Annex III. It should be noted that harvestable NTFP quantities given for *Caryota urens* (Kithul) is zero for the reason that, although the trees are mature the flowering could not be predicted. According to informants the yield estimates were also highly variable. All the trees encountered were identified as 'Renakithul' or 'Genukithul' by the local people; a specific morphological Kithul variety (or land race) of inferior type. They consider it the last species option in Kithul tapping.

Based on the harvestable NTFP quantities, income estimates, as per year in 2004, were calculated. These are as shown in Annex IV for different NTFPs and it showed that income varied from Rs.1 098 (USD 11) to Rs. 4 625 (USD 46) per 0.5 ha plot per year. On average the cash income is Rs.7 132 (USD 71) per ha per year. Cost of sustainable harvesting of NTFP in a year was estimated based on some proposed operational activities as shown in Annex V, and it ranges from Rs. 750 (USD 7.5) to Rs.1 250 (USD 12.5) per 0.5 ha plot. That is, on average, Rs. 2 000 (USD 20) per ha per year would be needed as manpower input for NTFP harvesting.

Discussion

Demography of high-income NTFP plant species
According to the sampling studies it was interesting to note that some plant species were confined to a one locality. Species such as *Dipterocarpus glandulosus, Enicosanthus accuminata, Doona venulosa, Shorea* sp. and *Calamus thwaitesii* were encountered only at Kanneliya forest site, while *Calamus ovoides, Pandanus ceylanicus, Caryota urens* and *Calamus digitatus* were encountered only at Sinharaja forest site. Meanwhile, ten species were recorded at both the sites. They are *Cinnamomum multiflora, Shorea congestiflora, Calamus pseudotenuis, Coscinium feneatratum, Calamus radiatus, Cinnamomum verum, Ochlandra stridula, Hopea discolor, Hopea jucunda* (occurred only in buffer zones) and *Garcinia quaesita*. Similarly, at Kanneliya, *Doona venulosa, Shorea* sp. and *Calamus thwaitesii* were recorded only within the plot established in its buffer zone, and *Enicosanthus accuminata* was confined to natural forest there. At Sinharaja site, *Calamus digitatus* was recorded only in its buffer zone site, while *Calamus ovoides* and *Pandanus ceylanicus* were recorded only within the natural forest site there.

Distribution of NTFP plants within the sampling plots showed some interesting features. Species like *Enicosanthus accuminata , Hopea jucunda, Calamus radiatus* and *Caryota urens* were spread over as much as 6-8 sub plots. Other species were less scattered within the plot. It needs further ecological research to understand such hererogenous distribution of tropical plants in those sites. However, the important message to forest managers is, that if they are to develop plans for sustainable extraction of NTFP, they have to follow site-specific approach rather than replicating a model developed for a particular site.

As shown in Annex II, the density of mature harvestable individuals was also highly varied, and, naturally, smaller life forms (shrubs and lianas) were numerous. *Dipterocarpus glandulosus, Doona venulosa* and *Calamus thweitesii* were encountered as only one individual in the entire area surveyed, hence an estimate of 11 individuals per ha for the respective site. *Calamus radiatus* was recorded as the most numerous individual per site and 22 individuals (242 individuals per ha) were encountered at the buffer zone site of Sinharaja forest. Seemingly, illegal exploitation pressure has a role in reducing the density of certain plant species, especially *Dipterocarpus glandulosus,* which has been endangered by destructive NTFP harvesting practices.

Cash income from NTFP and its livelihood sustainability
January and December are the peak NTFP harvesting months, hence if NTFP extraction programme is to be developed by foresters, these temporal dynamics have to be considered for best results.

According to the NTFP income data, the figures are highly variable depending on the NTFP types and combinations. However, in general there is an income of Rs.7 132 (USD 71) per ha per year, and to get that one has to put an effort valued at Rs. 2 000 (USD 20) per ha per year. Hence, the average NTFP net income is Rs. 5132 (51 USD) per ha per year from those forest sites, barely sufficient to provide a village family with basic needs.

Therefore, one can safely come up with a general statement on economic sustainability of NTFP extraction, that under the present (2004) circumstances, it requires 12 ha of forest area to support one village family, based on sustainable NTFP extraction, for a period of 12 months.

Issues and ground realities

It was noted that the number of NTFP and associated parameters of the guidelines might vary according to the context of interview, the quality of interaction with people, length of study, market research, yield studies, and ecological dynamics.

NTFP yield of certain plant species are not annual events. For instance, Beraliya, fruit of several Dipterocarp species is a highly valued source of food (starch from fruits). But their availability is not predictable - often every five or seven years. Flowering and fruiting is usually a result of a complex interaction of environmental factors and biochemistry of plants. Such 'unorthodox' behaviour of certain tropical plant species has not been considered in the present investigation.

Wild mushrooms are an important NTFP in both localities, but they are highly seasonal, unpredictable and mostly untraceable. They are not taken into account in the present study.

It should be noted that the NTFP data relevant to a particular site considered in the present survey may not be applicable to a similar sized plot nearby, mainly because of the uneven distribution of the NTFP species. As an interesting phenomenon, many NTFP species showed their unusual clustering in certain locations, locally known as 'Mandi', in the forest landscape, such as Kithul Mandi, Wewel Mandi, Banwel Mandi, etc.

Preliminary guidelines for sustainable extraction of NTFP:

- Sustainability is the core concept that has to be addressed in extracting NTFP. In this regard several factors have to be considered: better economic returns, NTFP extraction without endangering the plant populations and adaptability to rural setting.

- It is important to understand the effect of harvesting in terms of changes in the ability of the species to replenish itself and maintain a given level of stock. List of premature plants (regenerating populations), their abundance and distribution largely contributes to making decisions on extraction specifications that are best 'guesstimates'.

- A precise calculation of the maximum level of sustainable harvesting would require monitoring of populations over a number of years, a technique which require much time and efforts especially in tropical ecological systems. Declines in reproductive potential can occur if too many adults are harvested or if not enough young live to become reproductive adults. Growth rates are important for understanding how often the resource can be harvested without harming future

growth. For example, collecting too many leaves from an individual plant can reduce the new ones, perhaps also the flowers and fruits that could be produced. Similarly, depletion of the soil nutrients in the long run can affect the productivity of forest sites.

- Intensive agronomic, silvicultural and tillage operations need not be adopted in order to meet the maximum economic yield and ecological safety. Although artificial forest regeneration or assisted forest regeneration for NTFP extraction is desirable, the technical uncertainties and costs involved do not fall in line with concept of sustainability. Almost all species lack research base for such ventures, especially the knowledge pertaining to phenology, seed germination, specific environmental factors like soil, water and light, companion species, dispersal agents, pollinators, pests etc. Haphazard enrichment of the forest with NTFP species is not desirable.

- Harvesting need to be carried out only during the driest month (January) in order to maximize the productivity of human resources and minimize the physical damage to the forest plot.

- Use the barest minimum number of access footpaths within the forest plot to minimize the impact on regenerating forest species.

- Care should be taken not to damage the other plants when harvesting NTFP.

- Residual plant parts after harvesting the products need to be retained in the forest for the sustainability of ground fertility.

Product specific preliminary guide to sustainable extraction of NTFP
Resin tapping: Tapping of resins from Dipterocarp species need to be carried out with due care for the survival of the trees. Always select trees of size 40cm gbh or bigger, which is considered to be mature enough for resin tapping. Trees of lower girth classes are not to be tapped since any damage done to them may adversely affect their growth. Middle-aged trees are said to yield more resins. Tapping can be started in December when dry weather sets in. So far no definite method of tapping has been evolved. Traditionally, it is a practice of wounding the bark with knife to expose the inner bark and a bit of wood. It is suggested that cutting a V shaped grove, 1 cm deep with two 15 cm long branches, could facilitate collecting of resin at the lowest point of the V. Preferably, a collecting device can be fixed similar to that for pine resin tapping, but of a larger size. The tapping can be done at 30 cm above ground level using a sharp axe or knife. Number of tapping points will depend on the girth of the tree; in larger trees several tapping points may be made. Cutting of deeper groves is not likely to be of any use and rather it may damage the tree and delay the process of healing. Damaging of a large portion of the bark does not seem to be successful in the long run as the trees are likely to be badly affected by infections and growth retardation. Sometimes, the large wounds on the bark lead to the premature death of the tree. The resins may be collected from the same groove again after one month, when the bark heals to yield the next round

of resin. The resin tapping may be continued once in two years so as to give a recovery period for the trees.

Cane harvesting: Usually, cane can be harvested in 5-year-cycles to ensure sustainability. They should be collected when the leaf sheath starts browning and the bottom portion is exposed. Dry season (December, January and June) is the best season for harvesting when they can be dried quickly in the sun to avoid discoloration. After the canes are pulled from the supporting trees, the leaves and leaf sheaths need to be removed at once. The top portion of the culm, which is weak and unsuitable for general purpose, is removed.

Bamboo harvesting: Mature culms can be harvested at ground level. January would be the best month. The main stem of the cleaned bamboo reeds can be taken away from the plot. Two-year harvesting cycled is prescribed for the ecological sustainability.

Pruning of Enicosanthus accuminata (Walwaraka) trees: Complete pruning of all branches below 3 m from the top of the crown is prescribed. Care should be taken not to damage the main trunk. The trees are fast growing and the branch wood can be harvested every other year. Only the cleaned wood needs to be removed from the plot leaving the rest. January would be best month for the harvesting.

Harvesting of Garcinia quaesita (Goraka): The fruit is a popular spice. It is globose fleshy fruit, yellow or red in colour with 6-8 groves. The fruiting season is usually a month before the dry season (November). However, exceptions are not uncommon. Fruits can be harvested by shaking the branches of the trees. Only the fleshy fruit carpels can be taken away from the plot leaving the seeds for regeneration. Harvesting can be done every year.

Harvesting of Cinnamomum spp.*(Kurundu and Walkurundu):* Harvesting can be done in June when the dry condition prevails. During February-April, a new reddish flush of leaves appears. It is said that this flush assumes the normal green leaf colour, usually in June-July. The stems are easily peeled. This is therefore the correct time for harvest. The tops of the stems and branches are first lopped off. Only the mature stems with brown bark are cut off from the bottom. After several years of harvest, cutting is done in such a way that the cut faces face inside the clump and not outwards. This has found to promote re-tillering.

Harvesting of Coscinium feneatratum (Banwel or Weniwelgeta): This highly valuable medicinal product can be harvested in the month of December when rains subsides. Woody liana stem can be cut off 50 cm above the base, leaving short stump for coppicing. Only the mature stem parts are taken out. Three-yearly harvesting cycles would be ideal.

Harvesting of Pandanus ceylanicus (Dunukeyya): This is simply the cutting off of mature leaves, keeping the young leaves and growing apex of the plant intact. December would be the ideal time for harvesting when the dry season commences.

Conclusions

Tropical rain forests in Kanneliya and Sinharaja in Sri Lanka have the potential to provide diverse NTFPs from diverse forest species, which are unevenly distributed in the forests.

Site-specific variations of NTFP composition and yield need to be taken into account when developing future programmes on sustainable extraction of NTFP in southwestern rain forests in Sri Lanka.

Generally, an average village family in the vicinity of forest areas needs at least 12 ha forest area for their livelihood sustainability when low impact methods are used in the extraction of NTFPs.

Considering present status of existing tropical rain forests in Sri Lanka, the extraction of NTFPs for social wellbeing should be carried out on sound scientific grounds, and it is appropriate to promote NTFP extraction as a supplementary income avenue rather than the mainstream livelihood base of peripheral communities.

Bibliography

Secretariat of the Convention on Biological Diversity. 2001, *Sustainable management of non-timber forest resources*. Montreal, SCBD, 30p. (CBD Technical Series no. 6).

Gunatilleke, I.A.U.N. & Gunatilleke. C.V.S. 1990. Distribution of floristic richness and its conservation in Sri Lanka. *Conservation Biology* 4:21–31

Jakson, W., J. & Ingles, A.W. 1998, Participatory techniques for community forestry: A field manual, IUCN, Gland, Switzerland and Cambridge, UK and World Wide Fund for Nature, Gland, Switzerland, 124 pp.

Legg, C. & Jewell, N. 1995. A1:50,000-scale forest map of Sri Lanka; the basis for a National Forest Geographic System. *The Sri Lanka Forester,* Special Issue (Remote sensing): The Sri Lanka Forest Department, Battaramulla, Sri Lanka, pp. 3–24

Martin, G. J., 1995. *Ethnobotany : a methods manual*. Chapman & Hall, London ; New York, 268p.

Annex I High priority NTFP species recorded at Kanneliya and Pitadeniya demonstration plots.

Plant family	Genera	Species	Life form	Local name	Product	Remarks
Annonaceae	*Enicosanthus*	*accuminata*	*Tree*	Walwaraka	Branch wood	The flexible nature of wood (splints) has become useful in basket making and other wicker work. Wood makes the skeleton for the wawing with bamboo. Trees above 15cm gbh can be harvested.
Bambusaceae	*Ochlandra*	*stridula*	*Shrub*	Bata	Bamboo reeds	A popular raw material for basket weaving.
Clusiaceae	*Garcinia*	*quaesita*	*Tree*	Goraka	Spice	The sun dried fruit slices are a valuble spice.
Dipterocarpaceae	*Dipterocarpus*	*glandulosus*	*Tree*	Dorana	Resin	A kind of Dammars obtained by tapping the bark. Trees above 40cm gbh can be tapped.
Dipterocarpaceae	*Doona*	*venulosa*	*Tree*	Yakahalu	Resin	do
Dipterocarpaceae	*Hopea*	*discolor*	*Tree*	Yakahalu	Resin	do
Dipterocarpaceae	*Hopea*	*jucunda*	*Tree*	Yakahalu	Resin	do
Dipterocarpaceae	*Shorea*	*congestiflora*	*Tree*	Thiniyadun	Resin	do
annonaceae	*Shorea*	*sp.*	*Tree*	Panamoradun	Resin	do
Lauraceae	*Cinnamomum*	*multiflora*	*Tree*	Wal kurundu	Bark	Processed bark is a spice and source of essential oil. Trees above 5cm gbh can be harvested.
Lauraceae	*Cinnamomum*	*verum*	*Tree*	Kurundu	Bark	Processed bark is a spice and source of essential oil. Trees above 5cm gbh can be harvested.
Menispermaceae	*Coscinium*	*feneatratum*	*Liana*	Ban wel	Medicinal	Mature stem is a valuble madicinal product. Stems above 5cm gbh can be harvested.
Palmae	*Calamus*	*digitatus*	*Liana*	Kukul wewel	Cane	A valuble raw material for handicrafts.
Palmae	*Calamus*	*ovoides*	*Liana*	Wewel	Cane	A valuble raw material for handicrafts.
Palmae	*Calamus*	*pseudotenuis*	*Liana*	Kolahanguna wel	Cane	A valuble raw material for handicrafts.
Palmae	*Calamus*	*radiatus*	*Liana*	Kukul wewel	Cane	A valuble raw material for handicrafts.
Palmae	*Calamus*	*thwaitesii*	*Liana*	Mawewel	Cane	A valuble raw material for handicrafts.
Palmae	*Caryota*	*urens*	*Tree*	Kithul	Sap	A valuble source of income. Made into Toddy and Juggery.
Pandanaceae	*Pandanus*	*ceylanicus*	*Shrub*	Dunukeyya	Leaves	Mature leaves are used to make handicrafts.

Annex II Density of high income NTFP plants.

				No.of Individuals per 9 sub plots				Estimated no.of Individuals per 0.5 ha plot.			
Plant family	**Genera**	**Species**	**Local name**	Sinharaja Natural Forest site	Sinharaja Buffer zone Forest site	Kanneliya Natural Forest site	Kanneliya Buffer zone Forest site	Sinharaja Natural Forest site	Sinharaja Buffer zone Forest site	Kanneliya Natural Forest site	Kanneliya Buffer zone Forest site
Annonaceae	*Enicosanthus*	*accuminata*	Walwaraka	0	0	12	0	0.0	0.0	66.0	0.0
Bambusaceae	*Ochlandra*	*stridula*	Bata	0	18	15	0	0.0	99.0	82.5	0.0
Clusiaceae	*Garcinia*	*quaesita*	Goraka	0	3	2	0	0.0	16.5	11.0	0.0
Dipterocarpaceae	*Dipterocarpus*	*glandulosus*	Dorana	0	0	0	1	0.0	0.0	0.0	5.5
Dipterocarpaceae	*Doona*	*venulosa*	Yakahalu	0	0	0	1	0.0	0.0	0.0	5.5
Dipterocarpaceae	*Hopea*	*discolor*	Yakahalu	0	2	2	0	0.0	11.0	11.0	0.0
Dipterocarpaceae	*Hopea*	*jucunda*	Yakahalu	0	2	0	10	0.0	11.0	0.0	55.0
Dipterocarpaceae	*Shorea*	*congestiflora*	Thiniyadun	3	4	1	0	16.5	22.0	5.5	0.0
Dipterocarpaceae	*Shorea*	*sp.*	Panamoradun	0	0	0	8	0.0	0.0	0.0	44.0
Lauraceae	*Cinnamomum*	*multiflora*	Wal kurundu	1	2	5	0	5.5	11.0	27.5	0.0
Lauraceae	*Cinnamomum*	*verum*	Kurundu	0	2	0	0	0.0	11.0	0.0	0.0
Menispermaceae	*Coscinium*	*feneatratum*	Ban wel	2	3	9	2	11.0	16.5	49.5	11.0
Palmae	*Calamus*	*digitatus*	Kukul wewel	0	10	0	0	0.0	55.0	0.0	0.0
Palmae	*Calamus*	*ovoides*	Wewel	5	0	0	0	27.5	0.0	0.0	0.0
Palmae	*Calamus*	*pseudotenuis*	Kolahanguna wel	5	0	1	0	27.5	0.0	5.5	0.0
Palmae	*Calamus*	*radiatus*	Kukul wewel	7	22	0	1	38.5	121.0	0.0	5.5
Palmae	*Calamus*	*thwaitesii*	Mawewel	0	0	0	1	0.0	0.0	0.0	5.5
Palmae	*Caryota*	*urens*	Kithul	8	12	0	0	44.0	66.0	0.0	0.0
Pandanaceae	*Pandanus*	*ceylanicus*	Dunukeyya	9	0	0	0	49.5	0.0	0.0	0.0

Annex III **Harvestable NTFP amounts in different sites.**

							Harvestable NTFP amounts per year			
Plant family	**Genera**	**Species**	**Local name**	**Exploitable Product**	**Units**	**Best season**	Pitadeniya Natural Forest	Pitadeniya Buffer zone Forest	Kanneliya Natural Forest	Kanneliya Buffer zone Forest
Annonaceae	*Enicosanthus*	*accuminata*	Walwaraka	Branches	Cubic M	June	0.0	0.0	6.6	0.0
Bambusaceae	*Ochlandra*	*stridula*	Bata	Bamboo	Cubic M	June	0.0	5.0	4.1	0.0
Clusiaceae	*Garcinia*	*quaesita*	Goraka	Spice	Kg	June, July	0.0	82.5	55.0	0.0
Dipterocarpaceae	*Dipterocarpus*	*glandulosus*	Dorana	Resin	Kg	June	0.0	0.0	0.0	2.8
Dipterocarpaceae	*Doona*	*venulosa*	Yakahalu	Resin	Kg	June, December	0.0	0.0	0.0	2.8
Dipterocarpaceae	*Hopea*	*discolor*	Yakahalu	Resin	Kg	June, December	0.0	5.5	5.5	0.0
Dipterocarpaceae	*Hopea*	*jucunda*	Yakahalu	Resin	Kg	June, December	0.0	5.5	0.0	27.5
Dipterocarpaceae	*Shorea*	*congestiflora*	Thiniyadun	Resin	Kg	June, December	8.3	11.0	2.8	0.0
Dipterocarpaceae	*Shorea*	*sp.*	Panamoradun	Resin	Kg	June, December	0.0	0.0	0.0	22.0
Lauraceae	*Cinnamomum*	*multiflora*	Wal kurundu	Bark	Kg	June, December	0.6	1.1	2.8	0.0
Lauraceae	*Cinnamomum*	*verum*	Kurundu	Bark	Kg	June, December	0.0	1.1	0.0	0.0
Menispermaceae	*Coscinium*	*feneatratum*	Ban wel	Liana stem	Kg	December	22.0	33.0	99.0	22.0
Palmae	*Calamus*	*digitatus*	Kukul wewel	Ratan	Meters	December	0.0	275.0	0.0	0.0
Palmae	*Calamus*	*ovoides*	Wewel	Ratan	Meters	December	275.0	0.0	0.0	0.0
Palmae	*Calamus*	*pseudotenuis*	Kolahanguna wel	Ratan	Meters	December	165.0	0.0	33.0	0.0
Palmae	*Calamus*	*radiatus*	Kukul wewel	Ratan	Meters	December	154.0	484.0	0.0	22.0
Palmae	*Calamus*	*thwaitesii*	Mawewel	Ratan	Meters	December	0.0	0.0	0.0	44.0
Palmae	*Caryota*	*urens*	Kithul	Sap	Liters	N/A	0.0	0.0	0.0	0.0
Pandanaceae	*Pandanus*	*ceylanicus*	Dunukeyya	Leaves	Kg	December	14.9	0.0	0.0	0.0

Annex IV **NTFP income estimates for different sites.**

				Income estimate (Rs.) per year			
Plant family	**Genera**	**Species**	**Local name**	Pitadeniya Natural Forest	Pitadeniya Buffer zone Forest	Kanneliya Natural Forest	Kanneliya Buffer zone Forest
Annonaceae	*Enicosanthus*	*accuminata*	Walwaraka	0	0	165	0
Bambusaceae	*Ochlandra*	*stridula*	Bata	0	123.75	103.125	0
Clusiaceae	*Garcinia*	*quaesita*	Goraka	0	2475	1650	0
Dipterocarpaceae	*Dipterocarpus*	*glandulosus*	Dorana	0	0	0	1650
Dipterocarpaceae	*Doona*	*venulosa*	Yakahalu	0	0	0	137.5
Dipterocarpaceae	*Hopea*	*discolor*	Yakahalu	0	275	275	0
Dipterocarpaceae	*Hopea*	*jucunda*	Yakahalu	0	275	0	1375
Dipterocarpaceae	*Shorea*	*congestiflora*	Thiniyadun	412.5	550	137.5	0
Dipterocarpaceae	*Shorea*	*sp.*	Panamoradun	0	0	0	1100
Lauraceae	*Cinnamomum*	*multiflora*	Wal kurundu	13.75	27.5	68.75	0
Lauraceae	*Cinnamomum*	*verum*	Kurundu	0	38.5	0	0
Menispermaceae	*Coscinium*	*feneatratum*	Ban wel	330	495	1485	330
Palmae	*Calamus*	*digitatus*	Kukul wewel	0	137.5	0	0
Palmae	*Calamus*	*ovoides*	Wewel	137.5	0	0	0
Palmae	*Calamus*	*pseudotenuis*	Kolahanguna wel	82.5	0	16.5	0
Palmae	*Calamus*	*radiatus*	Kukul wewel	77	242	0	11
Palmae	*Calamus*	*thwaitesii*	Mawewel	0	0	0	22
Palmae	*Caryota*	*urens*	Kithul	0	0	0	0
Pandanaceae	*Pandanus*	*ceylanicus*	Dunukeyya	44.55	0	0	0
			Total (Rs.) per year	1097.8	4639.25	3900.875	4625.5

(Approx.Rs.100 = 1USD)

Annex V Activities and inputs envisaged for the sustainable extraction of NTFP.

	Site:			
	Pitadeniya-Natural forest	Pitadeniya-Buffer zone	Kanneliya-Natural forerst	Kanneliya Buffer zone
Proposed activities for the sustainable extraction of NTFP.	Tapping of resins: Damaging of bark of 16 trees of Thiniya dun in the dry period, preferebly, in one day in early December. Do the first round of harvesting of resin in one day in early January. Repeat the collecting practice every month for about 3 months.	Harvesting of 5 cubic meters of Bata in early January.	Lopping of branches of 66 Walwaraka trees, to a total amount of usable wood 6.6 cubic meters. One day in early January is prefereble.	Tapping of resins: Damaging of bark of 104 trees of Dipterocarpaceae (Yakahalu - H.Jucunda, H.discolor and Panamoradun) in the dry period, preferebly, in one day in early December. Do the first round of harvesting of resin in one day in early January. Repeat the collecting practice every month for about 3 months.
	Harvesting of Walkurundu stems, 5 trees, in the month of June.	Harvest the fruits from 16 Goraka trees if the seasonal fruiting is satisfactory in November.	Harvesting of 4.1 cubic meters of Bata in early January.	Harvesting of Banwel, 11 individuals of liana, amounting to 22kg, in December.
	Harvesting of Banwel, in December, 11 individuals of liana, amounting to 22kg.	Tapping of resins: Damaging of bark of 44 trees of Dipterocarpaceae (Yakahalu - H.Jucunda, H.discolor and Thiniyadun) in the dry period, preferebly, in one day in early December. Do the first round of harvesting of resin in one day in early January. Repeat the collecting practice every month for about 3 months.	Harvest the fruits from 11 Goraka trees if the seasonal fruiting is satisfactory in November.	Harvesting of Cane (Kukulwewe and Mawewel) altogether, 10 clumps, with a total length of 66m, in December, January or June.
	Harvesting of Cane (Wewel, Kolahangunawel and Kukulwel) altogether, 93 clumps, with a total length of 594m. Best months are December, January and June.	Harvesting of Walkurundu stems in December, from 11 trees.	Tapping of resins: Damaging of bark of 16 trees of Dipterocarpaceae (Yakahalu & Thiniyadun) in the dry period, preferebly, in one day in early December. Do the first round of harvesting of resin in one day in early January. Repeat the collecting practice every month for about 3 months.	
	Harvesting of Dunukeyya leves in December from 49 bushes.	Harvesting of Kurundu stems, 11 trees, in December.	Harvesting of Walkurundu stems, 27 trees, in December.	
		Harvesting of Banwel, 16 individuals of liana, amounting to 33kg, in December.	Harvesting of Banwel, 49 individuals of liana, amounting to 99kg, in December.	
		Harvesting of Cane (Kukulwel) altogether, 176 clumps, with a total length of 759m, in December, January or June.	Harvesting of Cane (Kolahangunawel) altogether, 5 clumps, with a total length of 33m, in December , January or June.	
Allocation of human resources.	3 Man-days spread over different times.	5 Man-days spread over different times.	5 Man-days spread over different times.	3 Man-days spread over different times.
Cost	Rs. 750/=	Rs. 1250/=	Rs. 1250/=	Rs. 750/=
Suggested mode of human resouce operations.	Small group community based approach. Cost allocation is for FD supervisory works.	Small group community based approach. Cost allocation is for FD supervisory works.	Small group community based approach. Cost allocation is for FD supervisory works.	Small group community based approach. Cost allocation is for FD supervisory works.