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DEVELOPING A MODEL PARTICIPATORY MANAGEMENT PROGRAMME FOR CONSERVATION OF BIODIVERSITY AND SUSTAINABLE USE OF NON-WOOD FOREST PRODUCTS IN KERALA

(Final Report of the Research Project KFRI/330/99, June 1999-July 2002)

P.K. Muraleedharan
C. Renuka
K.K. Seethalakshmi
N. Sasidharan

Research Fellow
Sreelakshmi Kannan

KERALA FOREST RESEARCH INSTITUTE
PEECHI – 680 653, THRISSUR, KERALA

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ABSTRACT OF THE PROJECT PROPOSAL

Project No : KFRI/330/99

Title : Developing a model participatory management programme for conservation of biodiversity and sustainable use of non-wood forest products in Kerala

Objective :
i. To examine the interlinkage between ecological and economic systems of NWFPs
ii. To develop a model participatory management programme for maintaining biodiversity and sustainable use of NWFPs
iii. To analyse the impacts of participatory management on collection, marketing, income and vegetation structure
iv. To prepare resource inventory of NWFPs in the study area and to undertake enrichment planting of selected species

Practical utility : The study will develop a model participatory management programme involving the interest groups, for maintaining biodiversity and sustainable use of NWFPs

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Investigators : P.K. Muraleedharan
C. Renuka
K.K. Seethalakshmi
N. Sasidharan

Research Fellow : Sreelakshmi Kannan

Study area : Wayanad Wildlife Sanctuary, Kerala

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ABSTRACT

Non-wood Forest Products (NWFPs) constitute an important element of the livelihood security of the tribal people in Kerala state. Although NWFPs are present almost ubiquitously in the forests, there has been concern about the sustainability of these resources, especially in view of changing land use patterns and over-exploitation of these resources. Commercialisation and associated over extraction of NWFPs and establishment of plantations have led to serious erosion of the resources in many parts of the state. This study is a continuation of two earlier studies where NWFP spectrum and its regeneration problems in the natural forests and collection, marketing and management of NWFPs in the state were closely examined. The earlier studies revealed that present system of management of NWFPs is ineffective particularly due to lack of participation of interest groups in the management. In view of this, the present study has attempted to develop participatory management programme to promote biodiversity conservation and sustainable use of NWFPs. To translate sustainable development principles into practice requires knowledge of both ecological and economic systems. Hence, analyzing interlinkages between both the systems relating to NWFPs, the study attempted to formulate a model participatory management programme through implementation of an action plan. The study was carried out at Wayanad Wildlife Sanctuary (WWS) in the Western Ghats.

In the ecological analysis, an attempt was made to evaluate the occurrence and abundance of NWFPs in the natural forests and plantations of WWS in the Western Ghats. The species richness of NWFPs varies among the sites within the sanctuary, but the natural forests consistently has greater density, diversity and biomass productivity for most NWFPs as compared to plantations. With regard to environmental and edaphic factors, understorey light availability was higher in the plantations (between 39 and 62% of full light in the plantations and between 26 and 50% in the natural forests). Data on NWFP productivity show that for all 10 selected NWFP species, the natural forest sites are superior to the plantations, despite pronounced inter site variations.

The economic analysis was carried out at micro level (society/hamlet), which helped in identifying the most needy among the primary stakeholders. The quantity of NWFPs collected and collection charge projected a declining trend

over the years, which reflected in the poor socio-economic conditions of the collectors. Low returns per unit effort, and more time spent and more distance traveled for collection, coupled with less share of proposed sale value lead the collection, a distress and less attractive job. The marketing of products by the Federation is not very effective partly due to the operation of intermediaries and partly due to market imperfection. Net result is that the tribes continue to live below the poverty line. However, NWFP collection continues in the area due to lack of other job opportunities.

The study indicated that there exists a close linkage between ecological and economic systems of NWFPs and a change in one system affects the other either positively or negatively. For instance, demand-pull and consequent price increase result in over extraction of species in great demand. Thus, appropriate management interventions are required to prevent the depletion and to conserve the biodiversity.

The participatory programme has been developed based on two basic assumptions: (i) there exists a close linkage between ecologicial and economic systems relating to NWFPs and (ii) sustained income is one of the pre-requisites for the success of the management. The programme was developed based on the implementation of an action plan which consists of forming resource management committee, preparation of micro-plan and testing of probable impact of management on collection, marketing and vegetation structure of the forests. NWFP resources were quantified at the sanctuary as well as hamlet/ foraging area levels. The determinants of household participation in the participatory management were identified.

One of the important features of the programme is that it gives high emphasis on activities which conserve resources or enhance resource availability in the forests through enrichment planting, preservation of genepool area and species substitution in the harvesting regimes, and increase income of the collectors through open market sale, value addition, etc. The programme also emphasises the importance of training and awareness creation among the interest groups on various aspects and activities of participatory management for better conservation and sustainable utilisation of NWFPs. The study has indicated that effective implementation of participatory management would enhance the income of the tribes and reduce pressure on NWFP species, which are essential for conservation of biodiversity of NWFPs in the study area. Long and short term strategies/activities for the above purpose are also presented in the report.

Section 1
Introduction

Exploitation of non-wood forest products (NWFPs) has been the primary mode of subsistence for many ethnic groups and indigenous people around the globe. With the development of newer uses and products, however, NWFPs began to play a proactive role in commercial income generation and employment (Runk, 1998). As NWFPs have become commercially valuable, then levels of extraction are driven by market forces (Neumann and Hirsch, 2000), leading to over-exploitation of such resources. Coincidentally, forest degradation continues unabated in most parts of the tropics (FAO, 1999), and consequently, many NWFP yielding plants have moved closer to extinction.

Although ecological degradation and biodiversity loss following misuse and/or over exploitation of the NWFP bearing forests occur in several tropical regions of the world, nowhere is the severity of the problem as great as in the Western Ghats, one of the 18 biodiversity hot spots of the world (Myers, 1988). The forest dwelling tribal people in the Western Ghats have been harvesting the NWFPs, presumably at low impact levels. Increased demand, however, has transformed the traditional low-impact patterns and techniques of resource extraction into more intensive forms; for instance, the extraction pattern of honey, soap nut (*Sapindus laurifolius*) and gooseberry (*Phyllanthus emblica*).

While commercial exploitation prognosticates changes in species composition, density, abundance, regeneration capacity and/or loss of biodiversity, the diminishing stocks of NWFPs that follows it are likely to affect the livelihood security of indigenous people (Muraleedharan *et al.*,1997). Although sustainability related concerns and issues are assuming an increasingly prominent place in policy discussions throughout the world today, the NWFP harvesting practices in the Western Ghats, Kerala, have seldom considered these (Kumar *et al.*, 2001). Given that a significant proportion (>50%) of the revenue of the Forest Departments in India is generated from NWFPs and 75-80 per cent of the forest export income is generated from NWFP trade (Tewari, 1998), it is perhaps crucial to evolve sustainable management regimes for these products.

There are indications that pressure to introduce alternatives to over exploitation of the NWFP bearing forests in Kerala, as in other parts of the world, will increase. This pressure is originating mainly from two sources. The first is the general public, who is starting to demand a wider range of environmental and social benefits from forests than solely timber. For instance, during many recent public consultation processes, sustainable forest management and biodiversity conservation were among the major issues raised by contributors (Bawa and Hall, 1992; Kumar *et al.*, 2001).

The second source of pressure is the tribal people themselves, who want to achieve sustainable production of NWFPs.

In general, the tribes in the Western Ghats involved in NWFP extraction are resource-poor and that most forest products and/or returns generated are intended for domestic consumption and seldom invested in productive capital. The traditional NWFP extraction scenario dominated by tribal people for subsistence has, therefore, been perceived as a low-impact operation. However, commercialisation of the NWFP trade over the past three to four decades has brought in a large number of changes in the sector of which the most important being the institutional one. The establishment of institutions such as the Kerala State Scheduled Caste and Scheduled Tribe Development Co-operative Federation Ltd. (the Federation) and the Tribal Service Co-operative Societies, which aim at facilitating collection and marketing of these products, have brought about significant changes in the sector. However, biodiversity conservation of NWFPs was alien to their agenda. The collection of selected items aiming to enhance the profitability by the Federation added further problems to biodiversity conservation.

NWFPs are collected mainly by tribes, but are used by a variety of groups, ranging from an individual to multinational firms. In the context of rampant unemployment and abject poverty among the tribes in Kerala, the collection of these products constitutes their main source of income. Consequently, biodiversity conservation and its sustainable management are the only options for the long term benefit of tribes and the society at large.

This study is a continuation of two earlier studies, with same title: 'Biodiversity in moist forests: a study on sustainable use of Non-wood forest products in the Western Ghats, Kerala,' funded by the Ford Foundation (Muraleedharan *et al.*, 1997 and 1999). These studies indicated a high rate of extraction of commercially important products by the gatherers, resulting in poor density, sparse distribution and loss of biodiversity. These also indicated that although institutions could streamline the collection and marketing of NWFPs, they alone could not solve the problems such as prevalence of intermediaries, illegal collection by non-tribals and over extraction of commercially important species. Further, the studies pointed out that the present management system is ineffective, especially with regard to biodiversity conservation and sustainable use and it should be replaced with an alternative participatory management system involving interest groups relating to these products. This study is a modest attempt to develop an alternative management system for conservation of biodiversity and sustainable use of NWFPs.

1.1 Objectives

The main aim of this study is to develop a participatory management system for conservation of biodiversity and sustainable use of NWFPs. Specific objectives of the study are:

1. To examine the interlinkage between ecological and economic systems relating to NWFPs to formulate strategies for developing model participatory management.

2. To develop a model participatory management programme for maintaining biodiversity and sustainable use of NWFPs.

3. To analyse the impacts of participatory management on collection, marketing, income and vegetation structure.

4. To prepare resource inventory of NWFPs in the study area and to undertake enrichment planting of selected species.

1.2 Study Area: the Wayanad Wildlife Sanctuary

The present study was carried out in the moist forests and plantation areas of the Wayanad Wildlife Sanctuary (WWS), which is located in the Western Ghats of Kerala (Figure 1). Following are some of the features of the study area.

1.2.1 Location

The district of Wayanad, with a total geographical area of 2132 km^2 (5.48 % of the area of the state), falls in the highland region. The district comprises of three taluks- Sulthan Bathery, Mananthavady and Vythiri. Nearly 37 per cent of the district comprises of forests, constituting 8.39 per cent of the states forest resource. The total area under forests in Wayanad is 539 km^2. WWS constitutes an area of 344.44 km^2 of which 243 km^2 is natural forests and the remaining area under plantations of Teak, Eucalypts, Rosewood, etc. WWS forms part of the western portion of the Nilgiri Biosphere Reserve and is contiguous to the Bandipur National Park and Nagerhole Wildlife Sanctuary of Karnataka on the North-east and Mudumalai Wildlife Sanctuary of Tamil Nadu on the south-east. The sanctuary consists of four ranges - Tholpetty, Kurichiat, Sultan Bathery and Muthanga.

1.2.2 Ecophysical features

The WWS lies between 11^0 33′ and 11^0 51′ N latitudes and between 76^0 02′ E and 76^0 27′ E longitudes. The altitude ranges from 650 to 1150 m, the highest point being Karottimala in Kurichiat Reserve (1158 m). The major part of the sanctuary is a table land of Wayanad plateau to the east of the main ridge which gradually slopes down to the north and east to Karnataka. For management purposes, WWS has demarcated core zone (111 km^2), mostly along the inter-state forest boundaries. The remainder is the buffer zone (233 km^2) and a small tourism zone. The core zone is supposed to be free of all human interference. However, there is limited tourism activity in the sanctuary.

The soil type- forest soil and hill soil- is characterised by a surface layer of organic matter derived from the forest. It is rich in nitrogen and base status varies depending on the degree of leaching. Soil varies from humus rich part in the montane areas to

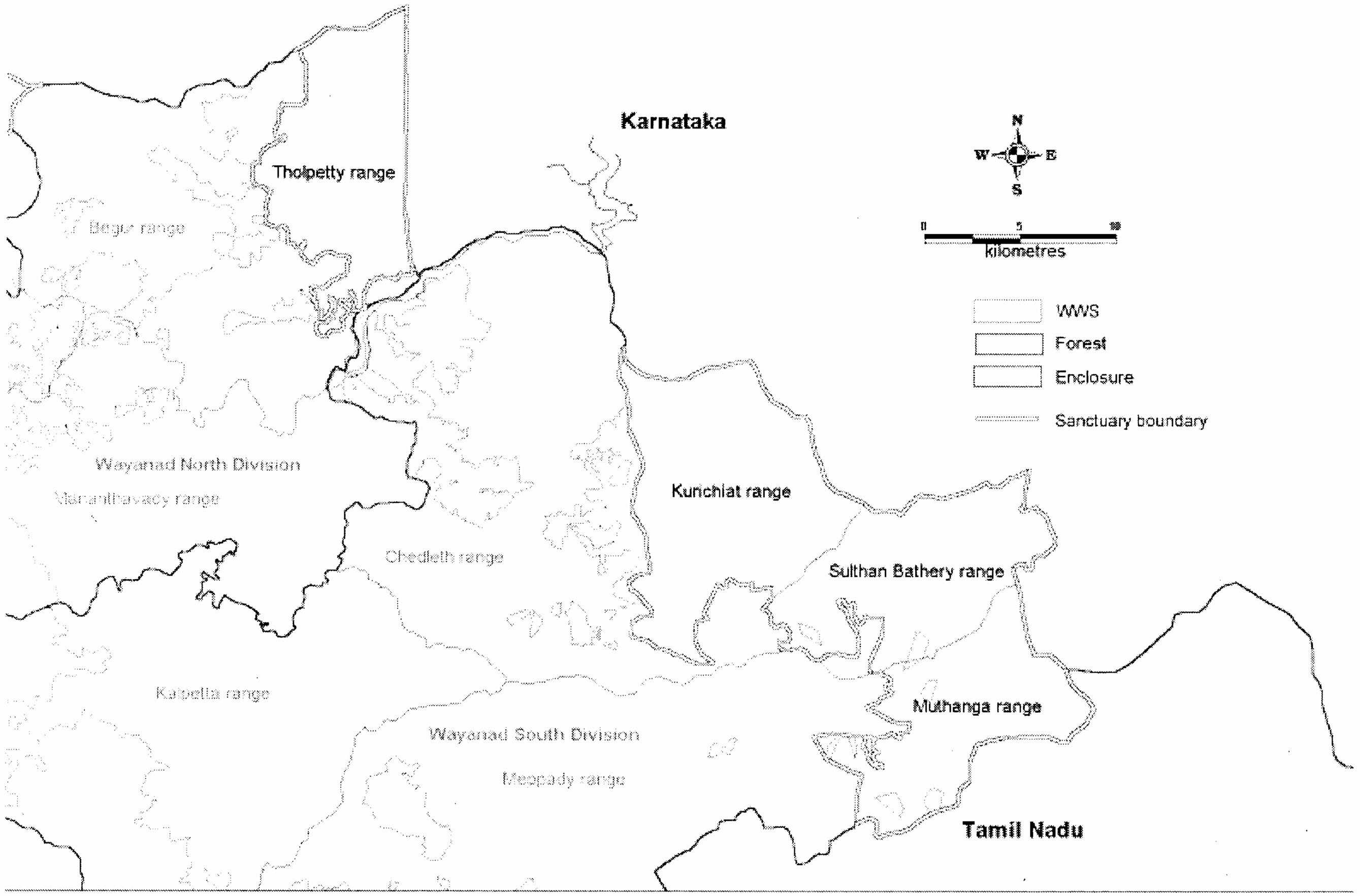

Figure 1.1 Wayanad Wildlife Sanctuary

lateritic in the lower elevation high rainfall belts and is generally acidic. Major soils of Wayanad plateau are clayey mixed Ustic Haplohumult and Fine-loamy mixed Aeric Tropaquept.

1.2.3 Climate

The temperature varies from 13^{0}C to 32^{0}C. The humidity is more in the valleys than in the hills. The plateau is comparatively drier. March to June are the hottest months. Mists are common from November to February on the plateau.

The south-west monsoon which begins during the first week of June brings the greater part of the rainfall. The heaviest rainfall in the monsoon occurs during July and August. The north-east monsoon begins by the end of September and spans up to November. The average rainfall is 2000 mm per annum.

1.2.4 Drainage

Papanasini (Bavali river) forms the main drainage system in Tholpetty Range. The river originates from Thirunelli Reserve and flows through Kudirakode and Begur Reserved Forests and drains to Kabani river. Three main streamlets flow southwards from the upper part of the Range and join Bavali river. Some of these are perennial network of streamlets that provide almost uniform water supply to Tholpetty region. Northern portion of Kurichiat Range is drained by Kannarampuzha and Kurichiat river flowing northwards to join Kabani river. Towards the Southeast, Manchalthodu and other streamlets join Nuguhole river to flow further Northeast to Karnataka. Southern portion of the sanctuary is being drained by Noolpuzha and Mavinhallathodu which combine to Nuguhole river (Gopinanthan, 1990).

1.2.5 Natural forests

The natural vegetation of the sanctuary can be classified into following types (Chandrasekharan, 1962 and Champion and Seth, 1968).

- Southern moist mixed deciduous forests
- Southern dry mixed deciduous forests
- West coast semi-evergreen forests
- Moist bamboo brakes

The major tree species found in the sanctuary are: *Anogeissus latifolia, Tectona grandis, Dalbergia latifolia, Terminalia crenulata, Terminalia bellirica, Phyllanthus emblica, Cassia fistula, Randia uliginosa, Lagerstroemia microcarpa, Xylia xylocarpa,* and *Ailanthus triphysa*. Shrubs include *Helicteres isora, Glycosmis pentaphylla,* and *Lantana camara*. Herb layer is dominated by many NWFP species such as *Sida rhombifolia, Desmodium velutinum, Pseudarthria viscida,* etc. Fauna consists of Asian Elephant (*Elephas maximus*), Gaur (*Bos gauras*), Sambar (*Cervus unicolor*), Chital (*Axis axis*), Tiger (*Panthera tigris*), Leopard (*Panthera pardus*), Indian Wild dog (*Cuon alpinus*), Sloth bear (*Melursus ursinus*), Wild boar (*Sus scrofa*), Bonnet macaque (*Macaca radiata*), etc.

Teak is the major plantation species covering an area of about 74 km^2. Eucalyptus, rosewood and sandal wood are other plantation species, occupying an area of 16 km^2 in the remaining area. Apart from timber, a large number of NWFP species are found in the study area.

1.3 A backdrop of study area

The comparison of structure and composition of forest types indicates that anthropogenic pressures coupled with adverse climatic conditions have brought about changes in the vegetation types in the past and these pressures are continuing. There has been massive change in areas under forest cover. According to Jayaprasad (2002), around 1018 km^2 area had been converted for agriculture and related purposes in the District between 1950 and 1982.

The historical backdrop of the study area, as gathered with the help of the selected communities, is given below (Tables 1.1 to 1.3)

Table 1.1: Historic matrix

Canopy	During 1960's	1970-1980	1980-2000
	Closed	Open	Open
Dependency on forest	High	High	High
Basic Needs	Low	Medium	Medium
Food availability	High	Medium	Low
Fuel availability	High	Medium	Low
NWFP availability	High	Medium	Low

Source : Primary data (PRA)

Table 1.2: Historic matrix - tree species

Species	Before 1960	1960-80	1980-2000
Canarium strictum	Abundant	Medium	Less
Dysoxylum malabaricum	Abundant	Medium	Very less
Dalbergia latifolia	Abundant	Medium	Medium
Saraca asoca	Medium	Medium	Very less
Syzygium mundagam	Abundant	Medium	Very less
Pterocarpus marsupium	Abundant	Medium	Very less
Pittosporum neelgherrense	Abundant	Medium	Very less
Vateria indica	Abundant	Medium	Medium
Pterospermum suberifolium	Abundant	Abundant	Very less

Source : Primary data (PRA)

Table 1.3: Historic matrix - NWFPs

Species	1960-70	1970-80	1980-2000
Oroxylum indicum	Abundant	Medium	Very rare
Gmelina arborea	Abundant	Medium	Very rare
Terminalia bellirica	Abundant	Medium	Low
Pseudarthria viscida	Abundant	Medium	Low
Stereospermum colais	Abundant	Medium	Low
Indigofera tinctoria	Abundant	Medium	Very rare
Rauvolfia serpentina	Abundant	Low	Very rare

Source : Primary data (PRA)

1.4 Major reasons for forest degradation

The reasons for forest degradation in the study area are numerous of which population increase due to migration from the plains and consequent pressure on land are the most important. Conversion of forest land for agricultural purposes and plantation activities is another reason for the forest degradation. As mentioned earlier, about 1018 km^2 of forest area in Wayanad district was lost due to encroachment and conversion for plantation activities. Under the pretext of shade regulation and maintenance, trees in the coffee plantations have been destroyed. Senile trees in cardamom estates are also uprooted along with the crops considering them as an impending danger for future productivity of the land.

1.5 The tribes

Total population of Wayanad district enumerated in the 2001 census is 7.86 lakhs constituting 2.47 per cent of the total population of the state. The unique characteristic demographic feature of the district is its highest proportion of tribal population.

Tribal people are distinctly different from others as characterized by isolated habitation, high incidence of poverty, illiteracy and low health status. As against a literacy rate of 89 per cent for the non-tribal population, it is 49 per cent among the tribals (Government of Kerala, 1999). Sex ratio is reported to be declining reflecting poorer nutrition and lack of health care among women. Seventy three percent of the tribals eke out their living from agriculture. While cultivators constitutes only 17 per cent, the remaining 56 per cent are labourers. Tribal people living inside the forests are engaged in gathering NWFPs and forest protection works. Half the number of tribals are reported to be 'below poverty line' (Government of Kerala,1999).

The state has a tribal population of 0.32

million, accounting for 1.1 per cent of the total population. Total number of tribal settlements in the state are about 4,000 of which 671 are forest settlements. These are spread, rather unevenly, across 14 districts. Tribal population is the highest in Wayanad (about 0.12 million) accounting for 17 per cent of the total population in the district. There are 35 scheduled tribe groups in the state and of these Cholanaickans, Kattunaickans, Kurumbas, Kadars and Koragas (constituting about 4.8% of the tribal population) are categorized as primitive groups, based on pre-agricultural stage of development, stagnant population and low literacy rate.

Tribes mainly found in and around the Wayanad Wildlife Sanctuary are Kurumans (Mullukurumans), Kattunaickans, Paniyans, Uralis, Kurichiars and Adiyans. The tribes live in both enclosures and periphery of the forests and their distribution is shown in Table 1.4. About 60 per cent of the population live in enclosures, while remaining in periphery.

Table 1.4 : Percentage of tribal population in the enclosures and periphery

Caste	Enclosures	Periphery
Kattunaikan	33.99	28.42
Kuruman	30.12	19.63
Paniyan	20.29	24.78
Adiyan	5.49	10.95
Urali	3.83	5.37
Kurichian	6.27	10.85

Source: Jayaprasad (2002)

The Kattunaickans live in the interior forests whereas other tribes such as Paniyas, Adiyans, Uralis and Kurichians inhabit more in the periphery. Kattunaickans are predominantly forest-dwellers, while others, particularly Paniyans have moved out to non-forest areas because of their longer history as labourers. Each tribe has its own unwritten language or dialect although there are strong affinities with the major regional languages, i.e. Malayalam, Kannada and Tamil. (Jayaprasad, 2002).

1.6 Kattunaickan: the selected community

The study is undertaken among Kattunaickans in selected tribal colonies of Thirunelli Panchayat existing in the fringes of the sanctuary. Kattunaickans are the only tribal group in Wayanad declared as primitive tribe by the Government. They are considered to be the descendants of a nomadic primitive hunter-gatherer group who roamed on the hill tops and caves instead of settling down. The term Kattunaickan implies king of the forest; Kattu denoting forest and Naickan, the king. Traditionally they are honey collectors, food gatherers and hunters. Majority of the group are heavily dependent on gathering NWFPs for their livelihood. The two hamlets selected for the study- Neduthana and Begur- are inhabited by Kattunaickans who lead more or less same life style. The sources of income, education and other features are quite similar and hence the two hamlets are homogenous.

1.6.1 Population structure

The socio-economic details of the selected colonies are given in Appendix1. The total population in Begur and Neduthana is 133 and 165 respectively. Of the population in both the hamlets, females constitutes 54 per cent. Further, about 64 per cent, were youth and children. The average family size is 4.1 and 5 in Begur and Neduthana respectively.

About 80 per cent of the grown up population has primary education. Only one per cent has been to high school. In Begur hamlet, around 47 per cent of the people are illiterate and among the literates 23 per cent are men and the rest are women. About 22 per cent of the community are small children who have yet to start schooling. The hamlets lie in the periphery of the forest, but far from the town. The nearest school is the government high school at Kattikulam, about 5 and 8 km away from Begur and Neduthana respectively.

1.6.2 Details of selected settlement

In Neduthana, there are 25 houses built by the government and the rest are mostly thatched ones built by the tribes themselves, where as in Begur hamlet they are 20 and 12 respectively. Although there are housing programmes for schedule tribes, these have not implemented fully in the area. With the implementation of the Kerala Government's Sampoorna Maithri Bhavana Nirmana Programme, the housing problems of all the scheduled caste and scheduled tribes are expected to be mitigated. Thirunelli Panchayat has the largest number of tribes in Wayanad District and there had been several programmes conceived in the past to meet their primary necessity, but could not meet the target till date. The health facilities are also poor in the hamlets with poor accessibility to health care centers. The nearest hospital is the Government Hospital, Mananthavady, about 15 km away from the Begur hamlet. The educational and health facilities are not easily accessible to the community. They prefer to follow indigenous treatments developed by them with medicinal plants available in the forest.

1.6.3 Occupation

The main source of livelihood of the tribes is NWFP collection. Nearly 80 per cent of the men are involved in NWFP collection. Seventy one per cent prefer to work in Kodagu where they obtain more wages. Women generally prefer forest jobs like weeding, planting, and boundary work. As and when the agricultural season starts at Kodagu, tribes move there and engage in works in different plantations. The main crops in Kodagu include coffee, ginger, chilli and orange. The forest work also provide them with income. But these are not sustained sources and hence the only sustained source of income is from NWFPs. The major crops cultivated by the tribes are banana, pepper, coconut and tuber crops. About 90 per cent of the households cultivate pepper, 61 per cent banana and about 45 per cent tuber crops.

The government has given 20 and 30 ha of land on lease to the Neduthana and Begur hamlets respectively where all the

community members jointly cultivate paddy. The yield obtained from the cultivation is just sufficient to meet their needs because no scientific practices are followed and no outside labour work is involved. In Neduthana for the past two years paddy had not been cultivated owing to problems among the people. In terms of livestock ownership, 81 per cent households do not own cattle. As per different tribal development schemes, cattle were supplied, but the community, due to poverty, was forced to sell all the cattle. Only one household owned more than three cows. In the settlement 53 per cent households owned goats and 19 per cent owned cattle. Even poultry birds are not found in as many as 84 per cent of the households. This is indicative of the complete dependence of the community on forest products other than livestock.

1.6.4 Problems faced by tribes: Observations

There are several problems faced by the tribes in their work place due to a number of reasons. These are summarized below.

Work in Kodagu
- Wages are not paid in time
- Lack of payment
- Uncertainty of job
- Low bargaining power
- Ill treatment
- Competition from workers from different parts of Kerala, Karnataka and Tamil Nadu.

Forestry work
- There is not enough work
- The job is risky (human-wildlife conflict)
- There has not been much improvement in wages
- Preference is given to non-tribals
- Only few tribes are employed as fire watchers and forest guards

Loading
- Rotational work
- There is no future for the work (felling is stopped)

Society
- The price obtained is too less
- Over the years there has not been much increase in the real disposable income
- Difficulty in collecting certain items like lichens, honey.
- Returns is very low
- Low bargaining power since monopoly market exists
- Closed market
- Illegal traders

Box 1.1 : Problems faced by tribes

Section 2

Management of NWFPs in Kerala: An Overview

The management of NWFPs in Kerala, particularly its collection and marketing, has witnessed significant changes over a period of time. An understanding of these changes is essential to know the importance and relevance of this study. Keeping this in view, some important aspects of management of NWFPs in the state are highlighted in this section.

2.1 Brief history

In Kerala, the tribal communities have been engaged in the collection of NWFPs since time immemorial. The dawn of colonial rule brought about significant changes in the collection scenario. The Britishers allowed different agencies (private contractors) besides the tribal people to collect NWFPs on an annual lease basis. Since 1915, the local people were issued free passes to collect thatching materials by the government. Under the cover of 'seigniorage permits', they were allowed to collect products like bamboos, reeds, rattans, manure leaves, etc. In the 1940s, the extraction of honey, wax, skins, ivory, etc. was done departmentally for a stipulated period and other items were leased out to private traders. The lessee collected only those items which fetched him/her a good remuneration.

In 1978, the right of collection was granted to the tribal people by the Government of Kerala. The Tribal Service Co-operative Societies (TSCS) meant for the welfare of the tribal people were started with membership reserved only for them. The ultimate aim of TSCS is to ensure a fair price for the products collected by the tribes and to protect them from being exploited by the middlemen. However, no evident change was observed in the gatherers' standard of living in spite of the establishment of TSCS. Thus, in perception of the problem, in 1981 an apex body of the TSCS called the Kerala State Scheduled Caste and Scheduled Tribe Development Co-operative Federation Limited (Federation) was formed. The Federation has been entrusted with the right of monopoly procurement and sale of all NWFPs collected by the societies. The Federation has branch offices in Trivandrum, Adimali, Thrissur and Wayanad and local societies are affiliated to respective branch offices.

The Government of Kerala has set up a high level committee, viz. Minor Forest Products Committee (MFP Committee) to take decisions on various aspects in relation to the collection of NWFPs in the state. The committee consists of the Chief Conservator of Forests (Development) as Chairman and the Registrar of Co-operative Societies, the Director of Tribal Welfare, the Managing Director of Kerala Pharmaceutical Corporation, the Health Secretary, the Managing Director of Kerala State Scheduled Caste and Scheduled Tribe Development

Co-operative Federation Limited., as members. The committee meets annually before the beginning of the collection season and takes decisions on issues such as allotment of ranges, amount of lease rent to be paid by the societies, and prices of products. The decisions of the committee regarding various aspects of collection of NWFPs are then intimated to the Forest Department and the Federation. The present management system of NWFP collection is shown in Figure 2.1.

NWFP collection by the society begins after the agreement on range allotment is signed in the presence of the Divisional Forest Officer concerned before July 31st every year. Collection permits are then issued to the members of the societies. Collection agents are appointed for the collection period and funds are advanced for making necessary infrastructure facilities. Once the collection depots exhaust their storage capacity, the goods are transported to the societies and then to the Federation's godowns for marketing.

Of the 119 commercially important NWFPs listed by the Forest Department (Appendix 2) only a few easily marketable commercial items are collected by the selected societies. For instance, the tribal service societies

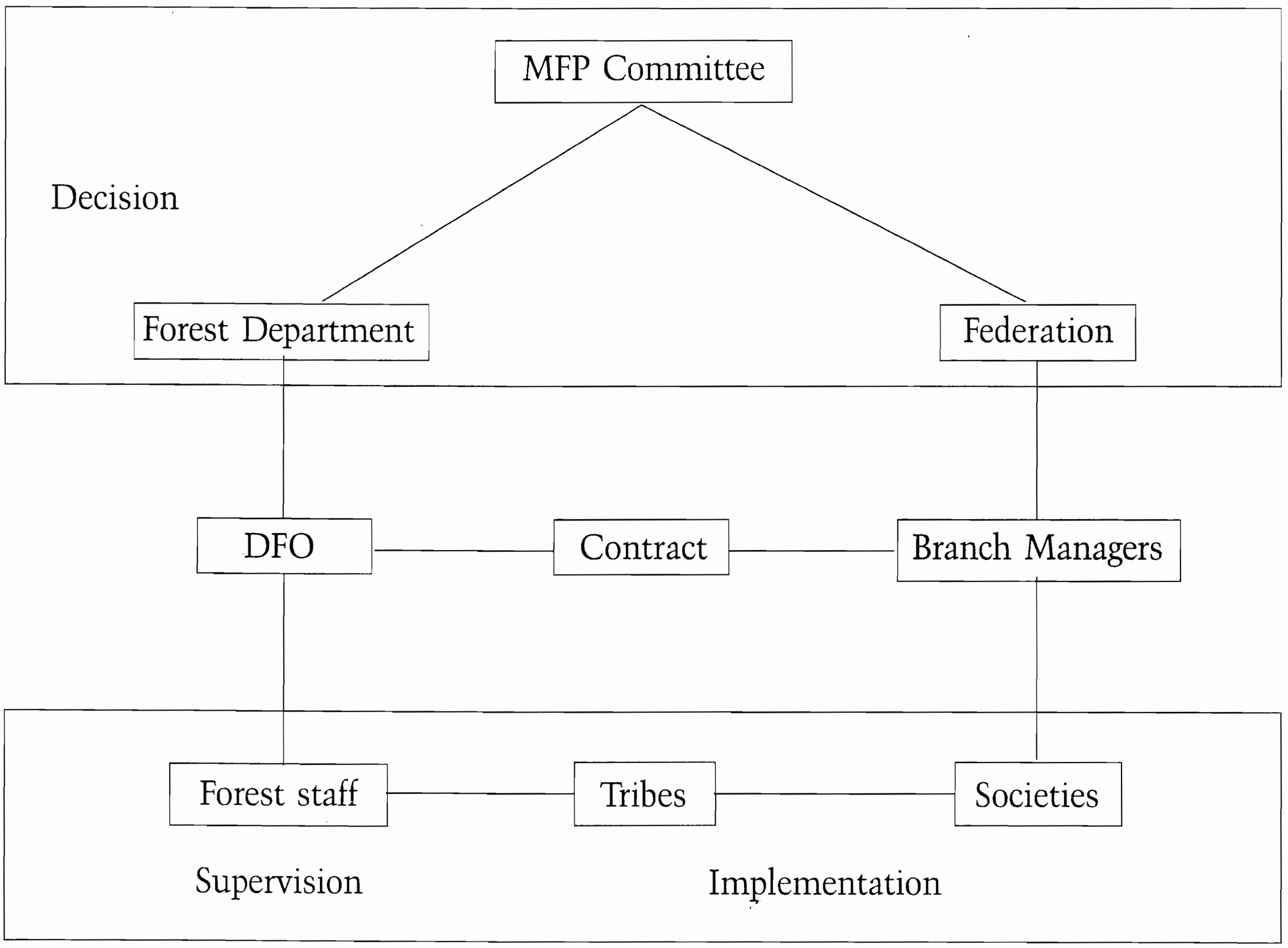

Figure 2.1: Present management system

collected only 32 items in Wayanad, 27 items in Nilambur and 38 items in Attappady during 1995-1996 (Muraleedharan, *et al.*1997)

Before the establishment of co-operative societies, the tribal people collected more items and sold them to the private traders. But the collection is now restricted to premium items by the societies because the collection of other items is unprofitable due to high wage cost and low product demand.

There has been a significant increase in the collection of NWFPs during the period 1982 to 1997-98. For instance, total quantity of NWFPs collected during 1982-83 was only 3,000 tonnes which has increased by around 8 times to 24,000 tonnes in 1997-98. Along with this increase, there has been variation in the collection of these products in certain years (Figure 2.2).

NWFPs are usually classified on the basis of their use or the plant part (Gupta and Guleria, 1982; Shiva, 1993). Based on use, Shanker (1999) has classified NWFP products into toiletries, edible products, resins, medicinal plants, dyes, oil seeds, essential oils, canes and miscellaneous products. She also pointed out that of the 119 commercially important items listed by the Forest Department, only 50 per cent of the items were collected by the Federation. Further, during the period from 1982-83 to 1997-98 only 23 items were collected continuously.

It was reported that there has been unsustainable harvesting of NWFPs existing in the state. Proposed (based on regeneration index) and actual harvesting of 10 selected commercially important species shown in Table 2.1 indicate that the actual harvesting is significantly higher than the proposed harvesting of NWFPs.

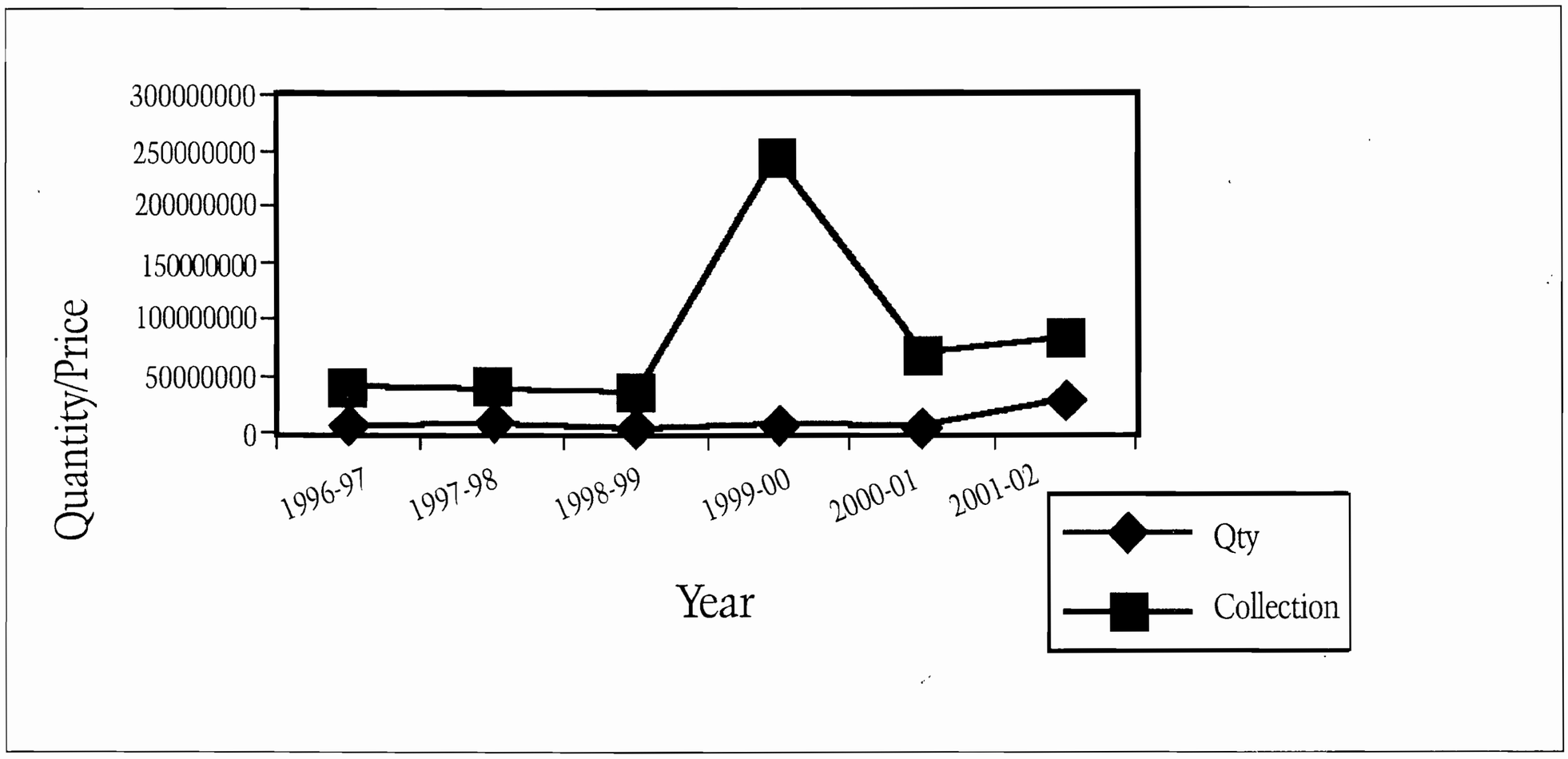

Figure 2.2: Collection and collection charge of NWFPs in Wayanad

Table 2.1: Percentage of proposed and actual harvesting of NWFPs in Kerala and reasons for high/low harvesting

Species	Proposed	Actual	Reasons
Asparagus racemosa	95	100	Easy to collect
Curcuma aromatica	95	100	Easy to collect
Hemidesmus indicus	95	59	Difficult to collect and low price
Cyclea peltata	85	75	Difficult to collect and low price
Baliospermum montanum	75	100	Easy to collect and high price
Desmodium velutinum	75	99	Easy to collect
Pseudarthria viscida	75	93	Easy to collect and high price
Sida rhombifolia	75	93	Easy to collect and high price
Strobilanthes ciliatus	50	90	Easy to collect and high price
Rauvolfia serpentina	25	80	High price

Source: Muraleedharan *et al.*(1997)

2.2 NWFP collection in Wayanad

For collection and marketing of NWFPs, five TSCS have been established in the district. Altogether 6500 families are members of these five societies. More than 30 products are being collected (not regularly) through these societies. The main products collected are cheenikkai (*Acacia sinuata*), honey (*Apies* sp.) gooseberry (*Emblica officinalis*), kattumanjal (*Curcuma aromatica*), kodampuli (*Garcinia gummi-gutta*), orila (*Desmodium velutinum*), moovila (*Pseudarthria viscida*), pachottitholi (*Symplocos cochinchinensis*), etc.. Total collection and collection charge paid to the gatherers showed variation over a period of time (Appendix 3).

2.3 Marketing

The marketing of NWFPs in Kerala is carried out by the Federation in either of the three ways: auction, quotation and negotiation of which the first one is the most common practice of marketing. The auction is done after issuing auction notice, stipulating various conditions, time and place of auction. Generally a number of traders attend the auction and quite often they form an alliance/ring to push down the prices. In case if the Federation does not receive a fair price in auction, it resorts other methods of marketing such as quotation and negotiation with traders. Of the three ways, maximum quantity is sold through auction.

2.4 Market structure of NWFPs in Kerala

The structure of market is defined as those characteristics of the organisation of the market that seem to exercise strategic influence on the nature of competition and pricing within the market (Bain, 1969). It also includes the manner of operation of the

market (Acharya and Agarwal, 1987). Thus understanding of the market structure is essential for identifying the imperfections in the performance of a market. The marketing structure of NWFPs in Kerala is shown in Figure 2.3.

Economic efficiency of marketing of NWFPs in Kerala is very low as pricing and proper marketing of NWFP is a secondary goal for the Federation (Muraleedharan *et al.*, 1997). It was indicated that one of the objectives of establishing the Federation is to eliminate the intermediaries between collectors and consumers. But there exist a number of middlemen in the marketing chain and take significant marketing margins (Table 2.2) The existence of official (societies,

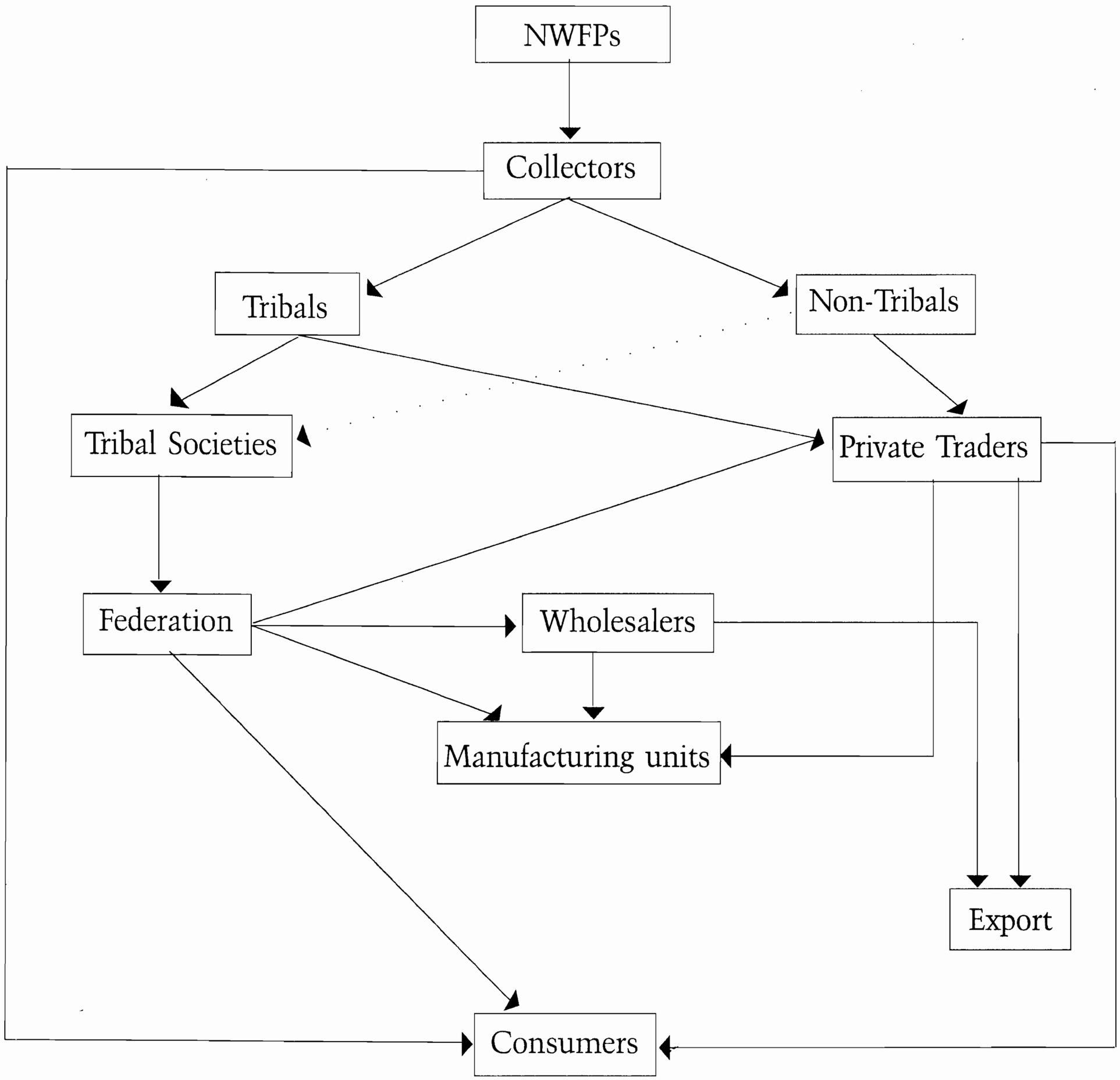

Figure 2.3: Marketing system of NWFPs in Kerala

Table 2.2: Marketing margins of selected items of NWFPs (%)

Sl.No	Items	Federation	First wholesaler	Second wholesaler	Retailer
1	*Canarium strictum*	20.63	7.60	16.29	2.21
2	*Coscinium fenestratum*	20.66	54.56	14.47	10.50
3	*Acacia sinuata*	6.57	38.91	16.00	11.51
4	*Curcuma aromatica*	15.31	13.95	8.95	12.21
5	*Phyllanthus emblica*	24.12	15.43	7.88	11.00
6	*Stereospermum colais*	35.18	5.97	8.39	3.48
7	*Desmodium velutinum*	18.57	28.00	—	11.65
8	*Sida rhombifolia*	16.00	13.33	—	14.09
9	*Honey*	24.62	19.60	5.96	3.58
10	*Terminalia chebula*	9.33	39.87	10.22	14.09

Source: Muraleedharan *et al.*, (1997)

Federation, etc.) and unofficial channels (private traders) in NWFP marketing has been pointed out by Shanker (1999), who indicated that marketing margins in unofficial channels were slightly higher than that of official channel (Table 2.3). Similarly,

Table 2.3: Price spread, marketing costs and net margin of selected NWFPs

Products	Channel-1				Channel-2			
	Share of collector	Price spread	Marketing costs	Net margin	Share of collector	Price spread	Marketing costs	Net margin
Acacia sinuata	52.6	47.4	25.5	22.0	56.3	43.7	23.1	20.5
Honey	53.9	46.1	20.7	25.4	56.6	43.4	15.3	28.1
Canarium strictum	47.6	52.4	22.3	30.1	58.7	41.3	24.5	16.8
Sida rhombifolia	54.2	45.8	32.7	13.2	65.0	35.0	21.6	13.3
Stereospermum colais	50.0	50.0	11.9	38.2	62.5	37.5	10.4	27.2
Hydnocarpus pentandra	45.3	54.7	21.1	30.6	52.8	47.2	19.7	25.0
Wax	50.5	49.5	13.6	35.9	58.9	41.1	12.5	28.6
Average	50.6	49.4	21.1	27.9	58.7	41.3	18.5	28.8

Source: Shanker (1999)
Channel 1consists of collectors-society-Federation-wholesaler-retailer-consumer
Channel 2 consists of collectors-private traders-wholesaler-retailer-consumer

gross share of collection charges received by the collectors in the unofficial channel is slightly higher than that of official channel, whereas net collection charge that is net share received by the collectors after deducting transportation cost is higher in the official channel.

Why do private traders offer higher collection charge to collectors? There are two reasons: first, unlike societies, the overhead charges are less for the private traders and second, in order to compete with the societies, they have to offer higer prices (Shanker, 1999).

2.5 Some drawbacks of the present management system

The drawbacks associated with present system enumerated in the first phase of the study are given below:

1. The entire decision is taken at the top and thrust upon the grassroot workers which include local forest staff, society officials and collectors and consequently, they do not show much interest to conserve the biodiversity.

2. The institutions such as the Federation and societies are established mainly to streamline the management of NWFPs and to uplift the socio-economic conditions of tribes. Due to lack of proper policies and programmes these objectives have not been achieved. Further they have not been able to eliminate middlemen from the marketing channels and consequently there is wide gap between final consumer price and collection charge. This is an indication that the management is not efficient.

3. The institutions do not make any attempt to make sure that the products are being harvested sustainably without affecting the ecological set up of the landscape as well as socio-economic conditions of the tribes.

4. Due to the lack of proper pricing policies, the gatherers received low collection charge compared to final consumer price. As the real income of the gatherers is low in this system of management, they resort to intensive harvesting that affect biodiversity and sustainable use of NWFPs.

The above discussion indicates that there exists some inherent weakness in the present system of management. This calls for an alternative system of management, which envisages strong participation of the interest groups or stakeholders, particularly at the grass root level with a focus on sustainable management of NWFPs and biodiversity conservation.

Section 3

Materials and Methods

This section gives in detail the methods adopted for the selection of study area and hamlets for ecological and socio-economic and participatory management aspects. Attempt is also made to present detailed methodologies used to study individual problems in each of the aspects.

3.1 Ecological aspects

3.1.1 NWFP spectrum in the natural forests of WWS

A one km transect of 10 m width was laid out in the study area after a reconnaissance survey. The transect was positioned considering the terrain, vegetation type, etc. to cover a range of species associations and degradation levels. All potential NWFP producing plants (herbs, shrubs, climbers and trees) excluding seedlings at cotyledon stage and shorter herbs encountered along the transects were sampled. Enumeration of NWFPs was carried out with the assistance of tribal people (Kattunaickans) engaged in NWFP collection. Two tribal hamlets, each consisting of 15 to 20 gatherers were randomly selected from the total number of tribal hamlets, and they constituted the survey teams. Specimens were collected and identified after comparing with the collections maintained at the Kerala Forest Research Institute, Peechi.

For a detailed vegetation analysis of the NWFP bearing forests in the WWS, however, 15 quadrats (20 x 20 m) were laid out during 1996 and 1997. This was done by marking 2 x 2 m grids on vegetation maps of scale 1:1,25,000. Herbaceous NWFP yielding plants in the quadrats were regularly uprooted during the pre- and post-monsoon seasons of 1996 and 1997 and their number noted, species-wise. In addition, the diameter of trees and shrubs was measured at 1.37 m above the ground, and for herbs the diameter was measured at 2 cm above the ground.

3.2. Distribution and abundance of selected NWFPs in the natural forests

3.2.1 Selection of sample plots

On the forest cover map of WWS, grids of 1 km^2 representing natural forests were marked and identified on the ground during a reconnaissance survey. Sample plots of 20 x 20m in natural forests were established in the centre of these 1 km^2 grids. A total of 243 plots were thus laid out in the natural forests of the four ranges of WWS (Table 3.1). NWFP trees and saplings in the natural forests and plantations were enumerated in these plots during post monsoon periods (August to December) of 1999-2001. For enumerating shrubs, however, 5 x 5 m subplots and for studying the herbs and seedlings, 2 x 2 m sub-plots were established. Quadrat dimensions were decided considering species-area curves (Muraleedharan *et al.*, 1997).

Table 3.1: Details of experimental plots in the natural forests and plantations of WWS

Forest Range	Natural forest	Plantations
Kurchiat	78	31
Sulthan Bathery	70	19
Muthanga	58	17
Tholpetty	37	43
Total	243	110

3.2.2 Density and yield of selected NWFPs in the natural forests

Distribution pattern, density and standing biomass of 11 selected NWFP species (Table 3.2) extracted from the natural forests during August-December were evaluated. Their presence or absence in each quadrat was noted. When present, the number of individuals was enumerated. Density was calculated as the number of individuals in unit sample area while ratio of the number of quadrats of occurrence and total number of quadrats studied formed frequency. For quantifying the herbaceous NWFP yields, weights of the useful parts of herbs were recorded in the field and their average calculated. The diameter of trees and shrubs was measured at 1.37 m above the ground and for herbs the diameter was measured at 2 cm above the ground. Other variables like, thickness of bark, number of branches, etc. were also recorded depending on the tree species involved. Furthermore, samples of bark were collected from trees of different girth classes to work out the bark weight for the tree species for which bark is extracted.

3.2.3 NWFPs in plantations

On the forest cover map of WWS, grids of 1 km^2 representing plantations were marked and identified on the ground during a reconnaissance survey. Sample plots of 10 x 10 m were established in the centre of these 1 km^2 grids. A total of 110 plots were thus laid out in the plantations of the four ranges of WWS (Table 3.1). NWFP trees and saplings were enumerated in these plots (in all four forest ranges) during the post monsoon period during the year2000 and 2001. For enumerating shrubs, however, 3 x 3 m subplots and for studying the herbs and seedlings, 1 x 1 m sub-plots were established in each plot. Quadrat dimensions were decided considering species-area curves.

3.2.4 Vegetation analysis

Vegetation data of NWFP population in the natural forests and plantations were quantitatively analysed for abundance, density, frequency, and abundance-to-frequency ratio (A/F ratio; Curtis and McIntosh, 1951). Simpson's Dominance Index (Simpson, 1949) and Importance Value Index (the sum of the relative frequency, relative density and relative dominance; Phillips, 1980) were computed. Species diversity of each study site was calculated using Shannon's Diversity Index. The ratio of abundance to frequency was used to interpret the distribution pattern of the species, i.e., regular distribution if the ratio is below 0.025, random distribution if it is between 0.025 and 0.05 and contiguous distribution if more than 0.05 (Curtis and Cottam, 1956). Species diversity was calculated using Shannon's Diversity Index

Table 3.2: Non-wood forest products species studied in the natural forests of WWS

Botanical name	Common name	Useful part(s)	Use(s)
Asparagus racemosus	Sathavari	Tuber	Food, medicine
Costus speciosus	Channakoova	Tuber	Medicine
Curcuma aromatica	Kasthuri manjal	Tuber	Medicine
Desmodium velutinum	Orila	Root	Medicine
Dioscorea pentaphylla	Noora	Tuber	Food
Hemidesmus indicus	Nannari	Root	Flavouring material and medicine
Phyllanthus amarus	Keezharnelli	Whole plant	Medicine
Pseudarthria viscida	Moovila	Root	Medicine
Sida rhombifolia	Kurunthotti	Root	Medicine
Solanum indicum	Puthirichunda	Root, stem	Medicine
Solanum viarum	Kandakarichunda	Root, stem	Medicine

as shown below (Magurran, 1988).

$$H' = -\sum p_i \ln p_i \quad (1)$$

where H' = Shannon's Diversity Index

p_i = proportional abundance of the i^{th} species = (n_i/N).

ln = natural logarithm

n_i = abundance in the i^{th} species

N = total abundance

3.2.5 Biomass estimation

Species usually collected by tribes and species, which were available at the time of sampling were collected for biomass estimation. To estimate biomass of the 11 selected NWFP bearing herbs and shrubs in the natural forests (Table 3.2), 25 plants of each species were randomly harvested. Main stem, branches, leaves, roots and tubers of the harvested plants were separated and air-dried till constant weight was attained.

For biomass estimation of the herbaceous and shrub species in the plantations (10 species, as listed in Table 3.3), 10 random plants of each species were harvested. After separating into main stem, branches, fruits and roots, these were oven-dried till constant weight and means calculated species-wise. Total biomass of each species in the study area was estimated considering the density and mean weight. Biomass of useful parts was also estimated. The estimated weight of the produce (kg) was calculated as weight of useful part of single plant x density x area divided by 1000. For trees, girth at breast height (GBH) and height were recorded.

3.2.6 Resource quantification

In the forest cover map of Wayanad Wildlife Sanctuary, grids of size 1 km^2 were marked and identified in the field by reconnaissance survey. Sample plots of size 20 x 20 m were laid out in one km^2 grid and NWFP trees and saplings were enumerated. For enumerating shrubs 5 x 5 m subplots were taken in each 20 x 20 m plots. In each subplot of 5 x 5 m, plots of 2 x 2 m were taken for studying the herbs and seedlings. From the above exercise, data on sufficient number of plots for different forest ranges were obtained.

The presence or absence of listed NWFP species was recorded in each quadrat. If a given species was present in a quadrat, its individuals were enumerated. For the quantification of trees, number of individuals, girth at breast height (gbh) and height were measured. Other variables like thickness of bark, number of branches, etc. were also recorded depending on the tree species. Samples of bark were collected from trees of different girth classes to work out the bark weight for the tree species for which bark is extracted. For the quantification of herbs, they were collected from the study area.

Table 3.3: Non-wood forest products species studied in the plantations of WWS

Species	Parts used
Asparagus racemosus	Leaf, stem and tuber
Costus speciosus	Leaf, stem and tuber
Curcuma aromatica	Leaf, stem and root
Desmodium velutinum	Leaf, stem and root
Hemidesmus indicus	Leaf, stem and root
Phyllanthus amarus	Leaf, stem and root
Pseudarthria viscida	Leaf, stem and root
Sida rhombifolia	Leaf, stem and root
Solanum indicum	Leaf, stem and root
Solanum viarum	Leaf, stem, root and fruit

Weights of the useful parts of herbs were measured and their average calculated. The densities of species were calculated as the number of individuals in unit sample area while frequency was calculated as number of quadrats of occurrence divided by the total number of quadrats studied. The estimated weight=weight of useful part of single plant x density of plant/hectare x area divided by 1000.

3.2.7 Enrichment plantation

Enrichment plantation was undertaken in about 5 ha covering at Tholpetti range. Five

tree species, *Saraca asoca, Gmelina arborea, Phyllanthus emblica, Oroxylum indicum* and *Terminalia bellirica* and three herbs *Indigofera tinctoria, Solanum viarum, Pseudarthria viscida* and one climber *Piper longum* were selected for enrichment planting based on the requirement and availability of these species. The planting stock was raised in nursery using seeds/ cuttings and maintained for six months in the nursery prior to planting. The tree species were planted in natural forests and the others were planted in teak plantations.

Enrichment planting was carried out in July 2001. For preparation of the planting site, weeding was done only around the planting pits which is about 1 m radius. The pits of 30 x 30 x 30cm were taken at a spacing of 2 x 2m. About 12,500 seedlings of different species were planted. For taking observations a few sample plots were laid out in randomised blocks. Three blocks with 25 saplings per block were taken for tree species and 20 saplings per block were taken for other species. Three blocks were planted with a mixture of all the species (20 seedlings of each species) in the same location. Observation on survival was taken after one year. The planted pits and remnants of dried parts were observed to assess the reasons for mortality.

3.2.8 Subcanopy PAR measurements

Continuous understorey measurements (9 a.m. to 5 p.m.) of photosynthetically active radiation (PAR) were made in representative and randomly selected teak plantations (stand age - 35 years and thinned five times as per the standard thinning schedule adopted by the Kerala Forest Department) from January 1 to January 22, 2002 and in natural forest areas from January 7 to January 14, 2002, using a Line Quantum Sensor (LI 191SA, LI-COR Inc., Lincoln, Nebraska). Within each plot, the line quantum sensor was installed on small wooden platforms at 30 cm above the ground on two consecutive days. The line of the sensor was oriented toward magnetic south as tree rows were oriented east-west. A battery powered data logger (LI 1000, LI-COR Inc.) integrated the mean flux of PAR at hourly intervals. PAR incident above the canopy of each plot was simultaneously recorded by the data logger with a Point Quantum Sensor (LI 190SA, LI-COR Inc.) in the open. The understorey PAR flux was converted to PAR transmittance - the ratio of PAR below the canopy to PAR incident on the top of the canopy.

3.2.9 NWFP extraction pattern and sustainable/unsustainable harvesting

The approximate resource available per kg per ha for extraction, that is quantity available for a person from the total area foraging, was assessed by conducting a PRA exercise among the tribes. The total foraged area in ha per person per day is approximated as 4 ha based on PRA and participant observation. The resource available for extraction by the household is determined by the number of persons representing the household. In the study two persons are

considered to represent a household unit. Hence, the total foraged area per household per day is approximated to be 8 ha. The average resource extracted per household per day is calculated based upon the individual extractable quantity per day. The quantity extracted per day per ha is the quantity which the household unit extracts from one hectare. The quantity remaining in the foraged area after harvesting per extraction is the resource available after extraction. The selected Begur hamlet constitutes 32 households and their minimum foraging area was approximated to be 256 ha. The per cent of resource extraction indicates the extent of resource use-sustainable or unsustainable one.

3.3 Economic aspects

3.3.1 Trends in quantity collected, collection charge and sale value

Secondary data on quantity collected, collection charge and sale value of different NTFPs collected over the past decade was subjected to statistical analyses to estimate the trend over the years. Compound growth rate was worked out to assess the growth rate of the three variables in the past decade. To assess the growth rate of the selected variables log-linear model was fitted to the data (Gujarati, 1995). The equation for compound growth rate takes the form as given below.

$$Y_t = Yo\ (1+r)^t \qquad (2)$$

i.e., $\ln Y_t = b_1 + b_2 t + u_t$

where Y_t = Quantity collected, collection charge and sale value over time

r = the compound rate of growth (over time, t)

b_1 = ln Yo = intercept

b_2 = ln(1+r)

ln = natural logarithm

u_t = disturbance term

In this model, the slope coefficient, 'b_2' measures the constant proportional or relative change in Y_t for a given absolute change in the value of the regressor. This log-linear model is particularly useful in situation where the regressor is time.

3.3.2 Acceleration and deceleration

The principle of acceleration and deceleration of growth rates was examined for judging the trends in growth rates. For this purpose a log quadratic function was fitted to the data (Parthasarathy, 1984). The instability measures were arrived at by following the method suggested by Schultz (1962). The method measures instability by year-to-year variations.

The equation is of the form:

$\ln Y_t = a + bt + ct^2$

where Y_t = as defined earlier

a, b and c are the regression coefficients

A quadratic equation of the given form was fitted to the data to assess whether the data showed deceleration or acceleration over the years. The sign of the coefficients determines the acceleration/deceleration.

3.3.3 Share factor (%)

In order to assess the share of collection charge in sale value, a formula was derived

for the study. The ratio of collection charge of the particular NWFP to the sale value of the same product would give the share factor (expressed as in percentage). The formula derived is presented below.

$$\gamma = \left[\frac{\alpha}{\beta}\right] \text{x } 100 \qquad (3)$$

where $\alpha = \frac{\Sigma P_c}{\Sigma Q_c}$; $\beta = \frac{\Sigma P_s}{\Sigma Q_s}$; therefore ;

$$\gamma = \left[\frac{\Sigma P_c / \Sigma Q_c}{\Sigma P_s / \Sigma Q_s}\right] \text{x } 100$$

γ = Share factor
P_c =Total collection charge
Q_c = Total quantity collected
P_s = Total sale value
Q_s = Total quantity sold

3.3.4 Difference in percent of actual value realized and proposed share of sale value

The Federation proposes to give the gatherers/collectors a fixed share of the sale value obtained. But in reality the per cent of actual value realized by the extractors differs from the proposed share. The difference in percent of actual value realized and proposed share of sale value was assessed to arrive at a meaningful conclusions regarding accrual of benefits to the extractors by way of realized share of sale value for different products. The formula is given by:

$$\delta = \gamma - X \qquad (4)$$

where δ = Difference in percent of actual value realized and proposed share of sale value

γ = Share factor
X = Proposed share

Hence $\delta = \left| \left[\frac{\alpha}{\beta}\right] \text{x } 100 \right| - X$

If $\delta \geq 0$, it indicates efficient distribution of benefits; share is more than or equal to the proposed value

If $\delta < 0$, it indicates inefficient distribution; share is less than proposed value

3.3.5 Incremental factor (K)

The ratio of sale value to collection charge is expressed as incremental factor (K). This ratio indicates the increase of sale value over collection charge giving the exact hike in the sale value over the collection charge of different NWFPs.

The formula for incremental factor is given as:

$$K = \frac{\Sigma P_c}{\Sigma P_s} \qquad (5)$$

where P_s = Total sale value (Rs.)
P_c = Total collection charge (Rs.)

3.4 Forest dependency index (FDI)

For any participatory management programme for the forest ecosystem to be successful, an assessment of the forest resource use by the different stakeholders is essential. This is because the stakeholders/ interest groups' dependency reflects a broad spectrum, wherein the extent and intensity

of dependence vary among and between the communities. Policies formulated, as a blanket approach will tend to under/ overestimate the communities' real use of the forest resources. Moreover the policy aimed at the majority will be conflicting in interests for the minority users and thereby proper implementation becomes a difficult task for the authorities. Hence a better understanding of the difference in the extent and intensity of resource use is imperative so that each community can be represented in a better way while formulating policies for forest conservation.

Not much has been attempted to develop an index based on the socioeconomic dependency of stakeholders of protected area in India and particularly in Kerala. This necessitated the formulation of a general index for measuring the forest dependency of the communities. The studies dealing with dependency have always been restricted to giving percentage analyses. In view of this, the study has attempted to develop a simple Forest Dependency Index (FDI) for the stakeholders of forest ecosystem.

The FDI is based on the simple principle of resource use. The stakeholder's resource uses have been classified into different groups(referred to as factor). A ten-fold classification of the forest resources has been made to represent all the resource uses in its entirety. The ten-fold classification was formulated based upon the stakeholder analyses carried out in the study using various tools in the Participatory Rural Appraisal (PRA) technique for a period of two years. In the initial phase of developing the FDI, a process of elimination was carried out to exclude those factors/uses, which are not representative of at least 25 per cent of the stakeholders/interest groups. Some of the resource use in the classification for example, soil, which is not generally included as a resource use in the forestry sector, has been deliberately included in the classification, considering its importance in the study area. It was observed that forest soil was carried out from the forest in baskets by the stakeholders for cultivation of crops. Similarly, other uses were also classified as per the survey result.

Having classified the resource uses as per the criterion, the second phase dealt with the more convoluted phase of quantifying the factor/resource use according to the data generated through PRA and participant observation. The consumption, in its totality, of each household in the sample was assessed and quantified accordingly. The total consumption of a resource by the stakeholders of the sanctuary encompasses the quantum obtained from the forest and also the quantum from outside the forest; henceforth referred to as other sector. Excluding the entire quantity obtained from the other sector helped in segregating the share of quantity from the forest. Wherever exact quantification was difficult, approximations have been made with repeated cross checking and consultation to keep the error margin at the minimum. The Forest Dependence Ratio (FDR) is the share of the quantum from forest to the total quantum consumed. This gives the magnitude of dependence of each household, which, when pooled, is

representative of the population of the particular community under study. The FDR expressed as percentage gives the FDI of the community. The Community Factor Ratio (CFR) is the share of each factor to the total consumption, which gives the entire stakeholder's dependence on each factor. The FDR when pooled gives the CFR. The Community Factor Index is the CFR expressed in percentage.

Forest Dependence Ratio (FDR)

$$\varphi = \sum_{i-1}^{n} \left| \frac{x_i}{X} \right| \qquad (6)$$

where φ = forest dependence ratio
x_i = share from forest
X = total quantity consumed

Forest Dependency Index (FDI)

$$\theta = \sum_{i-1}^{n} \left| \frac{x_i}{X} \right| \text{ x } 100 \qquad (7)$$

where θ = forest dependency index
x_i = share from forest
X = total quantity consumed

Community Factor Ratio (CFR)

$$\phi = \Sigma \left| \sum_{i=1}^{n} \left| \frac{x_i}{X} \right| \right|$$

where ϕ = community factor ratio

Community Factor Index(CFI)

$\rho = \phi$ x 100

i.e., $$\rho = \Sigma \left| \sum_{i=1}^{n} \left| \frac{x_i}{X} \right| \right| = \text{x } 100$$

The FDI falls between 0 and 1 where 0 indicates no dependence and 1 indicates perfect dependence (entirely dependent). The higher the value, the more the dependence and *vice versa*. This is true with respect to the CFI also where the higher value of a resource group indicates a comparative higher use of that resource by the community. The FDI and CFI provide a comparison between the communities with respect to the resource use and the resource use among the community. Besides, this is an effective tool in comparing the resource uses among the individual households, households within a locality and between regions, and individual resource uses.

FDI represents the total dependency index of all the resources under consideration in the ten-fold classification of the particular community. Community Factor Ratio is the dependency ratio of the particular community for each resource under consideration.

3.5 Demand and supply analysis of NWFP

(8) The demand and supply of the NWFPs were analyzed in the study area. Considering the oligopolistic nature of the market, supply function was fitted for the quantity of NWFPs supplied by the Federation. The model adopted for the study is as follows.

(9) The estimated supply function is of the

form,

$$Y=b_0+b_1X \quad (10)$$

where Y = quantity of NWFP supplied (kg)
X = price(Rs.)
b_0 and b_1 are coefficients

Elasticity

$$\eta_\rho = b_1 \times \left| \frac{\overline{X}}{\overline{Y}} \right| \quad (11)$$

where η_ρ = price elasticity
$\overline{X}$ = average price in the sample(Rs.)
$\overline{Y}$ = average value of the quantity in the sample(kg)
b_1 is the coefficients obtained from (10)

3.6 Determinants of participation of stakeholders in the participatory management programme

To identify and measure the impact of various selected parameters on the extent of participation by interest groups, regression analysis was carried out. Since Ordinary Least Squares (OLS) method was found unsuitable for the model developed, Weighted Least Squares (WLS) method was adopted. The specified model is presented below.

The determinants of participation in NWFP based participatory management were assessed using Weighted Least Squares(WLS) method. The regressand is the stakeholder participation and the regressors are age, education, alternative sources of income, income and awareness regarding forest conservation.

$$Y=\beta_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+u$$

where u = the stochastic disturbance term
Y = participation
X_2 = age
X_3 = alternative sources of income
X_4 = awareness on forest conservation
X_5 = education
X_6 = income (Rs.)

3.7 Impact of participatory management programme on vegetation structure of the sanctuary

A study was carried out in the sanctuary to assess the role of awareness in the harvesting pattern of the NWFPs. Four groups were identified. These groups are: tribes who have been closely associated with the PFM activities (PFM group), tribes who have been made aware of PFM activities (AWARE group), tribes who are not aware (UNAWARE group), and an all Women group to assess the gender differences (WOMEN group). The WOMEN group was not trained in any of the PFM activities.

Data were collected on the distance traveled (km/day), time spent (hours/day), quantities of three selected NWFPs viz., *Solanum indicum*, *Desmodium velutinum* and *Pseudarthria viscida* (kg/day) refered to as *NWFP-1*, *NWFP-2* and *NWFP-3*, respectively. The species were selected based upon the

commercial importance, availability and collected by both men and women. The data were subjected to statistical analysis in order to find out the variation between groups with respect to the variables considered and it was followed by mean comparison test using Duncan's Multiple Range Test (DMRT).

Section 4

Floristic Richness and Species Diversity

This section elucidates the floristic richness and diversity of NWFP bearing forests and plantations in the study area and evaluate the major determinants that affect the regeneration potential of NWFPs, so as to provide insight on the biodiversity conservation and sustainable use. In this section, we address some questions: What is the spectrum of NWFP resources in the study area? What constitutes a sustainable level for the conservation of NWFP resources? What is the level of NWFP productivity in the plantations and natural forests? What micro-environmental factors favour NWFP occurrence and abundance?

4.1 Results and Discussion

4.1.1 NWFP spectrum in the natural forests of WWS

A total of 151 NWFP species, representing 54 plant families, was recorded at the study site (Appendix 4). Of these, 34 families were represented by more than one genus. The most dominant families (>6 species) were: Fabaceae (15), Asteraceae (9), Acanthaceae (9), Malvaceae (9) and Euphorbiaceae (6). Total number of species presently reported is, however, lower than what Godbole (1996) has stated for the northern parts of the Western Ghats (219 species).

Appendix 4 not only brings out the diversity of NWFP species in WWS, but also their uses and parts used. In addition, it points to the fact that some of the species are genuinely under-exploited ones with enormous potential for improvement. These species play vital roles in our present day economic life by providing various products and a variety of non-monetary services, and are the key components of sustainability and environmental protection. Some of these species are traded through the cooperative societies (e.g., 32 at Wayanad), and the rest being channellised either through private traders or used for consumption purposes. Data presented in Table 4.1 suggests that the Shannon's Diversity Index for NWFP was 2.9 and Simpson's Dominance Index and the number of species exploited were low.

Table 4.1: Density, species diversity and dominance of NWFP species in the natural forests of WWS

Parameters	Natural forests
Number of species present	151
Number of species exploited	37
Density of tree species (no. ha^{-1})	10
Density of non-tree species (no. ha^{-1})	240
Shannon diversity index (H')	3.19
E	0.81
Simpson's index (D)	0.924
Cd	0.076

E=Equitability ; Cd = Concentration of dominance

NWFP spectrum probably reflects the general floristic richness of a locality, which

in turn, is dependent on the magnitude of disturbance that a site experiences. Although strong associations between local environment and plant community composition have been reported (Pregitzer *et al.*, 1983) in areas subjected to considerable anthropogenic influence, these relationships are probably obscured. That is, disturbance may sometimes override the site influences, especially where differences in these factors are relatively small, resulting in weaker association between the vegetation and site conditions (Brosofske *et al.*, 2001). Presumably, locations from where a large number of species are extracted may suffer far greater disturbances than other sites. Thus, it is probable that floristic richness of a forest may be strongly impacted by the magnitude of NWFP extraction.

Differences in the number of species extracted also mirror the level of protection from human disturbances a site enjoys. For instance, the WWS, being a 'protected area' is characterized by a reasonably higher level of protection than other nearby sites. Earlier work at this site (Muraleedharan *et al.*, 1997) has shown that NWFP extraction, as other forms of human-induced disturbances, is related to decline in species richness and greater the magnitude of such disturbances, greater is the potential for species loss. There is perhaps increased local extinction of some potential NWFP yielding plants at the nearby sites, which do not receive *pro rata* 'protection' as the WWS. Uma Shankar *et al.* (1998) also found that the distant stands (less disturbed) showed far greater species richness and density than proximal stands (more disturbed). Discussion above has been devoted primarily to NWFP species diversity as measured by richness (H'). Local environmental and edaphic factors also determine in part, the composition of the plant community, which are examined later in this section.

4.1.2 Structural attributes and importance value index

The total basal area was 3.59 $m^2 ha^{-1}$, of which 2.89 $m^2 ha^{-1}$ was contributed by overstorey trees and the rest by understorey plants. *Sterculia villosa*, *Strobilanthes ciliatus*, *Phyllanthus emblica* and *Sida rhombifolia* exhibited the top four IVI values (Table 4.2). *Sida rhombifolia* and *Curculigo orchioides* formed other dominant species. Regarding spatial distribution patterns of NWFP species, contiguous distribution for 79 per cent of the species was seen at WWS (Table 4.2). The shift in spatial pattern from contiguous to regular and to random may imply changes in species mortality and/or regeneration strategies. Highest proportion of continuously distributed species signifies that environmental and edaphic changes following human-induced disturbance may favour contiguous/regular distribution of more individuals. Differences in species diversity, species composition and species distribution pattern can thus be explained by variations in the environment, vegetation type and the level of management. We have not been concerned in this study with examining temporal changes in the NWFP spectrum.

4.1.3 Distribution, abundance and standing biomass of important NWFP species in the natural forests

To evaluate the distribution pattern and standing biomass yield of important NWFP

Table 4.2: Density, basal area, percentage frequency, A/F ratio and importance value index of commercially important NWFP species in the natural forests of WWS (IVI>10)

Species	Family	Density (ha^{-1})	Basal area ($cm^2\ ha^{-1}$)	% frequency	A/F ratio	IVI
Trees						
Sterculia villosa	Sterculiaceae	3	11465	13	0.12	34
Phyllanthus emblica	Euphorbiaceae	29	3399	63	0.02	18
Vateria indica	Dipterocarpaceae	2	4602	10	0.13	14
Terminalia bellirica	Combretaceae	2	3538	7	0.13	11
Others		21	5799			
Total		57	28804			
Shrubs						
Strobilanthes ciliatus	Acanthaceae	527	1802	33	1.13	26
Helicteres isora	Sterculiaceae	88	1352	53	0.12	13
Others		69	1032			
Total		684	4186			
Herbs, climbers & bamboos						
Sida rhombifolia	Malvaceae	332	99	53	0.13	18
Curculigo orchioides	Hypoxidaceae	362	88	43	0.77	17
Desmodium velutinum	Fabaceae	134	76	50	0.33	13
Biophytum sensitivum	Oxalidaceae	250	186	37	0.75	13
Elephantopus scaber	Asteraceae	225	83	33	0.81	12
Pseudarthria viscida	Fabaceae	193	61	33	0.70	10
Rhynchosia rufescens	Fabaceae	225	76	40	0.13	12
Others		621	2096			
Total		2342	2774			

species, surveys were conducted within all four ranges of WWS. Data on the occurrence and abundance of selected NWFP species (eleven species, Table 4.3) show that all species except the two *Solanum* spp. and *Pseudarthria viscida* were present in all the ranges of WWS, despite substantial between-location variations. Such variations

Table 4.3: Density (number of individuals ha^{-1}), frequency (%) and biomass (kg ha^{-1}) of NWFP species in the natural forests of different forest ranges in WWS.

Plant species	Parameters	Forest Ranges			
		Muthanga	Sulthan Bathery	Kurchiat	Tholpetty
Asparagus racemosus	Density	58.00	156.00	193.00	222.00
	Frequency	24.20	35.30	44.40	55.60
	Biomass	2.51	6.80	8.40	9.70
Costus speciosus	Density	1233.00	179.00	153.00	1817.00
	Frequency	21.20	17.60	20.00	83.30
	Biomass	40.26	5.90	5.00	59.30
Curcuma aromatica	Density	9.00	53.00	16.00	33.00
	Frequency	6.10	2.90	4.40	5.60
	Biomass	1.20	7.10	2.10	4.50
Desmodium velutinum	Density	15.00	156.00	200.00	6.00
	Frequency	12.10	20.60	37.80	5.60
	Biomass	0.39	4.00	5.20	0.15
Dioscorea pentaphylla	Density	155.00	27.00	40.00	22.00
	Frequency	36.40	14.70	26.70	22.20
	Biomass	1.60	0.30	0.40	0.23
Hemidesmus indicus	Density	218.00	338.00	180.00	50.00
	Frequency	39.40	47.10	40.00	11.10
	Biomass	0.71	1.10	0.60	0.16
Phyllanthus amarus	Density	491.00	406.00	271.00	33.00
	Frequency	15.20	23.50	26.70	11.10
	Biomass	0.28	0.23	0.15	0.02
Pseudarthria viscida	Density	0.00	359.00	231.00	28.00
	Frequency	0.00	26.50	55.50	16.70
	Biomass	0.00	6.80	4.40	0.51
Sida rhombifolia	Density	236.00	374.00	642.00	2217.00
	Frequency	21.20	67.60	64.40	77.80
	Biomass	1.90	3.00	5.20	18.01
Solanum indicum	Density	33.00	0.00	0.00	161.00
	Frequency	9.10	0.00	0.00	16.70
	Biomass	0.42	0.00	0.00	2.04
Solanum viarum	Density	12.00	6.00	0.00	0.00
	Frequency	6.10	2.90	0.00	0.00
	Biomass	0.37	0.18	0.00	0.00

(between ranges), however, did not follow a consistent pattern. Overall, *Sida rhombifolia* showed the highest density, followed by *Costus speciosus*. The latter also recorded the highest overall standing biomass yield (21.7 kg ha^{-1}). Furthermore, *Sida rhombifolia*, *Asparagus racemosus* and *Hemidesmus indicus* were the most widely distributed NWFP species in WWS.

Not only the standing biomass of different NWFP species showed tremendous variations (Table 4.3), but also the proportion of useful part(s) to the total plant biomass showed considerable variability among the species (Table 4.4). Whilst the whole of *Phyllanthus amarus* is used for medicinal purposes, in *Solanum indicum* and *S. viarum*, only the below ground components, are used for commercial/ medicinal purposes. Table 4.5 contains estimates of useful products of the nine species available in different forest ranges of WWS, calculated based on area estimates of the ranges.

4.1.4 NWFP spectrum in the forest plantations of WWS

The current status of NWFP yielding plants in the understorey of teak plantations in WWS included 25 species at Tholpetty, 32 at Kurchiat and 23 each at Muthanga and Sulthan Bathery. This, however, is substantially lower than the NWFP spectrum in the natural forests of WWS. Overall, the presence of a teak overstorey does not seem to adversely affect the

Table 4.4: Biomass distribution in different parts of NWFP species and percentage contribution of useful part/s to the total plant biomass

Plant species	Useful part/s	Biomass (g $plant^{-1}$)						% of biomass parts
		Leaf	Stem	Fruit	Root	Tuber	Total	
Asparagus racemosus	Tuber	1.31	1.49	-	-	40.80	43.56	93.60
Costus speciosus	Tuber	2.08	7.90	-	-	22.70	32.65	69.50
Curcuma aromatica	Tuber	12.74	25.40	-	1.07	95.40	134.70	70.80
Desmodium velutinum	Root	3.07	11.70	-	10.80	-	25.86	41.80
Dioscorea pentaphylla	Tuber	0.40	0.36	-	-	9.96	10.36	96.10
Hemidesmus indicus	Root	0.33	1.18	-	1.71	-	3.24	52.70
Phyllanthus amarus	Whole	0.19	0.29	-	0.09	-	0.57	100.00
Pseudarthria viscida	Root	2.96	11.50	0.20	4.54	-	19.06	23.80
Sida rhombifolia	Root	0.81	5.29	0.75	1.28	-	8.13	15.70
Solanum indicum	Root, stem	3.23	6.35	-	3.06	-	12.64	74.40
Solanum viarum	Root, stem	8.16	10.10	5.90	5.75	-	30.50	52.00

Table 4.5: Biomass (kg) of useful part/s of NWFP species in the natural forests of different forest ranges[1] in WWS

Species	Forest Range			
	Muthanga	Sulthan Bathery	Kurchiat	Tholpetty
Asparagus racemosus	1343	45110	60842	34034
Costus speciosus	160115	28891	26854	15487
Curcuma aromatica	4966	35803	11484	11930
Desmodium velutinum	940	11960	16689	227
Dioscorea pentaphylla	8801	1872	3074	830
Hemidesmus indicus	2131	4098	2373	320
Phyllanthus amarus	1601	1642	1192	71
Pseudarthria viscida	0	11551	8092	473
Sida rhombifolia	1725	3383	6326	10629
Solanum indicum	1792	0	0	5691
Solanum viarum	1098	664	0	0

[1] Area under natural forests, Muthanga – 5722 ha, Sulthan Bathery- 7097 ha, Kurchiat- 7720 ha and Tholpetty- 3757 ha

regeneration and establishment of NWFP species. George *et al.* (1993) also reported similar observations on understorey regeneration in the abandoned *Eucalyptus tereticornis* plantations in the Neyyar Wildlife Sanctuary in peninsular India.

Furthermore, floristic elements in the sub-canopy of plantations at different sites in the WWS, especially their structural attributes (density, frequency, etc.), exhibited a fair amount of variability. For instance, at Tholpetty *Curcuma zedoaria* and *Sida rhombifolia* were the most dominant NWFPs (Table 4.6).

Other prominent species included *Curcuma neilgherrensis, Cassia fistula, Solanum indicum, Desmodium velutinum, Pseudarthria viscida, Curcuma aromatica, Acacia sinuata, Helicteres isora, Hemidesmus indicus,* etc. Rare species like *Rauvolfia serpentina* was also observed in this range.

As far as Kurchiat range is concerned (Table 4.7), the flora of the teak plantation floor is characterised by an overwhelming presence of *Pseudarthria viscida, Helicteres isora, Sida rhombifolia and Randia dumetorum* (>300 individuals ha^{-1}). Other dominant NWFP species included *Cyclea peltata, Desmodium velutinum, Hemidesmus indicus, Solanum indicum, Curcuma zedoaria, Asparagus racemosus, Acacia sinuata, Phyllanthus amarus, and Desmodium gangeticum.*

Table 4.6: Structural attributes of dominant NWFPs in the teak plantations of Tholpetty Range

Species	Density (No. ha^{-1})	Relative freq.	Relative abund.	Relative density	Importance value index
Curcuma zedoaria	961	7.14	7.21	20.25	27.40
Sida rhombifolia	733	9.01	4.36	15.45	24.50
Curcuma neilgherrensis	350	5.90	3.18	7.37	13.30
Cassia fistula	228	5.28	2.31	4.80	10.10
Solanum indicum	186	3.73	2.68	3.92	7.65
Desmodium velutinum	139	4.04	1.85	2.92	6.97
Pseudarthria viscida	119	4.04	1.59	2.51	6.56
Curcuma aromatica	208	1.86	6.00	4.39	6.25
Randia dumetorum	89	3.73	1.28	1.87	5.60
Desmodium gangeticum	78	2.48	1.68	1.63	4.12
Acacia sinuata	53	2.80	1.01	1.11	3.91
Urena lobata	89	1.86	2.56	1.87	3.73
Helicteres isora	69	2.17	1.71	1.46	3.63
Hemidesmus indicus	61	1.86	1.76	1.28	3.15
Curcuma spp.	97	0.93	5.60	2.04	2.98
Glycosmis pentaphylla	56	1.55	1.92	1.17	2.72
Cyclea peltata	36	1.86	1.04	0.76	2.62
Elephantopus scaber	14	1.24	0.60	0.29	1.53
Rauvolfia serpentina	11	1.24	0.48	0.23	1.47
Costus speciosus	11	0.93	0.64	0.23	1.16
Phyllanthus amarus	11	0.93	0.64	0.23	1.16
Flemingia strobilifera	14	0.62	1.20	0.29	0.91
Asparagus racemosus	11	0.62	0.96	0.23	0.85
Solanum viarum	11	0.62	0.96	0.23	0.85
Lobelia nicotianaefolia	6	0.62	0.48	0.11	0.74

The most dominant NWFPs species in Muthanga range (Table 4.8) was *Hemidesmus indicus*. Other important NWFP species included *Mimosa pudica, Cyclea peltata, Solanum indicum, Helicteres isora, Desmodium velutinum, Asparagus racemosus, Solanum viarum, Sida rhombifolia, Curculigo orchioides, Curcuma zedoaria,* etc.

Table 4.7: Structural attributes of dominant NWFPs in the teak plantations of Kurchiat Range

Species	Density (No. ha^{-1})	Relative freq.	Relative abund.	Relative density	Importance value index
Pseudarthria viscida	328	7.37	3.97	9.88	17.26
Helicteres isora	317	6.84	4.14	9.57	16.41
Sida rhombifolia	331	6.32	4.68	9.98	16.31
Cyclea peltata	162	10.53	1.37	4.89	15.42
Randia dumetorum	314	5.79	4.84	9.46	15.26
Desmodium velutinum	172	5.79	2.66	5.20	10.99
Hemidesmus indicus	107	6.32	1.51	3.22	9.55
Solanum indicum	152	3.68	3.68	4.57	8.26
Curcuma zedoaria	190	2.11	8.04	5.72	7.83
Asparagus racemosus	62	5.79	0.96	1.87	7.66
Acacia sinuata	124	2.63	4.21	3.74	6.38
Curcuma spp.	124	2.11	5.26	3.74	5.86
Phyllanthus amarus	52	3.16	1.46	1.56	4.72
Desmodium gangeticum	41	3.16	1.17	1.24	4.41
Desmodium spp.	45	1.58	2.53	1.35	2.93
Mimosa pudica	34	1.05	2.92	1.04	2.09
Flemingia strobilifera	10	1.58	0.58	0.31	1.89
Cassia fistula	24	1.05	2.05	0.72	1.78
Biophytum sensitivum	17	1.05	1.46	0.52	1.57
Glycosmis pentaphylla	31	0.53	5.26	0.93	1.47
Elephantopus scaber	10	1.05	0.88	0.31	1.36
Curcuma neilgherrensis	21	0.53	3.51	0.62	1.15
Nervilia aragoana	21	0.53	3.51	0.62	1.15
Polygonum chinense	17	0.53	2.92	0.52	1.05
Allophylus cobbe	14	0.53	2.34	0.41	0.95
Polygonum spp.	14	0.53	2.34	0.41	0.95
Costus speciosus	10	0.53	1.75	0.31	0.84
Cryptolepis buchananii	7	0.53	1.17	0.20	0.74
Justicia betonica	7	0.53	1.17	0.20	0.74
Adhatoda zeylanica	3	0.53	0.58	0.10	0.63
Clerodendrum serratum	3	0.53	0.58	0.10	0.63
Rauvolfia serpentina	3	0.53	0.58	0.10	0.63

Table 4.8: Structural attributes of dominant NWFPs in the teak plantations of Muthanga Range

Species	Density (No. ha^{-1})	Relative freq.	Relative abund.	Relative density	Importance value index
Hemidesmus indicus	344	7.09	2.77	5.888	12.98
Mimosa pudica	281	6.30	2.55	4.818	11.12
Cyclea peltata	144	6.30	1.31	2.462	8.76
Solanum indicum	188	3.94	2.72	3.211	7.15
Randia dumetorum	125	3.94	1.81	2.141	6.08
Helicteres isora	169	2.36	4.08	2.890	5.25
Desmodium velutinum	113	3.15	2.04	1.927	5.08
Asparagus racemosus	63	3.94	0.91	1.070	5.01
Solanum viarum	150	2.36	3.63	2.569	4.93
Sida rhombifolia	100	3.15	1.81	1.712	4.86
Curculigo orchioides	81	2.36	1.96	1.391	3.75
Curcuma zedoaria	94	1.57	3.40	1.606	3.18
Bambusa bambos	81	1.57	2.95	1.391	2.96
Elephantopus scaber	31	2.36	0.76	0.535	2.90
Flemingia strobilifera	31	1.57	1.13	0.535	2.11
Cassia fistula	19	1.57	0.68	0.321	1.89
Nervilia aragoana	13	1.57	0.45	0.214	1.78
Oxalis corniculata	31	0.79	2.27	0.535	1.33
Glycosmis pentaphylla	25	0.79	1.81	0.428	1.22
Desmodium spp.	19	0.79	1.36	0.321	1.11
Acacia sinuata	13	0.79	0.91	0.214	1.00
Desmodium gangeticum	13	0.79	0.91	0.214	1.00
Phyllanthus amarus	13	0.79	0.91	0.214	1.00

At Sulthan Bathery, the predominant NWFP species included *Pseudarthria viscida and Sida rhombifolia. Cyclea peltata, Asparagus racemosus, Hemidesmus indicus, Solanum indicum, Helicteres isora, Curcuma zedoaria Desmodium velutinum, Acacia sinuata, Phyllanthus amarus* and *Solanum viarum* were also abundant (Table 4.9).

A comparison of the data in Table 4.10 indicates that most NWFP species included in the study showed higher densities in the natural forests compared to plantations. For instance, in Muthanga, densities of *Phyllanthus amarus, Sida rhombifolia, Hemidesmus indicus,. Dioscorea pentaphylla* and *Asparagus racemosus* were

Table 4.9: Structural attributes of dominant NWFPs in the teak plantations of Sulthan Bathery Range

Species	Density (No. ha^{-1})	Relative freq.	Relative abund.	Relative density	Importance value index
Pseudarthria viscida	188	6.49	2.58	4.5411	11.03
Sida rhombifolia	200	5.19	3.42	4.8309	10.02
Cyclea peltata	112	7.14	1.40	2.7053	9.85
Asparagus racemosus	108	6.49	1.48	2.6087	9.10
Hemidesmus indicus	152	5.19	2.60	3.6715	8.86
Solanum indicum	156	3.90	3.56	3.7681	7.67
Helicteres isora	152	3.25	4.16	3.6715	6.92
Curcuma zedoaria	116	3.25	3.18	2.8019	6.05
Desmodium velutinum	64	3.90	1.46	1.5459	5.45
Acacia sinuata	40	3.25	1.10	0.9662	4.22
Phyllanthus amarus	64	2.60	2.19	1.5459	4.15
Solanum viarum	44	1.95	2.01	1.0628	3.01
Mimosa pudica	36	1.95	1.64	0.8696	2.82
Cymbopogon citratus	80	0.65	10.96	1.9324	2.58
Phyllanthus emblica	12	1.95	0.55	0.2899	2.24
Clerodendrum serratum	28	1.30	1.92	0.6763	1.98
Polygonum spp.	28	1.30	1.92	0.6763	1.98
Argyreia cuneata	20	1.30	1.37	0.4831	1.78
Elephantopus scaber	16	1.30	1.10	0.3865	1.69
Cassia fistula	8	1.30	0.55	0.1932	1.49
Curcuma spp.	20	0.65	2.74	0.4831	1.13
Lobelia nicotianaefolia	20	0.65	2.74	0.4831	1.13
Smilax spp.	4	0.65	0.55	0.0966	0.75

higher in natural forests than that in plantation areas. Likewise, in Sulthan Bathery, densities of all selected species except *Solanum indicum* and *Solanum viarum* were higher in the natural forests. In Kurchiat also, densities of *Asparagus racemosus, Desmodium velutinum, Dioscorea pentaphylla, Hemidesmus indicus, Phyllanthus amarus* and *Sida rhombifolia* were greater in the natural forests. However, densities of *Hemidesmus indicus, Solanum indicum, Solanum viarum, Desmodium velutinum* and *Pseudarthria viscida* at Muthanga, and *Pseudarthria viscida, Curcuma aromatica* and *Solanum indicum* in Kurchiat were higher in the plantation areas. Similarly, in Tholpetty, densities of majority of the

Table 4.10: Comparison of selected NWFP species in the natural forests and plantations of four ranges in WWS

Species	Density (number ha^{-1})							
	Muthanga		Sulthan Bathery		Kurchiat		Tholpetty	
	forest	plantation	forest	plantation	forest	plantation	forest	plantation
Asparagus racemosus	58	0	156	108	193	62	222	11
Curcuma aromatica	9	0	53	20	16	124	33	208
Desmodium velutinum	15	113	156	64	200	172	6	139
Dioscorea pentaphylla	155	0	27	0	40	0	22	0
Hemidesmus indicus	218	344	338	152	180	107	50	61
Phyllanthus amarus	491	13	406	64	271	52	33	11
Pseudarthria viscida	0	13	359	188	231	328	28	119
Sida rhombifolia	236	100	374	200	642	331	2217	734
Solanum indicum	33	188	0	156	0	152	161	186
Solanum viarum	12	150	6	44	0	0	0	11

selected species were higher in plantations except that of *Sida rhombifolia, Asparagus racemosus and Dioscorea pentaphylla.* Coincidentally, *Sida rhombifolia* was the most abundant species in the natural forests at this site.

4.1.5 NWFP diversity in different ranges of WWS

The natural forests in general had a far greater NWFP species richness and diversity (Table 4.2, Appendix 4 and Tables 4.12 to 4.14). Although the plantations are not considered species-rich, they exhibit a moderate to high degree of NWFP diversity. Clearly, the Shannon's Diversity Index of 2.5 to 3.1 (Table 4.11) for the plantations is lower than the natural forest ecosystem (Table 4.1). However, it falls well within the range of 1.98 to 3.53 recorded for sal (*Shorea robusta* Gaertn.) plantations of Gorakhpur

Table 4.11: Comparison of NWFP diversity indices among plantations in four ranges in WWS

Location	Shannon Wiener's Diversity Index	Simpson's Diversity Index	Simpson's Dominance index	Evenness
Sultan Bathery	2.61	0.86	0.14	0.72
Muthanga	2.50	0.80	0.20	0.64
Kurchiat	2.93	0.93	0.07	0.78
Tholpetty	3.05	0.91	0.09	0.75

(Pandey and Shukla, 1999). Consequently, the plantations of Wayanad assume significance as a source of NWFPs. These results also show that teak plantations are capable of catalyzing native forest succession, which includes an array of NWFPs.

Among the four ranges of WWS, Tholpetty had the highest Shannon's Diversity Index for shrubs and herbs (NWFP species), followed by Kurchiat. Muthanga and Sultan Bathery ranges had modestly lower diversity values. The Shannon's Index is a general index of diversity which takes into account the species richness component and the variability of density within each species, and is the most popular among the variety of diversity indices. Dominance as expressed in terms of Simpson's Index was higher in the natural forests than plantations (Tables 4.1 and 4.11). Among the four ranges of WWS, Kurchiat showed higher index value followed by Tholpetty and Muthanga registered the lowest value. Probably, lower values of evenness imply the existence of a large number of rare species.

4.1.6 Standing biomass of NWFPs in the forest plantations of WWS

As expected, dry weights of individual NWFP yielding plants in the teak plantations and their tissue types showed considerable variability among the locations (Table 4.12). This coupled with variations in density/abundance (Table 4.13) resulted in massive variations in the biomass productivity of different NWFP yielding species (Table 4.14). Although perceptible variations across different forest ranges, with regard to the sites, for example, plantation and natural forest, were discernible, little generalisation could be made. The most probable conclusions could be directed only at the productivity wherein the same was more in natural forest compared to the plantations. Also, comparative data from other ecosystems within the Western Ghats are not easily available. Nevertheless, data presented in Table 4.13 provide valuable comparative estimates of NWFP availability in the forests and plantations of WWS. Similarly Table 4.14 presents the data on overall productivity of individual NWFP species in the teak plantations of WWS, which seems to be quite low.

4.1.7 Implications for sustainable extraction and conservation of NWFPs

For a wide spectrum of NWFP yielding species encountered at the study sites, harmful harvesting methods have been a major threat (Muraleedharan *et al.*,1997). For sustainable resource use, the replenishment (regeneration) rate of the resources should be considered (Peters, 1996). Muraleedharan *et al.* (1997) demonstrated that in the case of plants propagated vegetatively, regeneration index has been between 100 and 30 at 95 per cent harvest rate (e.g. *Asparagus racemosus*, *Curcuma aromatica* and *Hemidesmus indicus*). However, from Biligiri Rangan Hills, Murali and Hegde (1996) reported that for *Phyllanthus emblica* fruits, 50 per cent harvest level is sustainable. Peters (1990) found that up to 80 per cent of the fruit

Table 4.12: Biomass of plant parts of NWFP species in the plantations of four ranges in WWS

Species	Parts	Biomass (g plant^{-1})			
		Muthanga	S. Bathery	Kurchiat	Tholpetty
Asparagus racemosus	Leaf	1.20	1.37	1.60	2.50
	Stem	1.55	1.54	1.70	2.78
	Tuber	36.20	48.64	54.32	45.30
Costus speciosus	Leaf	2.20	2.15	1.90	2.00
	Stem	6.50	5.36	4.59	6.21
	Tuber	20.30	18.21	16.23	19.56
Curcuma aromatica	Leaf	13.52	10.36	12.36	12.10
	Stem	24.32	22.30	25.32	22.30
	Tuber	52.30	45.54	50.23	48.20
Desmodium velutinum	Leaf	2.50	2.70	2.93	3.25
	Stem	10.50	10.90	9.35	10.25
	Root	10.30	9.36	9.50	10.50
Hemidesmus indicus	Leaf	0.35	0.40	0.45	0.42
	Stem	1.15	1.18	1.23	1.20
	Root	1.50	1.43	1.36	1.69
Phyllanthus amarus	Leaf	0.20	0.22	0.25	0.21
	Stem	0.25	0.23	0.27	0.20
	Root	0.05	0.09	0.10	0.10
Pseudarthria viscida	Leaf	3.10	2.56	4.12	4.25
	Stem	11.20	11.30	10.90	12.40
	Root	4.21	4.10	5.32	5.67
Sida rhombifolia	Leaf	0.90	0.82	0.95	1.20
	Stem	4.10	4.91	5.23	5.45
	Root	1.10	1.00	1.45	1.59
Solanum indicum	Leaf	3.20	2.54	3.67	4.29
	Stem	6.52	6.90	7.19	8.12
	Root	3.29	3.45	4.20	4.78
Solanum viarum	Leaf	6.20	5.90	7.45	7.80
	Stem	9.23	8.54	9.43	10.96
	Root	5.80	5.43	6.10	8.57
	Fruit	5.23	4.34	5.45	5.30

Table 4.13: Total standing biomass (kg ha^{-1}) of selected NWFPs in the plantations and natural forests of WWS

Species	Habitat	Muthanga	S. Bathery	Kurchiat	Tholpetty
Asparagus racemosus	Plantation	0.58	5.56	3.57	0.55
	Natural forest	2.51	6.80	8.40	9.70
Costus speciosus	Plantation	0.05	0.05	0.22	0.30
	Natural forest	40.26	5.90	5.00	59.30
Curcuma aromatica	Plantation	0.18	1.56	10.90	17.18
	Natural forest	1.20	7.10	2.10	4.50
Desmodium velutinum	Plantation	7.34	1.46	3.74	3.33
	Natural forest	0.39	4.00	5.20	0.15
Hemidesmus indicus	Plantation	2.88	0.45	0.32	0.20
	Natural forest	0.71	1.10	0.60	0.16
Phyllanthus amarus	Plantation	0.01	0.00	0.03	0.00
	Natural forest	0.28	0.23	0.15	0.02
Pseudarthria viscida	Plantation	0.64	3.37	6.67	2.66
	Natural forest	0.00	6.80	4.40	0.51
Sida rhombifolia	Plantation	1.70	1.34	2.52	6.04
	Natural forest	1.90	3.00	5.20	18.01
Solanum indicum	Plantation	6.83	2.01	2.28	3.19
	Natural forest	0.42	0.00	0.00	2.04
Solanum viarum	Plantation	11.11	1.06	0.28	0.35
	Natural forest	0.37	0.18	0.00	0.00

Table 4.14: Average productivity of NWFP plant biomass for all ranges

Species	Total biomass (kg ha^{-1})
Asparagus racemosus	2.57
Costus speciosus	0.16
Curcuma aromatica	7.45
Desmodium velutinum	3.97
Hemidesmus indicus	0.96
Phyllanthus amarus	0.01
Pseudarthria viscida	3.34
Sida rhombifolia	2.90
Solanum indicum	3.58
Solanum viarum	3.20

production could be harvested without negatively affecting the regeneration of Grias peruviana in the Peruvian Amazon, implying species to species variations in respect of sustainable harvest levels. Furthermore, sustainable extraction rate may be based on whether the reproductive part or whole plant is collected; it is generally lower for the latter category.

Unsustainable extraction has long-standing adverse effects on the population structure, which will be detected only in the long run (Bawa and Hall, 1992). In addition, at the individual tree level, harvesting of NWFPs such as fruits, may also lead to changes in flowering and fruiting patterns and lowered yields. Resolution of such ecological hassles, however, may be possible by providing encouragement to the gatherers for conservation and better management of NWFP resources. Likewise, the economic uplift of the tribal people and providing institutional and public policy support are important. Value addition of the NWFPs through improved post-harvest processing may guarantee higher profits to the collectors. In the present context one of the important management interventions proposed includes encouraging the tribals to adopt harvesting techniques that minimise the impacts through participatory management of interest groups.

4.1.8 Sub-canopy PAR transmittance

The Figures 4.1 and 4.2 illustrate diurnal variations in sub-canopy PAR transmittance of natural forests and forest plantations at 30 cm above the ground. PAR flux beneath the canopy ranged between 26 and 50 per cent of full light in the natural forests and from 39 to 62% in the plantations, depending on the time of measurement (Table 4.15). Temporal variations, however, make it difficult to characterise the understorey light regimes, which is perhaps required for explaining the variations in occurrence, abundance, growth and yield of NWFPs in the sub-canopy. In this context, Kumar *et al*. (2001) reported that midday PAR flux (between 1200-1300 h) having lower standard deviations, provides a better approximation of the mean daily understorey PAR flux, and must be used in preference to instantaneous PAR measurements in light interception studies. It is expected that the tree canopies would block progressively less radiation as the sun moves higher in the sky where path length through the canopy is shorter.
(Figures 4.1 and 4.2: Hourly integrated values of PAR above and below canopies in plantations (15-1-02 to 22-01-02) and natural forests (7-1-02 to 14-1-02) of Wayanad. Hatched regions represent the relative proportion of radiation intercepted by the canopy.

In addition, the present data also illustrate that midday PAR flux in the plantations was greater (~10%) than that of natural forests (Table 4.15 and Figure 4.2). Such differences in subcanopy PAR flux can be explained based on the variations in canopy structure, specifically the stand leaf area index (LAI). However, in the absence of structural measurements of the canopy, it is probably difficult to provide further justification in this regard. Nevertheless, it is reasonable

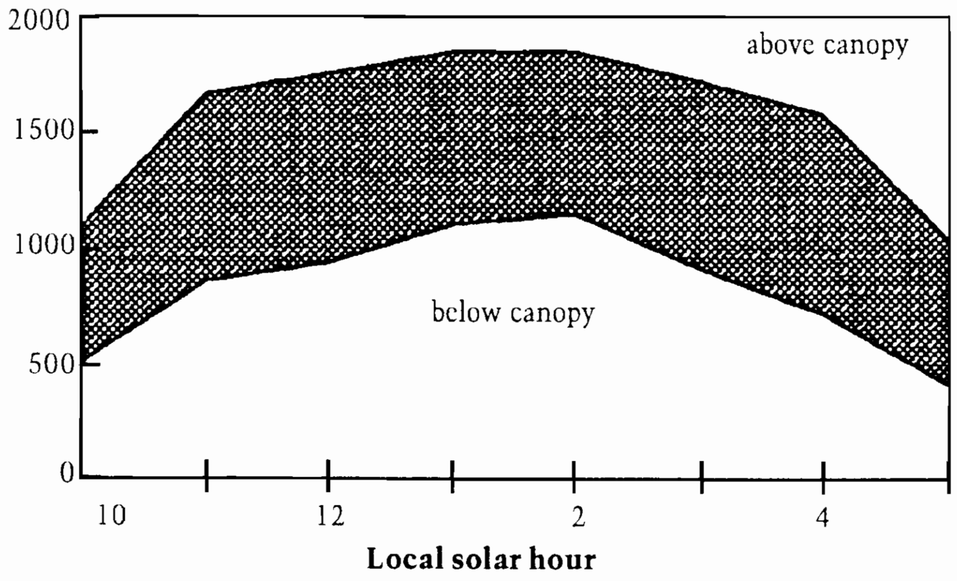

Figure 4.1: Plantation

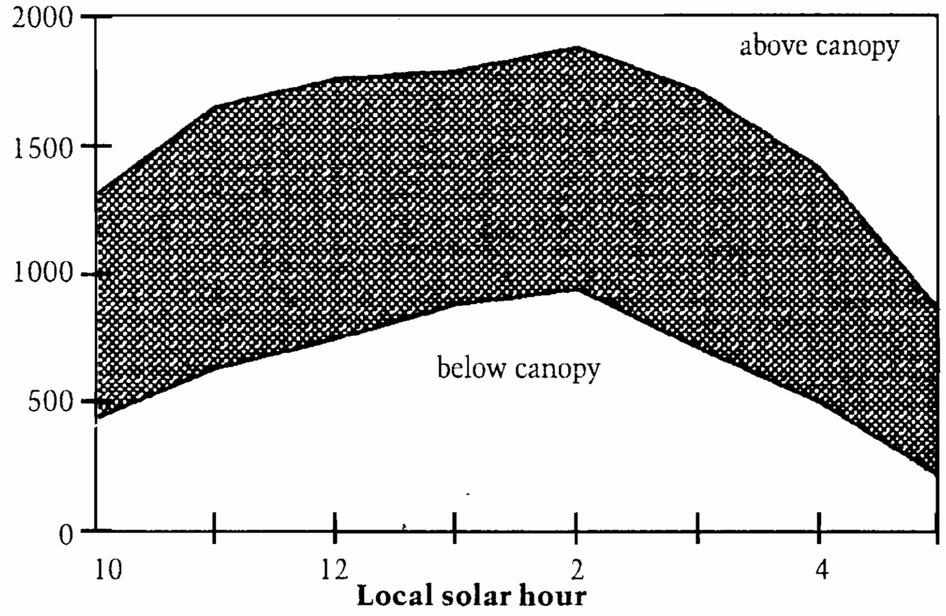

Figure 4.2: Natural forest

to assume that the multi-tiered moist forest canopy, owing to its higher LAI, may intercept more incoming solar radiation than the regularly thinned 35 year old teak stands.

Results of other studies on nearby sites (Kumar *et al.*, 2001) also indicate that sub-canopy PAR flux generally followed a negative exponential relationship with increasing LAI. Canopy architecture and dimensions are also cardinal determinants of understorey light regimes. However, little information is available on this from the present sites.

Thus, despite a concomitant increase in the density and frequency of NWFPs in the

Table 4.15: Hourly integrated values of photosynthetic active radiation (PAR) above and below canopies in plantations (15-1-02 to 22-01-02) and natural forests (7-1-02 to 14-1-02) of Wayanad

Time	Above canopy (m moles s^{-1} m^{-2})		Sub-canopy (m moles s^{-1} m^{-2})		% PAR transmission	
	Teak plantation	Natural forest	Teak plantation	Natural forest	Teak plantation	Natural forest
9-10	1100	1300	508.20	434.20	46.2	33.4
10-11	1680	1650	868.56	623.70	51.3	37.8
11-12	1760	1760	939.84	746.24	53.4	42.4
12-1	1860	1790	1106.70	880.68	59.5	49.2
1-2	1860	1880	1151.34	941.88	61.9	50.1
2-3	1730	1710	920.36	716.49	53.2	41.9
3-4	1590	1410	723.45	500.55	45.5	35.5
4-5	1040	870	407.68	221.85	39.2	25.5

natural forests (Tables 4.1 and 4.12), no cause-effect relationships could be ascribed to variations in edaphic attributes and NWFP diversity in natural forest/plantations sites of WWS.

Plant distribution is known to vary in response to the local environment and edaphic factors and it is generally expected that NWFP distribution may reflect the general floristic structure/diversity attributes (Muraleedharan *et al.*,1997). Attempts to relate environmental and edaphic attributes to vegetation distribution, however, have been rare in the tropics. Nonetheless, studies in the temperate region have shown that species diversity commonly declines with increased shading (Keenan and Kimmins, 1993), a relationship that did not hold in the current study. Conversely, our results show that the NWFP spectrum was greater in the natural forests characterised by a lower PAR flux. One plausible explanation for this apparent inconsistency is the fact that being shade tolerant, most NWFPs prefer an understorey environment. Furthermore, high light intensities (similar to that of fully exposed conditions) or disturbances may favour ruderal species such as *Lantana camara* or *Chromolaena odorata* which, in turn, may supress the NWFP abundance. The relatively lower range of variability observed in the understorey light regimes (Table 4.16) also may explain this in part.

The discussion in this section highlighted that there has been serious erosion of the NWFP resources in the study area, probably due to commercialisation and associated over extraction. The rate of extraction of NWFPs, to a great extent, is a function of the socio-economic status of the gatherers, which in turn is dependent upon its collection/availability and marketing. The next section focuses on these aspects in detail.

Section 5

Collection, Marketing and Sustainable Use of NWFPs

The sustainability of NWFPs depends upon the sustainability of forests. The sustainable use of NWFPs is closely linked with their collection and marketing and socio-economic status of the gatherers in the region. Each of these factors has varying ecological and economic dimensions. This section examines some key issues relating to collection and marketing of NWFPs in the study area and also various determinants of sustainable use and their linkages. It also gives some insight into how far it helps to improve the socio-economic conditions of the collectors and sustainable use of NWFPs.

5.1 Sustainable use of NWFPs

In the context of natural resource management, sustainability means the ability of each generation to maintain and pass on to the next generation a stock of natural resources no less productive, protected and utilizable than what is inherited. It aims at meeting the needs of the present without affecting the future requirements of goods and services. Further, it embodies a concern for equity between current and future generation and affirms the need for improved living standards of people (Pears and Turner, 1990; Repetto and Pezzey, 1990). The sustainable management of natural resource depends certainly upon its continuous supply, which is determined by interaction of a variety of biotic, social and economic factors. Thus sustainability has become more complex than just 'optimal harvest'.

The dimensions of linkages between factors such as collection/extraction, marketing and socio-economic status of the gatherers are shown in Figure 5.1.

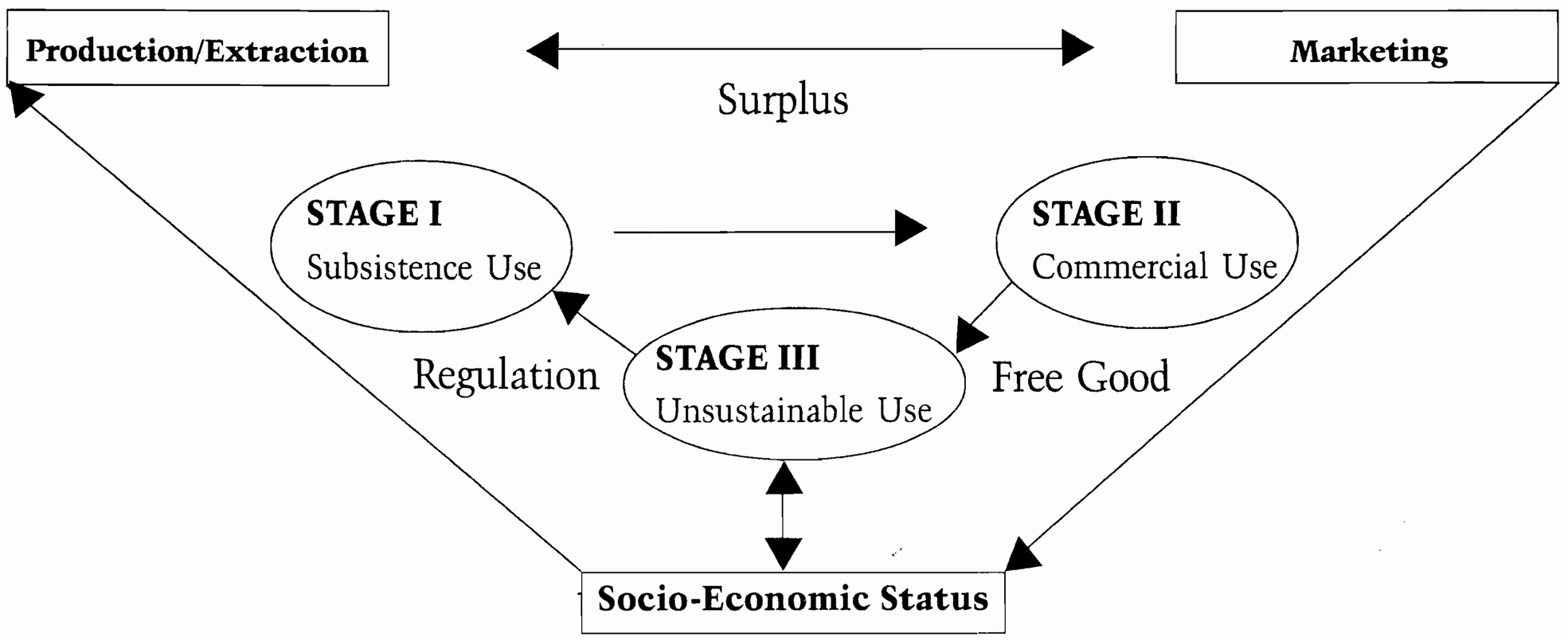

Figure 5.1: NWFP- Dimensions of linkages

Stage I portrays the utility of the NWFPs, which satisfies the subsistence needs of the tribes where the extraction of NWFPs is below the potential sustainable use (quantity demanded is less than marketable surplus, that is Qd < Qms). Since sustainability implies judicious use of the resources, the zone is irrational. The pattern changes when there is marketable surplus along with market demand for the produce, wherein the demand equals the marketable surplus. Stage II explains this change in utility. In this stage, there is sustainable use where Qd = Qms and hence it is a rational zone. Unlike in Stage I, the social and economic standards are improved here, there is maximum utility of the resource in use and the consumer welfare is maximum. This is followed by the third stage, where the demand is more than the marketable surplus leading to extraction of NWFPs over and above the sustainable threshold (Qd>Qms) (Figure 5.2).

The study identified the extraction of NWFPs in WWS to be in Stage III. The change from stage II to stage III brings forth the hidden dimensions of the linkages between production, marketing and socio-economic status of the gatherers.

In stage I the NWFPs collected satisfied the basic needs of the gatherers like, food, clothing and shelter with the quantity collected, since Qd < Qms. With the increased economic growth and development the tastes and preferences of the consumer changes and accordingly the utility of the NWFPs gathered varied giving equal weightage to commercial use as well. The imbalance in this stage can be attributed to the change in the social and cultural aspects of the gatherers. The dependency pattern changed over the years as is evident from the Forest Dependency Index worked out for the area (refer,section 7). The share of food obtained from the

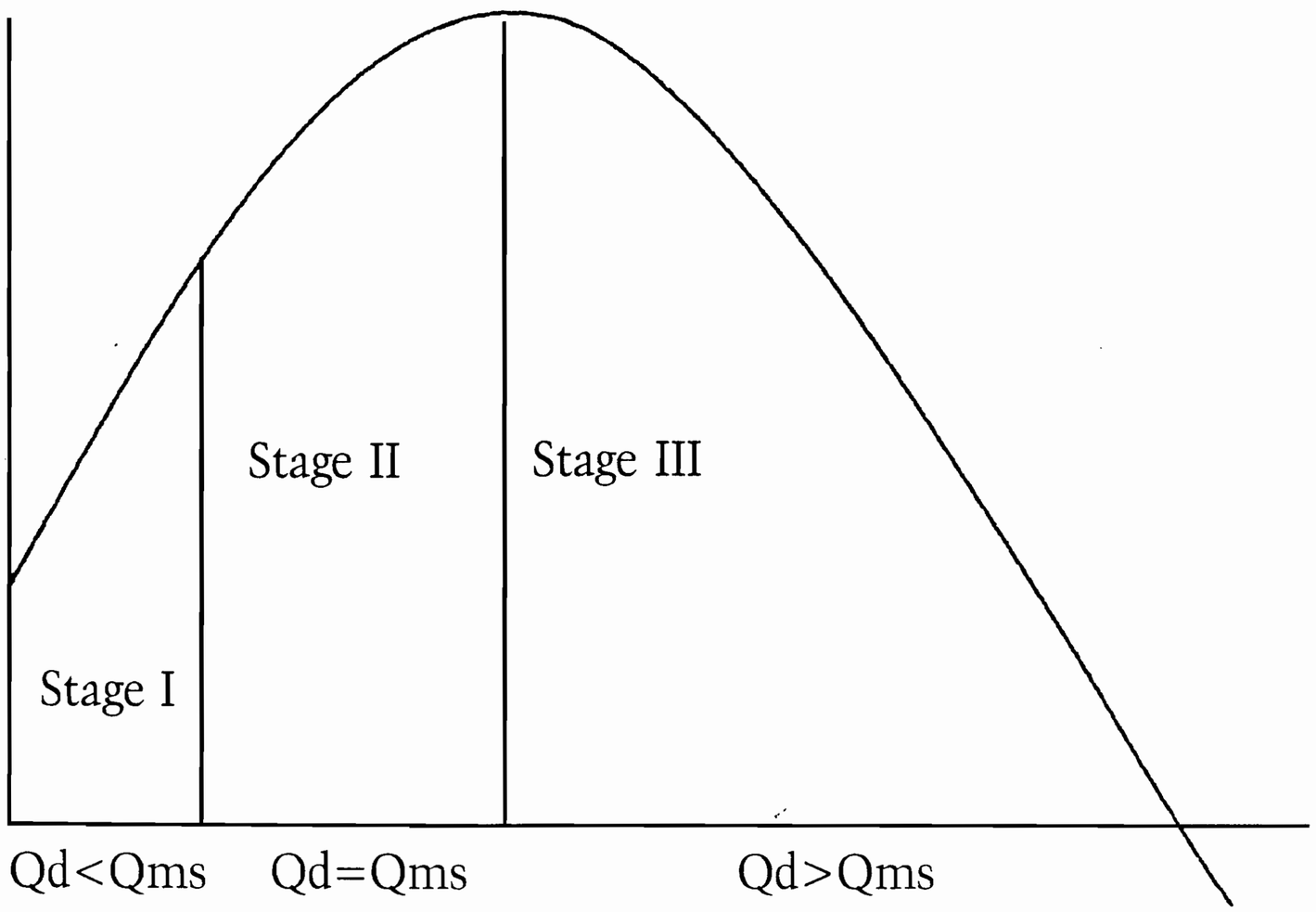

Figure 5.2: Different stages of NWFP extraction

forest is reduced and the same trend could be seen in dependency on medicines too. Our enquiry showed that the selected tribes, who are traditionally hunter-gatherers depended on tubers, honey, etc. available from the forest for their livelihood. Whatever is collected from the forests is exchanged locally for other products such as rice, ragi, etc. With the establishment of tribal societies during 1980's, the collection was directed to commercial purpose and barter system was replaced with cash transactions. Further, more than 75 per cent of income was spent on food.

The same trend could be observed in the third stage also, where with an increase in the income the per cent share spent on food increased indicating the deep-rooted poverty existing in the area. Also the average income was worked out to be Rs.6 per household per day. This is a paradoxical situation and the question one asks is why the standard of living of the gatherers has not improved over the three phases of NWFP extraction? This is particularly interesting, despite presence of institutions like the societies and the Federation which aim at facilitating collection and marketing the products, thereby to improve the socio-economic conditions of the collectors. The situation demands an inquiry into the existing extraction, and the market situation and how far these affect socio-economic conditions of the gatherers and sustainable use of NWFPs in the study area.

5.2 NWFP collection by selected society

The study aimed at analyzing the existing situation regarding NWFP collection and marketing in Wayanad. Since an in-depth empirical study necessitated the case study approach, only one among the five societies was studied in detail. Besides, as the functioning of all the societies more or less follows a homogenous pattern, it is assumed that the results of the case study can be extrapolated to other societies also thereby generalizing those societies with geographical similarities.

The selected colonies are located in the jurisdiction of Thirunelli Tribal Service Co-operative Society, which organise the collection of the products. Details of percentages of quantity collected, collection charge and sale value of different NWFPs over the years are presented in Table 5.1.

The quantity collected over the years shows that only limited products are extracted in all the years. *Acacia sinuata* (cheenikka), *Solanum torvum* (chunda), *Sida rhombifolia* (kurumthotti) and honey are the major items collected, accounting for 82 per cent. Cheenikka and honey constitute 75 per cent of the collection charge and 62 per cent of the sale value. In the case of honey, though quantity collected was less at a meagre 12 per cent, the collection charge was as high as 54 per cent. Cheenikka was collected in bulk over the years accounting for 22 per cent of the quantity, but the collection charge was low at 21 per cent. Products like, *Garcinia gummi-gutta* (kudampuli), and *Parmelia dilatata* (kalpasam) though accounted for only one per cent of the total collection, contributed eight per cent of the collection charge indicating the high value of the species along

Table 5.1: Total quantity, collection charge and sale value of different NWFPs collected over years in percent (1990-2000).

Item	Quantity	Collection charge	Sale value
Acacia sinuata	27.20	21.00	20.60
Sida rhombifolia	21.70	7.19	13.20
Solanum torvum	20.90	3.75	10.90
Honey	12.30	53.90	41.10
Pseudarthria viscida	6.67	1.23	2.81
Piper nigrum	2.67	0.43	0.37
Raphidophora pertusa	1.88	0.62	0.94
Symplocos cochinchinensis	1.64	0.54	0.49
Canarium strictum	0.88	1.97	1.83
Parmelia dilatata	0.83	4.07	3.21
Curcuma aromatica	0.78	0.12	0.19
Garcinia gummi-gutta	0.58	3.63	2.99
Curcuma angustifolia	0.19	0.05	0.05
Mesua ferrea	0.11	0.02	0.02
Bees' Wax	0.09	0.61	0.50
Desmodium velutinum	0.08	0.02	0.02
Cyclea peltata	0.04	0.10	0.08
Entada rheedii	0.01	0.01	0.04
Total	100.00	100.00	100.00

with honey. The Tables 5.2 and 5.3 given below present details of trends in the quantity collected, collection charge and sale value during 1990-2000.

The compound growth rates worked out showed a significant increase in the variables under consideration over the years. Quantity collected and sale value showed significance

Table 5.2: Trends (acceleration and deceleration) in the quantity collected, collection charge and sale value (1990-2000)

Particulars	Compound Growth Rates	A/D
Quantity collected	30.37*	D**
Collection charge	38.46**	D **
Sale value	42.65*	A*

*- Significant at 1% level of significance, **- Significant at 5% level of significance
* A- Acceleration, that shows an increase at an increasing rate.
*D- Deceleration that shows an increase at decreasing rate

Table 5.3: Estimated log quadratic equations

Variable	Constant	B Coefficient	C Coefficient	Significance
Quantity	3.7997	0.19425	-0.00718	*
Collection charge	4.1956	0.46921	-0.02980	**
Sale value	4.3458	0.44621	0.02654	*

*: Significant at 1 % level **: Significant at 5 % level

at 1 per cent level of significance. The deceleration observed in quantity collected and collection charge unlike sale value is indicative of the disproportionate increase in the sale value.

5.3 Degree of instability

With a view to assess the fluctuations in the data, instability was worked out. Average variation is arrived at from year to year variations calculated. Ranks were assigned and accordingly the value of instability measured (Table 5.4)

much fluctuation in the prices received by the gatherers over the years, probably because of the society.

5.4 Distance traveled and time spent for collection of NWFPs

The distance traveled and time spent for collection are indicators of the availability of NWFPs (Ramprasad *et al.*, 1999) and the same pertaining to the study areas are worked out and presented in Table 5.5.

The tribal people have to travel at least

Table 5.4: Instability in quantity collected, collection charge and sale value (1990-2000)

Particulars	Quantity collected	Sale value	Collection charge
Total No. of years	10	10	10
Average variation (%/year)	77.56	75	59.86
Trend(%/year)	30.37	42.65	38.46
Difference	47.19	20.23	21.4
Ranks by degree of Instability	I	II	III

It was observed that the quantity collected showed a higher degree of instability than the other variables over the years, due to variations in the availability of the NWFPs. The collection charge showed a lesser instability indicating that there was not

6 km and spend 5 hours/day to gather NWFPs. This distance traveled is indicative of the depletion of resources in the periphery. The distance up to 6 km is considered to be the 'zone of minimum NWFP extraction'. This area is also used by the gatherers and

Table 5.5: Labour input in NWFP extraction

NWFPs	Distance travelled		Time spent	
	Mean km/day		Mean hours /day	
Item	Minimum	Maximum	Minimum	Maximum
Honey	7	20	6	10
Bees' Wax	7	20	5	10
Parmelia dilatata	6	15	6	9
Sida rhombifolia	6	14	4	6
Solanum torvum	6	15	6	8
Pseudarthria viscida	6	16	4	7
Raphidophora pertusa	6	10	5	8
Acacia sinuata	7	10	7	9
Sapindus laurifolius	5	10	7	8
Canarium strictum	6	11	6	9
Curcuma aromatica	4	12	4	7
Curcuma angustifolia	6	20	4	7
Mesua ferrea	6	16	5	8
Desmodium velutinum	7	12	4	8
Garcinia gummi-gutta	5	10	6	9
Entada rheedii	6	10	4	8
Symplocos cochinchinensis	8	15	7	9
Piper nigrum	6	12	6	8
Cyclea peltata	6	13	5	8
Mean	6.11	13.74	5.32	8.21

other stakeholders in the form of grazing and fuel wood collection. It was found in the survey that livestock population was at the minimum in the past, although it is increasing now a days. Hence, absence or less availability of economically valuable species in the area is attributable to past human pressure in the form of unsustainable NWFP extraction rather than livestock use.

The 'zone of minimum NWFP extraction' is functioning in stage III which is an irrational zone and transition from stage II (rational zone) to stage III could be attributed to the destructive use by the stakeholders. What is the economic impact of decline of NWFPs, especially from the point of view of gatherers? The most important impact is the lesser returns per unit effort. Table 5.6 presents returns per unit effort for selected products

Table 5.6: Returns per unit effort in NWFP extraction

NWFPs	Man days / year	Mean minimum hours/ day)	Hours / year	Income / year	Income/ day/year
Honey/Bees'wax	45	6	270	3612	80.27
Parmelia dilatata	25	6	150	813	32.52
Sida rhombifolia	0	4	180	250	8.33
Solanum torvum	25	6	150	324	12.96
Pseudarthria viscida	20	4	120	400	20.00
Raphidophora pertusa	20	5	120	200	10.00
Acacia sinuata	25	7	150	289	11.56
Sapindus laurifolius	15	7	90	350	23.33
Canarium strictum	20	6	120	401	20.05
Entada rheedii	15	4	90	250	16.67
Symplocos cochinchinensis	20	7	120	300	15.00
Total	260		1560	7189	

The returns per unit effort is less than the existing wage rate (Rs.120/-per day) in Wayanad for all the products. There is seasonal and disguised unemployment in the area, particularly in the agricultural sector. Partly because of this, decrease in wages has been observed in agricultural sector (Rs.50-60 instead of existing rate of Rs.120/day). Agricultural labour in Kodagu district, Karnataka is another source of income to the tribes, but the tribes are subjected to heavy exploitation and are offered a wage rate of Rs. 75-80/day. Further, tribes are not very mobile, so that they are unable to move to other places where wages are higher, indicating very low opportunity cost of labour. Owing to all these factors, even with very low returns per unit effort, tribes continue to gather NWFPs as a 'distress duty'.

5.5 Actual share of sale value realized

The share factor that is actual share of sale value realized is presented in Table 5.7.
As against the Ministry of Social Justice and Empowerment, Government of India, stipulation that tribes should receive at least 75 per cent of the final sale value, the Federation proposed to provide 80 per cent. The share of collection charge in sale value realized is indicative of the extent of differences in both. Over the years only 62 per cent of the sale value is realized as against the stipulation of 80 per cent. The high valued items like, honey and wax showed that the collection charge realized was over and above the proposed share of the sale value and in the case of *Parmelia dilatata* it is almost equal to sale value. The share factor showed a lesser share for *Sida rhombifolia, Solanum torvum, Pseudarthria*

Table 5.7. Share factor (%)

Sl.no	Item	1996-97	1997-98	1998-99	1999-2000	Mean
1	Honey	88	86	90	93	89.25
2	Bees' Wax	82	84	81	82	82.25
3	*Parmelia dilatata*	71	89	76	82	79.50
4	*Sida rhombifolia*	26	25	26	23	25.00
5	*Solanum torvum*	23	19	21	20	20.75
6	*Pseudarthria viscida*	79	99	22	21	55.25
7	*Raphidophora pertusa*	16	72	60	64	53.00
8	*Acacia sinuata*	88	68	65	60	70.25
9	*Sapindus laurifolius*	91	75	76	70	78.00
10	*Canarium strictum*	76	66	79	77	74.50
	Mean	64	68.3	59.6	59.2	62.78

viscida (except for one year), and *Canarium strictum* in all the years. The proposed share of 80 per cent of the sale value could not be achieved in most of the products in any of the years.

5.6 Difference in per cent of actual value realized and proposed share of sale value

The difference in per cent of actual value realized and proposed share of sale value was assessed to arrive at a meaningful conclusion regarding the realized share of sale value for different products.

Table 5.8 reveals the pattern of share of the sale value realized by the gatherers for

Table 5.8: Difference in per cent of actual value realized and proposed share of sale value

Item	1996-97	1997-98	1998-99	1999-2000	Mean
Honey	8	6	10	13	9.25
Bees'Wax	2	4	1	2	2.25
Parmelia dilatata	-9	9	-4	2	-0.50
Sida rhombifolia	-54	-55	-54	-57	-55.00
Solanum torvum	-57	-61	-59	-60	-59.25
Pseudarthria viscida	-1	19	-58	-59	-24.75
Raphidophora pertusa	-64	-8	-20	-16	-27.00
Acacia sinuata	8	-12	-15	-20	-9.75
Sapindus laurifolius	11	-5	-3	-10	-1.75
Canarium strictum	-4	-14	-1	-3	-5.50
Mean	-16	-11.7	-20.3	-20.8	-17.20

different products. The positive values indicate the share factor over and above the proposed 80 per cent share of the sale value. The negative values are more than the positive values over the years indicating that the benefits have not been ploughed back to the gatherers, except for a few products like honey and wax.

5.7 Incremental factor(IF)

The ratio of sale value to collection charge is expressed as the incremental factor and is shown in Table 5.9.

Table 5.9. Incremental factor

Item	1996-97	1997-98	1998-99	1999-2000	Mean
Honey	1.13	1.16	1.12	1.08	1.12
Bees'Wax	1.22	1.19	1.24	1.23	1.22
Parmelia dilatata	1.41	1.12	1.32	1.22	1.27
Sida rhombifolia	3.86	3.85	3.85	4.37	3.98
Solanum torvum	4.43	5.07	4.72	5.02	4.81
Pseudarthria viscida	1.27	1.02	4.60	4.75	2.91
Raphidophora pertusa	6.17	1.40	1.68	1.57	2.71
Acacia sinuata	1.14	1.46	1.54	1.66	1.45
Sapindus laurifolius	1.10	1.33	1.22	1.42	1.27
Canarium strictum	1.32	1.52	1.27	1.3	1.35
Mean	2.31	1.91	2.26	2.36	2.21

The exact hike of sale value over collection charge is presented. Incremental factors for products like, *Sida rhombifolia, Solanum torvum, Sapindus laurifolius, Pseudarthria viscida* over the years were high when compared to products like honey, wax, *Parmelia dilatata, Acacia sinuata, Raphidophora pertusa* and *Canarium strictum*. Of these, honey showed the least incremental factor probably due to the high increasing demand and high price over the years.

5.8 Reasons for the high incremental factor for most of the NWFPs

Demand: In NWFP sector, there exists pre harvest contract of produce. The increase/ decrease in demand for the product, after the harvest will change the price positively/ negatively, resulting in high/low deviation from the collection charge.

Supply: The demanded/required quantity of the produce could not be supplied either due to non availability, lack of skilled tribes, climatic factors, or due to post harvest damages and deteriorating the quality reducing the quantum of supply.

This reduced quantity will be sold as per the decision of the buyer, wherein the buyer demands the required quantity at the pre harvest contract rates or available quantity

at lower price and distress sales follows.

The summarized result of share factor and the incremental factor shows that as against the proposed share of 80 per cent of the sale value, only 66.5 per cent could be realized in selected society of Wayanad (Table 5.10).

Table 5.10: Per cent of sale value realized by tribes in Tholpetty and Begur

Particulars	Factor ratio	Percent
Share factor	0.665	66.57
Incremental factor	1.502	150.21
Increase in sale value over collection charge	0.502	50.20

The incremental factor shows that, there has been 50 per cent increase in the sale value over collection charge over the years.

5.9 Purchasing power of money

In the context of non-realization of proposed share of 80 per cent and consequent reduction of income, it would be interesting to know the trend of real income of the collectors, which depends on purchasing power of the money. There has been an increase in the prices of the commodities over the years. Since the value of money decreases with an increase in price, the purchasing power of the money will be low when compared to the previous years. Table 5.11 gives the details of purchasing power of money over the years. The results indicate that value of one rupee in 1999-2000 was 35 paise as compared to the year 1990. This is indicative of the low purchasing power of collection charge, there by the low disposable real income of the tribes.

5.10 NWFP: supply analysis

The elasticity of supply is the degree of responsiveness of supply to changes in the price of a good. Supply function was fitted to observe the pattern, if any, in the NWFP trade.

The demand for NWFPs is derived demand. The supply of NWFPs by the Federation is either based on a pre-harvest contract basis or auctions. If the demand for the product falls after the harvesting season (owing to several reasons) but primarily, produce bounteousness, the Federation will be

Table 5.11: Purchasing power of money (1/ price index)

Year	Price index	Purchasing powerof money
1990-91	100	1
1991-92	135	0.74
1992-93	155	0.65
1993-94	190	0.53
1994-95	244	0.41
1995-96	255	0.39
1996-97	254	0.39
1997-98	244	0.41
1998-99	271	0.37
1999-2000	287	0.35

unable to realize the full proposed sale value of the product. Notwithstanding, the oligopolistic picture of price rigidity; the sale value of the federation shows a significant difference from collection charges paid probably due to the uncertainty in the trade at the time of harvesting.

The price elasticity of supply for high valued items, like, honey, wax, *Parmelia dilatata* and *Canarium strictum* are elastic and for low valued species like *Acacia sinuata, Solanum torvum, Pseudarthria viscida, Sapindus laurifolia, Raphidophora pertusa* and *Canarium strictum* are inelastic (Table 5.12). This supports the trend of species specific exploitation.

marketing of collected products by the Federation. There exists different market situations in both the stages. In the first stage, the market structure is more or less similar to that of monopsony. The Federation/societies act as monopsonist; a single buyer of NWFPs. In this monopsonistic situation the Federation faces a large number of tribals who are mostly unorganized and whose geographical mobility of labour is very much limited. The Federation is in a position to influence the collection charge which acts as wage rate. The tribal people working under societies satisfy the essential condition for the existence of monopsony. Besides, the tribes are not sufficiently mobile, so that they are unable to move to other places/work places where wages are higher, indicating a low opportunity cost of labour.

Table 5.12: Estimated supply function and price elasticity of selected NWFPs

NWFP	Supply function	Price elasticity	Inference
Honey	Qs=-849.75 + 186.52P	$\eta_p=1.11$	Elastic
Acacia sinuata	Qs=13239.49 + 371.59P	$\eta_{p=0.23}$	Inelastic
Wax	Qs=-32.55 + 0.93P	$\eta_{p=1.6}$	Elastic
Parmelia dilatata	Qs=-13204 + 190.13P	$\eta_{p=1.5}$	Elastic
Sida rhombifolia	Qs=97173 + 13817.21P	$\eta_{p=0.71}$	Inelastic
Solanum torvum	Qs=54319.37 + 10915.25P	$\eta_{p=0.75}$	Inelastic
Pseudarthria viscida	Qs=268.90 + 299.75P	$\eta_{p=0.91}$	Inelastic
Raphidophora pertusa	Qs=6188.85 + 369.05P	$\eta_{p=0.70}$	Inelastic
Sapindus laurifolius	Qs=1725.80 + 195.44P	$\eta_{p=0.83}$	Inelastic
Canarium strictum	Qs=-2633.25 + 53.01P	$\eta_{p=1.58}$	Elastic

5.11 More on marketing

There are two stages of marketing of NWFPs in Kerala., sale of collected products by tribes to the Federation through society and

In the second stage, the market structure of NWFPs in the product market is oligopoly

in Kerala, with few firms or sellers in the market producing/selling the NWFPs. The NWFPs traded by the Federation are mostly medicinal plants which are also available outside the forests; e.g., private gardens, common properties, wastelands, and homesteads. This has led to condition of competition among the few- an oligopolistic market situation. Under oligopoly, the individual firms demand curve and therefore the marginal revenue curve are indeterminate and unknown. Thus with out additional assumption or qualification, no determinate solution for price output fixation can be provided.

The demand for NWFPs is derived demand arising out of the demand for medicines, health vitalizers, and many other uses. The supply of NWFPs by the Federation is either based on a pre-harvest contract basis or auctions. If the demand for the product falls after the harvesting season (owing to several reasons) but primarily due to produce bounteousness the Federation will not be able to realize the expected price or full sale value of the product and consequently is forced to give less than the proposed share. According to the economic theory, monopsonistic market structure is inferior to competitive market. The sellers/gatherers faces two-dimensional losses in monopsony. The monopsonist always buys lesser quantity from the sellers that too, at lesser prices.

5.12 Implications on sustainable use

The dimension of the emerging situation consequent to this trend is highly volatile, which exacerbates the NTFP extraction pattern. Since the returns per unit effort is very low for the products extracted, the gatherers would be forced to increase the quantum of products collected aiming at illegal sales. Gatherers try to increase the quantum per unit effort resulting in indiscriminate and careless extraction wherein the attitude of the gatherers would be highly demanding and unscrupulous, leading to unsustainable exploitation. If the products so gathered are very specific, owing to their high value, and continue for a long period, a definite loss in biodiversity occurs due to species specific exploitation which is irreversible. Contrary to this, the gatherers might try to increase the quantum by a proportionate increase in the efforts put in, resulting in wastage of labour productivity in the future along with unsustainable extraction as in the above case. This is especially true since the opportunity cost of labour is very low as discussed earlier.

Total quantum of NWFP supply in the state is the sum of those collected by the Federation and illegal supply by tribes/ non-tribes. Consequently, the Federation cannot assess the total supply and fix up a price, owing to the oligopolistic market structure and thus unable to follow a price policy. In other words, the demand and supply situation existing in the organised/legal NWFP sector does not depict the real picture of NWFP market partly because the societies collect only limited number of items and partly due to illegal collection, which goes to private traders. This is considered to be one of the weaknesses of the Federation which results in price decline

and low wages to the collectors. Because of poor standard of living the tribes are forced to collect more quantity of premium products which leads to their depletion. Hence, for sustainable management of NWFPs, policies giving more emphasis on enhancing income of the collectors must be adopted.

Section 6

Ecology-economic Linkage

In the preceding sections, the importance of ecological and economic aspects relating to NWFPs in conserving biodiversity and sustainable use has been indicated. The linkages between these have been implicitly mentioned earlier. However, these require more detailed analysis to frame future management strategies for the conservation of biodiversity and sustainable use of NWFPs.

6.1 Linkage dynamics

The viability of a management system under a sustained yield regime should foresee the multiple use of forests for both wood and non-wood products. However, the sustainable management of forests should be based upon two fundamentals: the cyclical character of exploitation and the specific nature of the exploitation of individual species (Nepstad *et al.*,1992).

Many people assume that harvests of NWFPs have less impact on a forest than logging (Peters, 1994). However, this assumption is unfounded. Forest ecosystems have such complex interrelationships that harvests of some non-wood resources can affect plant and wildlife populations as negatively as logging. Without a sound knowledge of the resources and regular monitoring, harvests of certain non-wood resources can have a disastrous impact that is not noticed until it is too late to remedy. For example, over-harvesting of fruits or seeds of a tree species can drastically reduce regeneration to the point of local extinction without any visible effect. Large individual trees may remain and the system might appear undisturbed. Only years or decades later, when the large trees die and no individuals replace them, will the environmental damage become evident (Peters, 1994).

6.2 Species groups: ecological, economic and orphan species

The economically important species are those which have an effective demand and thereby priced high. Contrary to this, ecologically important/sensitive species are those which are in the threshold of vulnerability/endangerment due to repeated/ over extraction. The situation separates out a group of species, which neither belongs to the former nor the latter in the existing/ present/short run situation. This will lead to the existence of a class/group of intermediate or orphan species. This group of species is always overlooked in the decision processes and at policy levels in the short run because of the lesser importance attached to it either economically or ecologically. In reality, these are the economically and ecologically potent species in the long run since through technological explosion there is a possibility of identifying non-substitutable uses of these species. This can be illustrated with the help of a diagram (Figure 6.1).

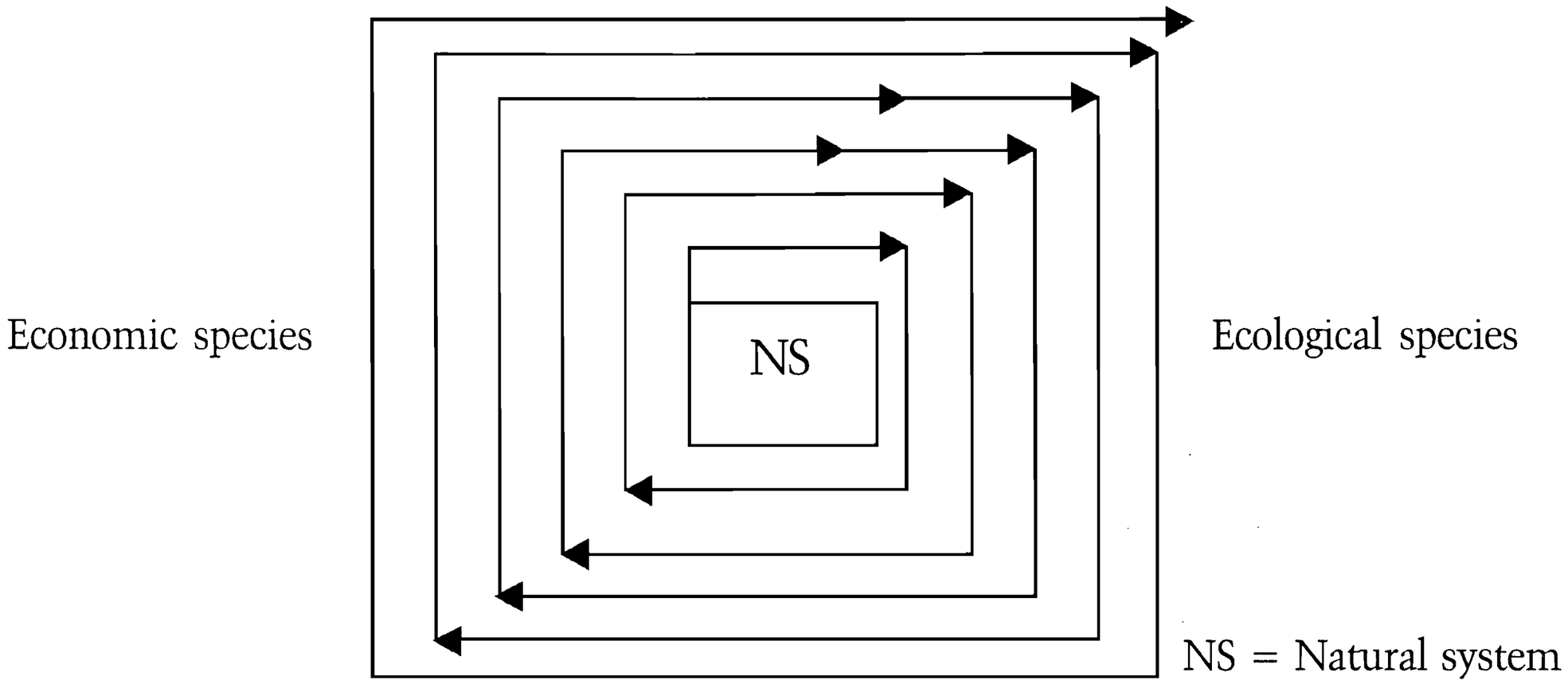

Figure 6.1 Ecologic-Economic Cycle

6.3 Multidimensional linkage

Figure 6.1 explains the economic and ecological linkages of the NWFP species. The economic species, as explained above are the species attached with a monetary value/high demand and the ecological species are those, which are vulnerable/ endangered due to over exploitation. In the natural system, extraction of species, except for the subsistence uses, is economically decided upon. When this type of species-specific exploitation continues indiscriminately for a long time, it leads to formation of a class of ecological species, which is threatened. The ecological species is considered endangered and further exploitation is restricted.

Since the economic importance of the species is decided by the demand, which in turn is a derived demand for many other uses, it necessitates the discovery of potential substitute/alternative in the natural system. This will lead to the formation of another class of economic species, which again leads to ecological species, and the 'ecology - economic species cycle' continues. This is on the assumption that there are substitutes/alternatives for many of the species exploited. But if there is no substitute/alternative for a class of species, exploitation continues leading to an irreversible loss of the species affecting the biodiversity. The potential substitute species are none but orphan species and hence it becomes imperative that due importance is to be given to the group. If and only if this ecologic-economic species cycle is thoroughly understood can one make judicious decisions for sustainable use of NWFPs.

The cycle explained above is resultant of the myopic approach adopted by the stakeholders of the resources. The pertinent question arising in this situation is regarding the economic species. Unless an effective demand is there, exploitation is futile; and if the demand exceeds supply the above situation occurs. This can be called a

"Decision Paradox" wherein the present economically right decisions taken in the short run are responsible for the future ecologically wrong condition which results in biodiversity loss.

One of the most basic, and rarely questioned, assumptions underlying much of the current interest in extractive resources is that commercial exploitation of NWFPs has little or no ecological impact on the forest ecosystem. For instance, regarding NWFP harvesting from the trees in the forests, many are of the opinion that this does not have any impact on the environment as long as the trees are not cut. This assumption seems to have originated from an inadequate interpretation of two simple observations: local people have been harvesting fruits, nuts and latex from forests for thousands of years, and a forest exploited for NWFPs, unlike a logged-over forest, maintains the appearance of being undisturbed. Of course, without appropriate explanation both could be incorrect and potentially very dangerous. Therefore, two qualifiers should be added to these observations. First, the intensity of subsistence harvesting as traditionally practised by forest people is usually substantially lower than that of commercial extraction. Second, the gradual extinction of a plant species which takes place over time is rarely a visible phenomenon. Every NWFP resource has a site specific, maximum sustainability level of harvest. If this harvest level is exceeded, the plant populations that are being exploited, as well as the faunal community that depend on them, will all be adversely affected (FAO, 1995a). Uncontrolled hunting and grazing in the forests and even recreational activities may have a detrimental effect on the forest ecosystems, reducing the production of NWFPs in the long run activities (WRI-UNEP-UNDP, 1994).

There has been some accidental loss of diversity due to over-exploitation by those possessing more sophisticated technology but less ethnology than hunter-gatherers. However, the main loss of diversity has been due to deliberate forest ecosystem destruction (Ehrlich, 1985). Fruits and seeds left in the forest after harvesting will almost certainly be subjected to an unusually high level of consumption by animals of the forest. Commercial collectors, in effect, are competitors with fruit-eating ground animals, and their activities reduce the total supply of food resources available to ground foraging animals. Decreased fruit densities could mean increased foraging and a corresponding increase in the overall percentage of fruits and seeds destroyed. As a consequence of the decreasing fruit and seed supply on the ground, the animal will migrate trying to find new foraging ground (Sutton *et al.*, 1983). This response could have a serious impact on seedling establishment for those species whose seeds require scarification by animals to germinate (Ng, 1983). Without a dispersal agent, a relatively high proportion of the fruits and seeds produced will fall directly under the crown of the parent tree where they are more easily gathered by collectors, more easily encountered by potential seed predators, and more susceptible to the effects of intraspecific competition (Augspurger, 1983;

Clark and Clark, 1984; Howe *et al.*, 1985; Schupp, 1988).

In addition to its impact on seedling establishment, population structure and the foraging behaviour of local animal populations, harvesting of fruits, nuts, and oilseeds in commercial quantities can also affect the genetic composition of the tree population being exploited (Peters, 1990). In this case, the important question is not how many fruits or seeds are harvested, but rather which ones. Tropical tree populations usually exhibit a high degree of genetic variability (Hamrick and Loveless, 1986; Bawa and Krugman, 1991). For example, a single population of forest fruit trees will invariably contain individuals that produce fruits of intermediate size and quality, and a few individuals that produce fruits that are commercially inferior in terms of size, (bitter) taste, or (poor) appearance. If this population is subjected to intensive fruit collection, the 'inferior' trees will be those whose fruits and seeds remain in the forest to regenerate. Over time, this will result in a population dominated by trees of marginal economic value (FAO, 1995b).

6.4 Anomaly of the market mechanism

The market mechanism is a regulatory instrument in the economy. The well-functioning market will manage resources efficiently. Abundant resources will command a lower price and no justification to be conserved and managed carefully. However, resources that are not part of anyone's environment or for whatever reasons remain outside the domain of markets cannot benefit from careful management and conservation that goes with increasing scarcity. Unfortunately, resources without a price lack scarcity and value register and hence these are inevitably overused, wasted and degraded since their zero price communicates a message of abundance or economic insignificance (FAO, 1995a).

6.5 Ecology-economic linkages in harvesting of NWFPs in the study area

Commercialization and harvesting of selected species mainly due to easy marketability and profitability have led to serious erosion of NWFP resources in the study area. The prime consideration of the gatherers is to maximize returns in the shortest time possible, regardless of whether sustainable or not. For example, fruit trees that produce bumper yields are selectively harvested thereby ensuring relatively high economic returns per unit effort. It is observed that while collecting roots of *Sida rhombifolia*, *Pseudarthria viscida*, etc., smaller and weaker plants are left out and only robust plants are collected for getting higher income. The smaller and weaker plants would grow and become the seed source for the next growing season, which will affect genetic diversity in the long run. Market forces play a prominent role in deciding which of the species are to be harvested. Partly due to ineffective harvesting and marketing strategies of the Federation and partly due to inflation, the real income of the gatherers showed a declining trend. In the absence of alternative employment opportunities, the tribes are

forced to gather more quantity for survival. Empirical evidence shows that regeneration potential of NWFP species declines as harvest intensity increases (Muraleedharan *et al.*, 1997).

6.5.1. Demand pull and unsustainable extraction: some empirical evidence

In view of the above discussion, an attempt was made, using PRA techniques, to work out the total availability of extractable resources (matured plants/parts), their level of extraction by sample households, degree of unsustainability and how the demand pull decides the sustainable/unsustainable extraction of NWFP products. The findings are indicative of the anomalies of the market mechanism in the NWFP sector and its influence on resource front. Table 6.1 presents the details of collection of NWFPs per household, maximum extractable quantity per ha and harvest ratios.

The under/over utilization of the resources implies unsustainable resource use in the area, which is determined by market forces, in the form of demand for the products. Nine of the 11 species studied projected an unsustainable level of harvest. The quantity extracted and over/under extractable quantity in the Table shows both positive and negative values. The positive and negative values indicate extraction of quantity over/under the available harvestable level of resource. If the harvest ratio of the given species is more than one, it indicates unsustainable extraction of the NWFP species and *vice versa*. Extraction of more quantity over extractable one points

Table 6.1 Resource extraction by sample households

NWFPS	Collection/ households Kg/ ha	Maximum extractable quantity Kg/ha	Quantity extracted over/ under extractable quantity kg/ha	Harvest ratio*
Asparagus racemosus	*2*	*1.5*	*-0.5*	*1.33*
Costus speciosus	0.25	2	1.75	0.13
Curcuma aromatica	1	3	-0.01	1.01
Desmodium velutinum	3	2.5	-0.50	1.20
Dioscorea pentaphylla	3.75	1.05	0.30	0.71
Hemidesmus indicus	3.75	1.9	0.95	0.50
Phyllanthus amarus	3.75	1.67	1.02	0.39
Pseudarthria viscida	5	4	-1.00	1.25
Sida rhombifolia	8	6	-2	1.33
Solanum indicum	5	3	-2	1.67
Solanum viarum	4.37	3.24	-1.13	1.35

*- Harvest Ratio= Q_e/Q_a where; Q_e =Quantity extracted and Q_a= Quantity available for harvesting. Q_a is that quantity which has attained the growth/maturity and is harvestable.

out that the tribes collect immature plants also for getting more income, which results in slow depletion of resources. Thus unless there are enough plants for regeneration or activities like enrichment planting, biodiversity and sustainable growth can not be maintained.

The degree of unsustainability brings out the actual extraction of the species over the proposed harvest rate. Since the proposed harvest rate of all the species selected for study was not available, the degree of unsustainability has been worked out for only six species (see details in Muraleedharan, *et al.*, 1997). Except for *Hemidesmus indicus*, all other species are subjected to unsustainable harvesting. The level of unsustainability for different species and the reasons for the same are given in Tables 6.2 and 6.3.

Given the content, a question arises: what are the reasons for over harvesting of selected products? Invariably, it was found that over harvested products are highly demanded products, characterizing demand pull and consequently, its prices also showed increase over a period of time. For instance, the price of *Curcuma aromatica* increased from Rs. 3.75 in 1982-83 to Rs. 20 in 1999 and that of *Pseudarthria viscida* from Rs. 4 in 1982-83 to Rs 16 in 1999. In the case of *Hemidesmus indicus*, the price showed a fluctuating trend; for instance, its price declined from Rs. 12.50 in 1982-83 to Rs. 6 in 1985-86, then increased to Rs.8 in 1990-91 and Rs.11.40 in 1994-95 and then shot up to Rs. 30 in 1996-97 (Muraleedharan *et al.*, 1997, p 64). This is indicative of the existing influence of demand-pull over sustainable/unsustainable extraction of NWFP species. This satisfies the condition of ecology-economic cycle where the economic species (the species extracted due to demand pull) leads to the formation of a set of ecologically vulnerable species. Thus it becomes imperative that the ecology-economics linkage dynamics are properly understood and it may be concluded that market management particularly, an understanding the demand-pull, is very essential for prevention of depletion of NWFP resources in the study area.

Table 6.2 Degree of unsustainability in NWFP resource extraction

NWFP	Per cent extraction over available resource	Proposed Harvesting*	Level of unsustainability
Asparagus racemosus	133	95	-38
Curcuma aromatica	101	95	-6
Desmodium velutinum	120	75	-45
Hemidesmus indicus	50	95	45
Pseudarthria viscida	125	75	-50
Sida rhombifolia	133	75	-58

* For details see Muraleedharan,et al.,1997, p 97.

Table 6.3 Level of sustainability/unsustainability and its reasons

NWFP	Sustainable/ Unsustainable	Reasons
Asparagus racemosus	US	High demand for food and medicine
Curcuma aromatica	US	High demand, multiple uses
Desmodium velutinum	US	High local demand
Hemidesmus indicus	S	Difficult to collect
Pseudarthria viscida	US	High demand
Sida rhombifolia	US	High demand

US-Unsustainable, S- Sustainable

6.6 Components of management strategy

Productivity and biodiversity conservation are two parts of sustainable management of NWFPs. Therefore, the ecological and economic aspects of these parameters should be incorporated as tools for management (Fantini, et al., 1992). The first and foremost thing is that any commercialization attempt should not rely on the presumption that NWFPs production in the sanctuary takes place by definition on a sustainable basis. Perhaps it should be accompanied by designing a basic strategy, suited for ensuring a constant monitoring and evaluation of the whole process. The proposed strategies include initial planning, development of forest inventory, species selection for harvesting, species substitution, yield studies, sustainable harvesting, demarcation of gene pool area and enrichment planting.

Initial planning operations include collection of information on the physical and biological characteristics of the protected area, particularly, the area containing the NWFPs. The second step, preparation of detailed forest inventory to document the existing resources within the selected management area. The forest inventory needs to be conducted through systematic procedure standardized for the area. This process should not be occasional but routine. This routine monitoring and evaluation process certifies the regular species composition and thereby any slight variation in the system is expected to be diagnosed and prevented before the worse is happened.

Species selection for harvesting or commercialization is a crucial step in cases where the selected management area offers a variety of NWFPs. Species selection needs to consider parallel studies that identify NWFPs having the highest market value, or the greatest potential for future market expansion. Social factors that indicate which NWFPs are exploited traditionally by the adjacent rural communities need to be considered. In this way, there will be no discontinuity in existing cultural traditions of forest use. Also, species selection should be dictated by the proven abilities of proposed species to withstand pressure of

continuous extraction. The selection needs to consider life cycle characteristics, multiplicity of uses and types of resources produced and abundance in different types of woodlands and size-class distributions of species population (NTPC document)

Species substitution is another important tool which helps to prevent depletion of ecologically and economically important species. Let us elaborate this point. Of the 119 commercially important species listed by the Forest Department, only less than one-third of the products are collected from the study area and non-collection of other species is not due to lack of demand but due to the high relative cost of collection compared to low relative income (Anitha and Muraleedharan, 2002). Generally, as the collection of orphan species is less partly because its collection is unprofitable or less profitable if it is collected by the society. Since there is demand, these products are illegally collected and sold in the market. In this context, in order to make them economically active species, the collection agency should prepare a portfolio of species harvested, by substituting regularly collected species with some orphan species, which are demanded in the market. This will maintain total income from NWFP collection and reduce the collection of ecologically threatened species.

Yield studies give an indication of the productivity of the selected NWFPs, or the quantity that existing population can produce. This is the crucial steps to define the sustainable level of extraction for a particular NWFP. From the results of yield studies, the management area may be sub-divided into distinct habitat/compartment based on population units. In other words, each habitat will be dominated by selected species and extraction of these species may be planned with twin objectives: to get maximum productivity/income and to prevent its depletion.

A sustainable harvest for the selected species in the habitat/compartments may be determined through 'successive approximation' technique where the population impact of exploitation is monitored and adjustment to harvest levels takes place to obtain a sustainable yield.

Finally, the strategy should consider to demarcate and protect gene pool areas to conserve species in the locality for future use and enrichment planting of selected species which may be commercially important or threatened species. The enrichment planting can be carried out in the degraded areas, preferably in the buffer zone. Some of the points discussed above have been taken into consideration while developing a model participatory management programme for the study area which is given in the next section.

Section 7

Participatory Management Programme for Conservation of Biodiversity and Sustainable Use of NWFPs

In analysing reasons for depletion of NWFPs in the first phase of the study, it was pointed out that present management system of NWFPs in the state is ineffective due to various reasons. And, it also indicated that present system should be replaced with participatory management by the interest groups because participation can create a sense of ownership and pride. Details of participatory management programme developed and its effects on various factors such as collection, marketing, income and vegetation are reported in this section.

7.1 Participatory management programme

The participatory management in this study envisages co-operative interaction among the interest groups regarding the management of NWFPs and aims at their active participation in the management at the grassroot level. The interest groups identified relating to NWFP management are, tribes, the Forest Department, the Federation, Tribal Service Co-operative Societies and Pharmaceutical companies.

This concept of participatory management is different from one being practised by the Forest Department in which participatory forest management envisages co-operation between tribes/local communities and the Forest Department. In this study, the emphasis is on the necessity of participatory management of interest groups, mainly due to the fact that some of the problems in the collection and marketing of NWFPs can be solved only through this strategy. For instance, if more number of Vana Samrakshana Samitis (VSS) are established, the marketing of the items will be difficult, as they have to compete with each other for sale which may push down the price resulting in low income of the collectors. The Federation and societies have infrastructure and managerial set up to handle a large quantity of the products that can be utilized by the VSS especially at the early stage of its functioning.

7.2 Determinants of participation in NWFP based participatory management

The success of participatory management depends upon the active participation/ involvement of the interest groups which again is decided upon by the income/benefit received by them from the NWFP based participatory management activities. This is further explained with the analysis carried out to assess the determinants of participation by the interest groups.

To identify and measure the impact of

various selected parameters on the extent of participation by interest groups, regression analysis was carried out. Since Ordinary Least Squares (OLS) method was found unsuitable for the model developed, Weighted Least Squares (WLS) method was adopted. The results of the analysis are presented in Table 7.1.

Table 7.1: Multiple regression (weighted least squares method)

Variables	B	SE B	Beta	T
AGE	-.083986	.043848	-.116648	-1.915*
ALTER	-.082256	.061566	-.088283	-1.336**
AWARE	.426321	.064402	.437443	6.620*
EDN	.182465	.055016	.197647	3.317*
INCOME	.0001642	.6219E-05	.395424	6.255*

* 1% level of significance and ** non-significant

The multiple regression analysis revealed and confirmed the determinants of the participation of tribes in forest conservation activities. As hypothesized, age and alternative sources (though non-significant) of income showed inverse relationship with the extent of participation implying that, aged/old people are comparatively unwilling to participate in any kind of development programmes since they considered any activity to be non-beneficial to them. The younger generation has a more favourable attitude towards the conservation programmes.

Alternative source of income showed an expected negative sign indicating a possible negative relationship with the participation, wherein the more the income/opportunities elsewhere, the lesser the participation would be. The variable represents the low opportunity cost of labour existing in the locality, coupled with lack of labour mobility in the area indicative of the very few alternative employment opportunities. The variables 'Awareness' and 'Education' showed a highly significant positive relationship with extent of participation. This reiterates the fact that Education and Awareness are *sine qua non* to participation, whereby the more the awareness/education the more will be the participation. This conclusion gains utmost importance in Wayanad since the area is very backward in literacy generally, with tribes occupying 17 per cent of the population.

The primary stakeholders of the forest conservation programmes in Wayanad are tribes and unless they are educated and made aware of the potential and beneficial activities of the same, participation will not take place true to the sense. The most important variable hypothesized to be influencing participation is income. As expected a high positive significance was observed, implying that, the more the income from the participatory activities the more the participation will be and *vice versa*. Since the tribes need to be sensitized regarding the potential income generating activities, literacy campaigns and awareness

programmes are necessitated.

7.3 Model participatory management : Pre-requisites

Participatory management programme was developed by implementing an action plan, which is focused on sustainable management of NWFPs, consisting of sustainable harvesting, regeneration, income enhancing and conservation activities, etc., with the active participation of interest groups. In other words, 'learning by doing' method was used to develop the programme. For this, some of the procedures of participatory programmes in the forestry sector such as constitution of resource management committee, and preparation and implementation of microplan were carried out (Box 7.1) The selection of area and interest groups for implementing the action plan was based on the following criteria.

1. Areas selected for implementing participatory management should be need based.
2. Management of NWFPs has to be carried out by the interest groups.
3. Homogeneity of the participating community should be ensured to avoid conflicts.

7.3.1 Selection of area

The selection of area for implementing the programme must be need based. The study area is an important ecosystem with high richness and diversity of NWFP bearing species. In the context of serious erosion of NWFP resources and ineffective management system, an alternative management intervention to conserve the biodiversity of these resources is required in the study area.

7.3.2 Selection of interest groups

While considering any conservation and management programmes, the interest groups are to be given priority. Since the interest groups are many viz., primary, secondary and tertiary groups representing the whole society, the very purpose of forest

The action plan consists of constitution of resource management committee at the grass root level aiming to implement plans and programmes of participatory management. This is more or less similar to forest protection committee or Vana Samrakshana Samithi (VSS). The action plan emphasized the need of the training and education to all the participating groups and preparation and implementation of microplans. It also emphasized institutional financial and research support for the successful implementation of the programme. For more details: see, Muraleedharan *et al.*, (1997)

BOX: 7.1 Components of action plan

conservation would be entangled in the wide varying conflicting interests of these interest groups. Hence it becomes essential that the actors in the participatory programmes have a primary interest in the forest. The primary interest occurs when the interest groups are depending on the forest to satisfy the basic necessities such as, food and shelter, along with other needs like medicines, and subsistence income generation. Tribes are the primary interest group that is identified for the study, followed by the secondary interest groups - Forest Department, the Federation, Tribal Service Co-operative Societies, and the tertiary interest group constitutes the pharmaceutical companies. The tribes who live in the forests or its periphery depend on NWFP collection for livelihood. The Forest Department, who is the manager and custodian of the forests, is interested in the conservation of biodiversity. The Federation and the tribal societies are primarily formed for collection and marketing of NWFPs in the state. Majority of NWFPs collected are medicinal plants/parts which are raw materials for the pharmaceutical companies in the State.

7.3.3 Homogeneity of interest groups

Conflict of interests of the participating groups is one of the major problems of participatory management programme and in order to minimize this participating communities must be as far as possible homogenous. This brings one to the concept of inter community and intra community differences. The inter community differences among tribes are common while intra community conflicts are very rare. The intercommunity differences arise when there is inequality in the standard of living of the tribal communities arising due to the disparity in their marginal propensity to save, which is resultant of the dissimilarity in the income earning ability of the different communities. Consequently, as the degree of marginal propensity to save increases the inter community disparity also increases leading to heterogeneous condition. Having accepted the inter community differences among the tribes, rigorous methods-dependency and consumption analysis- have been adopted for the selection of tribal group.

The Forest Dependency Index (FDI) worked out for the different tribal groups and the non-tribal group brings out the extent and magnitude of the local community's dependence on the forest (Table 7.2).

Among the tribal groups the intensity of dependence varied significantly. The Kattunaickans are the highly dependent group with a FDI of 71 followed by Paniyan (67), Kuruman (44) and Non-tribals (40). The Community Factor Ratio (CFR) indicates a high dependence on fuel wood, followed by grazing and manure (the less dependent community will tend to free ride at the cost of the highly dependent communities). It is very obvious that the tribes are more dependent on the forest, and among the tribes Kattunaickans are the predominant group in terms of dependence.

7.4 Extent of poverty among the interest groups

The existing difference in the income levels

Table 7.2 Forest dependency index (FDI) of various tribes and non-tribes in WWS

Particulars Factors\ Community	Factor ratio				Community factor ratio (CFR)
	Kattunaickan	Paniyan	Kuruman	Non Tribes	
Fuel wood	1.00	0.92	0.88	0.80	0.90
Fodder/grazing	0.95	0.93	0.79	0.75	0.86
Food	0.59	0.45	0.15	0.04	0.31
Manure	0.94	0.86	0.75	0.68	0.81
Medicine	0.75	0.74	0.59	0.09	0.54
Shelter	0.58	0.40	0.22	0.18	0.35
Timber	0.10	0.13	0.05	0.04	0.08
Wildlife	1.00	1.00	1.00	1.00	1.00
Soil	0.20	0.30	0.02	0.44	0.24
NWFP**	1.00	1.00	0.00	0.00	0.50
Forest Dependency Ratio (FDR)	0.71	0.67	0.45	0.40	0.56
Forest Dependency Index (FDI)	71.10	67.30	44.50	40.20	55.80

(high/low) among the interest groups is further substantiated with the analysis of the consumption expenditure of the same (the conclusions derived are based upon the Engel's Law which states that as the income increases the percentage income spent on food decreases). The study assumes that the more the income spent on food, the higher the poverty level of the group. The consumption expenditure for different tribal communities is worked out and presented in Table 7.3.

Table 7.3 Consumption expenditure of tribes in WWS (%)

Items	Kattunaickan	Paniyan	Kuruman	Kurichian
Food	71.21	68.99	52.36	41.13
Clothing	8.01	10.00	13.55	15.07
Education	1.09	1.55	11.06	16.77
Medicine	6.15	7.11	10.87	14.95
Others	13.54	12.35	12.16	12.08
Total	100.00	100.00	100.00	100.00

It is evident from the above Table that Kattunaickans spent 71 per cent of their income on food while other groups show a lesser percentage. Thus based on dependency and income analysis, Kattunaickans living in the forest were selected as representative of tribal group.

7.5 Major strategies

Any participatory programme requires well defined strategies for its proper functioning and attaining its objectives. Following are some of the strategies adopted in the participatory programme.

7.5.1 Constitution of resource management committee

For the preparation and implementation of microplan, a resource management committee (RMC/VSS), consisting of representatives of Forest Department, Federation, Society, Pharmaceutical companies and tribes was constituted. The research team was also a member of this committee.

7.5.2 Resource availability and extraction pattern

Quantity of NWFP resources for the whole sanctuary was estimated by the research team to know the resource position for future planning (Table 7.4).

Tables 7.5 and 7.6 give the details of estimated quantity of NWFPs in plantation areas. One important point to be noted here is that there are marked variations in availability of different species of NWFPs in different ranges in the sanctuary which has much implication in the preparation of micro plans.

Quantity of NWFPs collected in the foraging areas by the selected tribes was also estimated which is one of the bases of micro plan. Table 7.7 presents data on collection of NWFPs by the tribes in the foraging areas. Of the 11 species, *Sida rhombifolia* is largely collected species, followed by *Pseudarthria viscida* and *Solanum indicum*. *Costus speciosus* is least collected species.

It is evident from the Table that there is a gap between these resource available and collection at the hamlet level which necessitate more effective plan giving emphasis to sustainable harvesting.

7.5.3 Training workshop

Awareness creation regarding biodiversity conservation, sustainable use of NWFPs and the importance of participatory programmes is one of the essential requirements for the success of participatory management activities. In all six training workshops for creation of awareness regarding biodiversity depletion, sustainable utilization and participatory management were organized for the members of RMC. Special training programmes were also organized for identification of NWFPs, scientific extraction, semi-processing activities, propagation and planting of various NWFPs, PRA and preparation of microplans, etc. A meeting of interest groups

Table 7.4 Quantity (kg) of useful part/s of NWFP species in the natural forests of WWS

A. Herbs

1. Kurchiat Range

Species	Mean	Lower limit	Upper limit
Asparagus racemosus	28474	18665	38270
Biophytum spp.	2994	2626	3256
Centrosema pubescens	38501	28436	48107
Cardiospermum halicacabum	63300	48044	78556
Costus speciosus	247357	159188	335416
Curcuma aromatica	34821	25777	43858
Curcuma zedoaria	84703	45044	124309
Cyathula prostrata	3561	3561	3561
Cyclea peltata	89356	53464	125356
Desmodium velutinum	2240	1615	2863
Desmodium laxiflorum	833	530	1136
Elephantopus scaber	257267	221823	291767
Hemidesmus indicus	6913	4397	9381
Nervilia aragoana	3908	989	6825
Naregamia alata	172	166	175
Phyllanthus amarus	856	591	1101
Piper spp.	770658	305844	1235399
Pseudarthria viscida	2966	2711	3188

2. Muthanga Range

Asparagus racemosus	12575	8248	16912
Biophytum spp.	6720	5600	6944
Centrosema pubescens	117007	86397	146370
Curcuma zedoaria	62375	33176	91557
Cyclea peltata	41126	24611	57706
Desmodium velutinum	4949	3568	6326
Elephantopus scaber	74386	63514	83541
Hemidesmus indicus	2800	1781	3800
Nervilia aragoana	5181	1311	9049
Phyllanthus amarus	566	415	774
Pseudarthria viscida	2198	2009	2363
Sida rhombifolia	13028	9543	16518

3. Sulthan Bathery Range

Asparagus racemosus	47951	31433	64450
Biophytum spp.	7988	7007	8688
Centrosema pubescens	70935	52408	88737
Cardiospermum halicacabum	8883	6742	11023
Costus speciosus	104140	67020	141214
Curcuma aromatica	12216	9043	15386
Curcuma zedoaria	8490	4515	12460
Cyathula prostrata	21531	2212	2212
Cyclea peltata	86213	51583	120947
Desmodium velutinum	18863	13597	24109
Elephantopus scaber	312492	269439	354397
Hemidesmus indicus	7034	4474	9544
Nervilia aragoana	4937	1249	8621
Ocimum gratissimum	7410	6338	8480
Phyllanthus amarus	573	396	738
Piper spp.	81037	32160	129906
Pseudarthria viscida	832	761	894
Sida rhombifolia ssp. *retusa*	17526	12836	22216
Solanum viarum	2643	2363	2923

4. Tholpetty Range

Asparagus racemosus	9629	6312	12943
Baliospermum montanum	7146	4172	10121
Biophytum spp.	434	380	472
Centrosema pubescens	10002	7387	12515
Costus speciosus	474041	305072	642800
Curcuma aromatica	58881	43587	74162
Curcuma zedoaria	57973	30830	85081
Cyathula prostrata	12741	9407	16053
Desmodium velutinum	1408	896	1921
Elephantopus scaber	23529	20287	26684
Hemidesmus indicus	1948	1239	2643
Nervilia aragoana	661	167	1154
Phyllanthus amarus	836	764	898
Pseudarthria viscida	879	644	1115
Sida rhombifolia ssp. *retusa*	22993	19383	26604
Solanum indicum	2329	1914	2745

B. Shrubs

Range	*Helicteres isora*	*Holarrhena antidysenterica*
Kurchiat	993297	-
Sulthan Bathery	549749	2622
Tholpetty	1312537	-
Muthanga	127883	

Table 7.5 Total biomass of different NWFP species in plantations of different ranges in WWS (kg)

Species	Muthanga	SulthanBathery	Kurichiat	Tholpetty
Asparagus racemosus	4493	10240	34389	38078
Costus speciosus	72072	8884	20470	232791
Curcuma aromatica	2148	10691	8597	17665
Desmodium velutinum	698	6023	21288	588
Hemidesmus indicus	1271	1656	2456	628
Phyllanthus amarus	501	346	614	78
Pseudarthria viscida	0	10240	18013	2002
Sida rhombifolia	3401	4517	21288	70700
Solanum indicum	751	0	0	8008
Solanum viarum	662	271	0	0

Table 7.6 Total biomass of different species in plantations of WWS (kg)

Species	Biomass
Asparagus racemosus	29081.39
Costus speciosus	1821.83
Curcuma aromatica	84381.30
Desmodium velutinum	44946.03
Hemidesmus indicus	10953.61
Phyllanthus amarus	181.05
Pseudarthria viscida	37805.81
Sida rhombifolia	32883.47
Solanum indicum	40532.90
Solanum viarum	36278.19

to evaluate the progress of the work and appraise the results of the study was also organized in which results and recommendations of the study were discussed .

7.5.4 Research and financial support

The project team extended research and extension support and acted as the facilitator. The society and the Federation bought the products collected by the selected tribes, which constituted their major source of income. With the help of the societies and RMC, the selected tribal people undertook some of the semi-processing

Table 7.7 NWFP resource extraction of selected hamlet (kg)

NWFP species	Collection/ hh/ha	Collection /hh/day (kg)*	Resource available/ hamlet	Collection/ hamlet/day/ ha (kg)**	Collection hamlet/ day(kg)***
Asparagus racemosus	2	16	384	64	512
Costus speciosus	0.25	2	512	8	64
Curcuma aromatica	1	8	253	32	256
Desmodium velutinum	3	24	640	96	768
Dioscorea pentaphylla	0.75	6	268	24	192
Hemidesmus indicus	0.95	7	486	30	228
Phyllanthus amarus	0.65	5	427	20	166
Pseudarthria viscida	5	40	1024	160	1280
Sida rhombifolia	8	64	1536	256	2048
Solanum indicum	5	40	768	160	1280
Solanum viarum	4.37	35	829	140	1120

* Foraging area approximated to be 8 ha.
** Selected hamlet constitutes 32 household units.
***-Foraging area of the hamlet, approximated to the minimum, at 256 ha.

activities. The Forest Department engaged the members of the selected hamlets for forestry work and fire watching that provided a significant proportion of income. Some of the private traders purchased those products which are not purchased by the society at open market price.

7.6 Impact of participatory management on collection, marketing, income and vegetation

The major assumption of the study is that there exists a close link between economic and ecological systems in the study area and change in one system will affect the other positively or negatively. Also, an increase in income of the gatherers is assumed to have a positive impact on biodiversity conservation. Thus the attempt was to undertake the activities that enhance income of the gatherers and conserve biodiversity.

Keeping this in view, an attempt has been made to study the impact of participatory management programme on collection and marketing of NWFPs. In the collection front the major thrust was to reduce the pressure on the continuously harvested products so as to balance the regeneration equilibrium. The regeneration equilibrium is defined in the study as the threshold level wherein the quantity harvested and the regeneration potential of the species are at the maximum. Through continuous indiscriminate

harvesting of economic species, driven by the motive to enhance net income, the species becomes rare, threatening biodiversity. This is evident from the historical matrices constructed through PRA (see, Introduction).

In the proposed system of management, it is proved that through activities such as product substitution, open market sale, and value addition, the probability of reduction in the income is overruled. Substitution of other demanded species and compartmentalization of the foraging area for collection are the other experiments undertaken to predict the extractor behaviour in the collection front and also conservation of biodiversity.

The proposed management programme aims at maximum societal welfare. This objective can only be fulfilled if the stakeholders/interest groups are benefited through the programme. So the attempts have been directed towards providing incentives to the interest groups through income enhancement thereby motivating them to conserve the forest. This is in accordance with the economic-ecological linkage wherein the more the economic incentive the higher the ecological motivation to conserve the forest. The income enhancement for active participation in ecological activities is *sina qua non* forest conservation. Hence these activities have been given due importance in the proposed participatory management programme. The activities and the results are discussed separately below.

7.7 Benefit enhancement activities

7.7.1 NWFPS sector

• Income enhancement

Apart from collection of NWFPs, the study identified few possibilities to enhance income of the tribes, without further over exploitation of the NWFPs and for ensuring better participation in management activities. A large-scale enhancement of the income and high investment was beyond the scope of the present study. The main possibilities identified in the study, in addition to NWFP collection, are value addition, participation in the forestry work, agricultural operation, open market sale of those products which are not purchased by the society, substitution of less extracted species with regularly extracted one. The assumption of undertaking these activities is that additional income obtained from this source will enhance collectors' income and consequently reduce species-specific exploitation and intensity of dependency on selected NWFP products for their livelihood.

• NWFP collection

The collection of NWFPs by the selected people was closely observed for two years (1999 to 2001). Based on our request and awareness creation regarding conservation of biodiversity, there was a consensus among the members of the RMC to reduce quantity collected gradually. This was reflected on the income earned by the tribes during the period 1999-2001. For instance, during 2000-2001, income per household on

account of collection of NWFPs was estimated as Rs. 7189/- as against Rs. 7989/- during 1999-2000, indicating the reduction of collection of quantity (sale price remained same).

• Value addition

Value addition is a very broad term encompassing the simple local level semi-processing to highly advanced processing, aiming at domestic and international markets as well. Hence it becomes essential that the concept of value addition be explained in detail for exploring all the possibilities.

The gatherers, particularly the younger generations, are mostly unskilled and untrained in scientific methods of collection, resulting thereby wasteful, destructive and unsustainable harvesting. Post-harvest care is also poor in most cases and wastages are high. The products, which are perishable and delicate, spoil due to the rough handling during harvest. Controlling such practices will improve the keeping quality of the product. Moreover, careful handling coupled with simple value addition in the form of semi-processing, will fetch better prices in the market as primary and downstream processing adds value to a product. In respect of NWFPs for subsistence and local use, processing involved is mostly in the form of post-harvest treatment or intermediate processing such as cleaning, shelling, heating, cooling, drying, fumigation, grading, bundling and storage.

As part of the study, with the help of society and RMC, the tribes were asked to undertake semi-processing of selected items to assess the value addition potential of NWFPs. The results of this exercise are given in Table 7.8.

Table 7.8 : Value addition of different NWFPs

Item	Quantity Colle-cted**	Price/ Kg	Total Collection Charge	VAQ*	VAP/ Kg**	Collection charge after Value addition	Per cent Increase
Honey	78426	53.00	4156578	75289	59.38	4529102	8.96
Wax	595	85.00	50575	577	91.24	52657	4.12
Parmelia dilatata	5283	50.00	264150	4226	65.63	277358	5.00
Sida rhombifolia	137890	2.50	344725	110312	4.06	448143	30.00
Solanum viarum	133104	1.75	232932	99828	3.00	299484	28.60
Pseudarthria viscida	42462	3.00	127386	31846	4.80	152863	20.00
Raphidophora pertusa	11970	10.00	119700	9576	13.44	128678	7.50
Acacia sinuata	172988	9.58	1657225	121092	15.47	1873460	13.05
Total	582718		6953271	452746		7761744	11.63

*- Value Added Quantity (VAQ)

**-Value added Price (VAP)

Semi processing brings about 13 per cent increase in the income of NWFPs. The percent share of increase in prices of low valued species is found to be higher than the high valued species with semi processing.

• Open market sale

Of the total 119 commercially important NWFPs, only less than 35 species are collected for sale in Wayanad. The selected society collects only 12 items regularly from the study area. In other words, the society collects only those items, which can be easily marketed and earn high profit. Generally, the pharmaceutical companies require about 400 items of NWFPs for their working and thus most of the items have demand but at varying proportion. Although the sale of products in the open market against the consent of Forest Department/ Federation is illegal, the tribes sell the NWFPs in the open market as per the demand. The data of NWFPs sold in the open market were collected from the tribes and adopted after crosschecking with the traders in the market. It was found that on an average a household earned an amount of Rs. 7900/-, accounting for 29 per cent of the total income which is slightly higher than the income from society.

This raises some issues relating to the collection and marketing of these products. The Federation being a commercial organization is concerned with profitability and consequently, it collects only few products which have ready market. In order to enhance the income, the RMC/ VSS should be allowed to market at least those products, which are not marketed by the Federation. The results of the study proved beyond doubt the anomalies of market and the possibilities of open market.

• Substitution of species

Repeated harvesting of selected products has been one of the major reasons for depletion of these species and this is undertaken by the society mainly to maintain the income. From conservation point of view, substitution of frequently harvested species with less or least harvested species, without reducing total income is needed. The sensitivity analysis carried out revealed that there is potential for product substitution. This will reduce the pressure on specific species, if there is species-specific exploitation for higher income.

The advantage of carrying such sensitivity analysis is that, different combinations are worked out with different species. The most suited/ beneficial combination can be taken for a period; while the remaining combinations, which are retained after screening the non-beneficial combinations, may be tried at regular intervals. This practice will reduce the pressure on the sanctuary for rigorous and incessant species-specific NWFP exploitation. The regeneration of the species harvested will not be affected unlike the existing trend wherein same limited number of species are exploited continuously over the years, affecting their regeneration potential. Since regeneration potential is directly proportional to the productivity, the conventional practices will

have serious implications on the ecosystem. The harvesting areas can also be controlled by either reduction or change in area foraged for sustainable land use. Constant foraging deteriorates the land whereby not only the NWFPs are lost but also the entire land ecosystem *en masse*. A modest attempt was made to compartmentalize the foraging areas and do the collection. Attempt was also made to substitute some of the regularly collected products with other species having demand in the market. The results of the analysis are presented in Tables 7.9 and 7.10. The sensitivity analysis is done based on the assumptions made and hypotheses formed relating to income obtained and the extraction behavior of the gatherers. It is further hypothesized that there is potential for product and area diversification since the income earned is increasing.

Substitution of six species at different percentages was tried. Four substituted species will generate an income higher than with the six species. This implies, if demand of other potential species are properly accounted for, then even with lesser number of species, more income could be achieved. The income variation at 100, 83, 67, 50, 33, and 17 per cent was analysed. If six products are removed from the list of extraction without substitution, a reduction

Table 7.9: Species substituted for sensitivity analysis

Substituted species		Original species	
Achyranthes aspera	Kadaladi	*Sida rhombifolia*	Kurumthotti
Kaempferia rotunda	Chengazhaneerkoova	*Pseudarthria viscida*	Moovila
Cyclea peltata	Padakizhangu	*Rhaphidophora pertusa*	Athithippali
Pomoea mauritiana	Palmuthukku	*Entada rheedii*	Kakkumka
Rubia cordifolia	Manjatti	*Symplocos cochinchinensis*	Pachottitholi
Salacia reticulata	Ekanayakam	*Canarium strictum*	Kunthirikkam

Table 7.10: Sensitivity analysis: income changes due to species substitution

NWFP substituted	Altered income	Percent substituted	Present income	increase/decrease Percentage
0	5789	0	7189	-19.50
1	6389	17	7189	-11.10
2	6869	33	7189	-4.45
3	7109	50	7189	-1.11
4	8069	67	7189	12.24
5	8609	83	7189	19.75
6	10209	100	7189	42.01

in income of 20 per cent was observed. When products are substituted at different per cent levels there was an increase in the overall income. The experimental analysis could be tried for different species combination and the most beneficial species combination may be adopted and collected. In order to arrive at a conclusion on impact of this programme on vegetation, long term data needs to be collected. During the study period, we could collect only one and a half year data, which is not sufficient to arrive at a meaningful conclusion. Neverthless, it also indicates some positive trend. For instance, if there is no fall in the total income, people will be willing to collect less quantity of commonly collected species and substitute less demanded species. Further, experiment shows that the people who actively participated in the programme are more concerned about biodiversity conservation than that of others. However, this aspect of the study, though gave some positive trend between participatory management and conservation of biodiversity, requires more data and detailed analysis in future.

7.7.2 Other sectors

• Participation in forestry work

Generally the tribal people are engaged in the forestry work such as planting, and fireline work by the Forest Department. In addition, during one summer (2002), the people in the selected hamlets were assigned the work of fire prevention, which they undertook for about four months. This was a group work and each group consisting of 60 persons was assigned about 600 ha for fire prevention and an amount of Rs. 1.50 lakhs was offered (if there is no fire) for this work. On an average, general forestry work and fire prevention provided an amount of Rs. 700 and Rs. 7,000 respectively to each household. Our enquiry showed that there was no fire in areas managed by this group (Dasakatta section of the sanctuary). This effective work may be partly due to the influence of awareness created through training programmes.

• Agricultural operation

The selected people in the hamlet were encouraged to undertake more agricultural work both in Wayanad and Kodugu in Karnataka. On this account, the income generated by the selected group in two years was more or less same, that is Rs. 2998/-.

• Export potential

Some of the NWFPs collected from the study areas have export potential. A list of potential items and export and domestic prices are given in Table 7.11.

The VSS can explore the possibility of exporting some of the products which will enhance the income of the collectors

7.7.3 Ecological activities for conservation of biodiversity

Different activities together such as, enrichment planting and genepool area identification, etc. were carried out for conservation of biodiversity in the study area.

Table 7.11: Details of export and domestic price of selected NWFP species in the study area

Botanical name	**Family**	**Parts**	**Export price ($)/ domestic price (Rs./kg)**
Rauvolfia serpentina	Apocynaceae	Whole plant	$30.30 (Rs. 25)
Mesua ferrea	Clusiaceae	Flowers	$22.77 (Rs. 180)
Curcuma zedoaria	Zingiberaceae	Rhizome	$15.51 (Rs. 80)
Parmelia sps	Lichen	Whole plant	$13.53 (Rs. 70)
Garcinia morella	Clusiaceae	Fruits	$12.65 (Rs. 35)
Mimosa pudica	Mimosaceae	Whole plant	$12.54 (Rs. 20)
Alpinia galanga	Zingiberaceae	Rhizome	$11.55 (Rs. 60)
Gloriosa superba	Liliaceae	Seeds	$10.00 (Rs. 350)
Hibiscus rosa-sinensis	Malvaceae	Flowers	$9.90 (Rs. 30)
Asparagus racemosus	Liliaceae	Tubers	$8.25 (Rs. 35)
Indigofera tinctoria	Fabaceae	Leafy stem	$8.25 (Rs. 25)
Hemidesmus indicus	Asclepiadaceae	Root	$7.95 (Rs. 60)
Centella asiatica	Apiaceae	Whole plant	$7.26 (Rs. 25)
Rubia cordifolia	Rubiaceae	Root	$6.27 (Rs. 120)
Bombax ceiba	Bombacaceae	Flower bud	$9.06 (Rs. 24)

Source: Inter net

- **Enrichment planting**

Enrichment planting was undertaken by the tribes to enhance the stock of the species in the study area. The planting was carried out in the buffer zone areas, where the availability of species was found to be less. Of the five tree species, *Saraca asoca* showed maximum percentage of survival followed by *Gmelina arborea* and *Phyllanthus emblica*. The major reason for mortality was drought during summer months followed by grazing. Grazing has not affected two species, *Saraca asoca* and *Terminalia bellirica* in this location.

Generally the survival of herbaceous species was low when compared to the tree species. This may be due to the difference in moisture availability in the location of planting. Of the three species, *Solanum viarum* showed higher survival percentage followed by *Indigofera tinctoria* and *Pseudarthria viscida*. The survival of *Piper longum* was very low. Mortality of *Piper longum*, *Solanum viarum* and *Indigofera tinctoria* was due to drought, while both grazing and drought affected the survival of *Pseudarthria viscida*. For *Saraca asoca*, *Gmelina arborea* and *Phyllanthus emblica* survival percentage was about or higher than 50%. The results of the enrichment planting carried out are given in Table 7.12.

Table 7.12: Enrichment planting of various species raised in the nursery

Sl. No.	Name of species No.	Percentage of Survival	
		Pure planting	Mixed planting
Tree Species			
1	*Saraca asoca*	74.62	56.67
2	*Gmelina arborea*	58.67	41.67
3	*Phyllanthus emblica*	61.33	33.33
4	*Oroxylum indicum*	38.67	35.40
5	*Terminalia bellirica*	26.67	31.67
Herbs and Climber			
1	*Indigofera tinctoria*	30.00	0
2	*Solanum viarum*	20.00	43.33
3	*Pseudarthria viscida*	11.70	28.33
4	*Piper longum*	15.00	20.00

From the limited observations, we found that enrichment planting gave promising results for some of the species. In the present trials, six months old planting stock was used and it may be possible to increase the percentage of survival by increasing the age of planting stock.

Gene pool area: Identification and management

With the objective of attaining conservation oriented participatory management, a balance should be maintained between human and ecological needs. Traditionally forest has been the very life support system of the tribals and hence one would expect them to ensure its preservation and establish a relationship of mutual dependence. As part of the work a genepool area has been identified and protected, aiming to conserve some of the common species in the sanctuary. The identified areas, though accessible to the selected hamlets, was demarcated for preservation, without collection of products. Nearly 25 species were identified in the selected area and their density was found to be very high.

7.8 Impact of participatory management on collection, marketing and income

Table 7.13 summarises the impact of various activities of participatory management programmes on income.

As is evident from Table 7.13, there was an increase in income due to the adoption of diversified participatory activities and a change in the marketing strategy. Income from sale of products in the open market provided highest income, accounting for 29 per cent.

Table 7.13: Change in income through participatory management activities, semi-processing and open market.

Source of Income	Actual income (Rs)				Improved income (Rs)			
	Gross income	Cost	Net income	Percent Share	Gross income	Cost	Net income	Percent share
Society	7989	-	7189	67.0	7189	-	7189	28
Open market	-	-	-	-	7900	250	7650	29
Forestry work	700	-	700	6.5	7500	-	7500	29
Agricultural work*	2998	110	2888	27.0	2998	110	2888	11
Value addition	-	-	-	-	862	-	862	3
Total	11687	110	10777	100.0	26449	350	26090	100

* both at Wayanad and Kodugu

7.9 Impact of participatory management on the vegetation in the sanctuary

The experiments carried out to assess the potential of different activities to enhance monetary benefit and ecological health of the sanctuary proved to be successful and beneficial in the short run and it is assumed to be beneficial in the long run also. The major forces underlying the decision to participate in the management programme determine the success of the same in the short and long run. It is extremely difficult to predict the human nature and the complexity of the resource extraction behaviour. But an assumption has been made to the effect that, gain in knowledge and awareness will improve the extractors' attitude, as it changes the perception and gives an opportunity to perceive the importance of the forest from a different angle. In view of this, an experiment was carried out to assess the potential impact of the participatory management programme on the vegetation structure of the sanctuary. The different groups were identified based on the awareness level of the stakeholders (awareness ranking done through PRA). The four groups were made to extract the products from the sanctuary and the data were tested statistically to assess the significance. The discussion of the experiment and the results are presented below.

• Distance traveled

The analysis revealed that there was significant difference between the groups with respect to the distance traveled. This difference is mainly attributed to the presence of WOMEN group. Pair-wise comparison showed that the distance traveled /day of women differed significantly from that of all other groups and not between themselves (Table 7.14). The WOMEN group is significantly different from the other groups constituted by men. There is not much difference among the first

three groups - PFM, AWARE and UNAWARE. The distance traveled is a clear indication of the resource degradation in the peripheral area and supports the results obtained through the study emphasizing that the tribes necessarily have to travel more to collect the produce. The women involved in collection of NWFPs do not travel as much as the men do, highlighting the gender difference among the extractors. The women generally travel lesser distance as evident from the upper and lower bound of mean values for the different groups.

Time spent for collection (hours/day)

The analysis indicated that there was significant difference between groups in the time spent for extraction of the NWFPs. Pair-wise comparison showed that there was no significant difference between UNAWARE and WOMEN groups; UNAWARE and PFM groups and PFM and AWARE groups (Table 7.14). The mean time spent/day by women group for extraction was found to be lower, followed by UNAWARE, PFM and AWARE groups. This can be attributed to two reasons. First, the WOMEN group who is not much experienced in the NWFP extraction takes fewer quantities, which they are able to carry, resulting in lesser time spent. Secondly, the UNAWARE group is ignorant and unaware of the resource extraction pattern and the resource availability in the forest whereby it becomes difficult for them to locate the products and extract them. Moreover they do not employ the inherent skills to their advantage in the extraction of NWFPs with impromptu decisions like emphasising on the quantity rather than the quality of the products.

There was similarity among the groups UNAWARE and the PFM in the time spent for NWFP extraction. Based on the assumptions made to the effect that the PFM group is more aware about the sustainable extraction of the NWFPs and the UNAWARE group is ignorant of the same, it is inferred that the behaviour of the two groups is different though there is homogeneity in the time spent for NWFP extraction. The PFM group spends quality time to carefully harvest the species while the UNAWARE group spends the same time to harvest more of the produce irrespective of the stages or quality of the products.

Another subset showing homogeneity among the groups PFM and AWARE was observed. This is expected since the hypothesis formulated expected the group which has been made aware to behave in the same pattern as that of the PFM group.

- **Quantity of NWFP-1 extracted**

It was observed that there is significant difference between groups in the extraction of NWFP-1. Pair-wise comparison showed that the group WOMEN does not differ significantly from PFM group and AWARE group does not differ significantly from UNAWARE group (Table 7.14). But WOMEN and PFM groups differed significantly from UNAWARE and AWARE groups. The groups WOMEN and PFM showed homogeneity in the extraction of the species. This satisfies the assumption regarding the quantum of collection. As

Table 7.14: Mean values of distance traveled, time spent, and quantity of different NWFPs collected by the selected groups.

Group	Distance km/day	Time (hours/day)	Quantity collected (kg/day)		
			NWFP-1	NWFP-2	NWFP-3
PFM	10.60[a]	7.60b[c]	9.20[a]	10.40[ab]	9.40[ab]
AWARE	10.80[a]	8.00[c]	13.00[b]	11.60[b]	11.00[bc]
UNAWARE	11.60[a]	6.80[ab]	13.60[b]	12.00[b]	12.00[c]
WOMEN	5.60[b]	6.00[a]	9.00[a]	9.20[a]	8.60[a]

- Figures superscribed by the same letter do not differ significantly.
- NWFP 1: *Solanum indicum*, NWFP 2: *Desmodium velutinum* and NWFP 3: *Pseudarthria viscida*

discussed above, the women generally collect lesser quantity than men due to different factors viz., labour productivity and capacity to carry the produce. Besides, an interesting observation was made regarding the general behaviour of the women indicating a caring attitude towards the species. They extracted only matured plants. On the other hand the PFM group extracts less quantum of the species owing to their knowledge regarding the sustainable harvest. The experiment was conducted in July 2002 and the species was yet to attain maturity in different parts of the sanctuary. The PFM group extracted only those plants of the species, which had attained maturity. This is indicative of the positive influence of trainings on the vegetation structure of NWFPs.

Another subset showing homogeneity was formed between groups AWARE and UNAWARE. The quantum of collection was more among the group UNAWARE. This implies that the ignorance regarding the sustainable extraction of the NWFPs impacts on the vegetation since a mix of mature and immature plants was extracted by the group UNAWARE. The group AWARE should be given more training on the sustainable extraction of the NWFPs, since they also followed more or less the same pattern as that of the group UNAWARE in the extraction of NWFP-1.

• Quantity of NWFP-2 extracted

With respect to NWFP-2, the analysis showed significant difference between the groups. The homogeneous subsets were formed between groups PFM and WOMEN and between groups PFM, AWARE and UNAWARE (Table 7.14). This again is indicative of the gender difference in the extraction pattern and the inherent capacity of the women to carefully extract the products even without any training provided. The extraction pattern of the PFM group was as expected and similar to the NWFP-1 discussed above.

• Quantity of NWFP-3 extracted

The analysis revealed that there was significant difference between the groups

with regard to the quantity of NWFP-3 extracted. The pair-wise comparison showed that there was no significant difference between WOMEN and PFM; PFM and AWARE; AWARE and UNAWARE. This supports the discussion made in the previous cases. The second subset formed was between PFM and AWARE and the third subset was between AWARE and UNAWARE. This proves that there is not much difference among the groups AWARE and UNAWARE in the extraction of the NWFPs. This necessitates to conduct more awareness campaigns and trainings among the same.

On the whole the experiment brought out the possible impact of behaviour of extractors could have on the vegetation structure of the sanctuary, which indirectly implies the role, the participatory management programmes can have on the vegetation structure. The extraction behaviour of the tribes, as is explained elsewhere in detail, is dependent upon so many factors such as, socio economic status, NWFP markets and the resource availability. Notwithstanding, the role of participatory management, if conceived properly including the benefit sharing and equity, could well have a positive impact on the vegetation structure of the sanctuary. The experiment proved that there are gender differences among the extractors. The women generally travel lesser distance, spend lesser time and collect lesser quantity as compared to men. The women, even without training, showed quality extraction as compared to men without training. The PFM group collected only mature plants unlike the group UNAWARE. Awareness and knowledge should be imparted to the tribes for their active role in participatory management.

7.10 Proposed strategies/activities

The study, aimed at developing a participatory management programme, has formulated various strategies/activities for the sustainable use of NWFPs and conservation of biodiversity in sanctuary, based upon the major works carried out. The strategies/activities are aimed at both long term and short term development. The long term strategies/activities focused mainly on production/collection and marketing of NWFPs assuming that implementation of these will improve the conditions in the ecological front. The actions are suggested considering the past and present strategies in the sector.

7.10.1 Long term strategies/activities for NWFP based participatory magement programme

NWFP: Production/collection sector

- Assessment of availability of the resources
- Measuring carrying capacity of the sanctuary.
- Annual or biennial gap in harvesting NWFPs for sustained NWFP use.
- Training on resource assessment, harvestable maturity, sustainable quantity to be harvested and harvesting

should be imparted to each VSS.

- All gatherers should be members of the VSS; but all the members need not be gatherers.
- The government /forest department should consider the gatherers (tribes who are given training and who are good at work) as skilled workers.
- Proper documentation of the works carried out and products collected on an individual/household basis is essential.
- The societies may act as the facilitator, guiding and supervising for processing activities and other potential activities.
- Value addition of the products should be carried out at production level and marketing level.
- Potential species for value addition should be identified by the interest groups (societies, VSS, forest department).
- Gender dimensions should be considered; income generating activities should be segregated between men and women.
- Highly degraded areas need to be assessed by the VSS and enrichment planting should be carried out.
- A nursery can be raised by the VSS producing specific species of forest trees, shrubs and herbs (not exotic species), of medicinal and commercial value. The surplus species may be marketed on demand, generating an additional income.
- The bufferzone has to be demarcated along with core area and gene pool area.
- The VSS should compartmentalize and manage the forest.
- Extraction of diversified species and extraction of species from different compartments in alternative periods to prevent resource depletion.
- Education and skills of the gatherers need to be improved along with the life style through campaigns to create awareness.
- Self Help Groups, mainly for women are essential.
- Legal rights are to be given to gatherers.
- The traditional wisdom of the forest and NWFPs is singularly a part of the older generation and immediate steps should be taken to preserve the same through documentation.
- Infrastructure viz., storage (godown) transport (vehicles), etc. need to be set up.
- Alternate income generating activities should be thought of since it is proposed to undertake harvesting on alternate years or with a seasonal interval.
- Forest conservation should be need based and hence only interested parties should be considered.
- Export and domestic demand of the products should be assessed by the Society/VSS/NGO and high valued species should be domesticated and cultivated. The area can be leased in from

the forest department.

NWFP:Marketing sector

- The harvested products should be of quality and to maintain the quality emphasis should be given to ways of collection, semi-processing activities undertaken at the levels of collection area, transport, handling, storage and packing.
- The market should be opened contingent upon certain restrictions.
- The information on demand and supply should reach the gatherers and a section of the VSS should undertake such activities.
- The demand of pharmaceuticals needs to be assessed and the products needed by them should be provided by the VSS.
- The quantity collected of all the species through VSS in the state should be assessed and the supply has to be fixed accordingly.
- All VSS in Kerala should work in tandem to avoid conflicts in supplying the product, work more efficiently by sharing experiences and to avoid being exploited by other factions.
- The market may be opened with the objective of increasing the income of the gatherers. This attempt will be futile if the livelihood pattern of the tribes is not changed.
- There has to be a Market Monitoring Committee(MMC) to evaluate and monitor the scenario in order to avoid cartels and pseudo price hike. The societies/Federation can be a facilitator in this area.
- Each VSS should have different groups under a leader for carrying out several activities in production and marketing side.
- The forest department/research institution should provide the technical know-how and implement the Transfer of Technology (TOT).

7.10.2 Short term strategies/activities for NWFP based participatory management programme

- Zonation of forest for clear demarcation of boundaries.
- Naming of places in the sanctuary for easy and better identification.
- Proper mapping of the resources .
- Delineation of core zone and buffer zone. 'Zone Supervisors' will be responsible for all the activities carried out.
- Stringent legal restrictions; spot checking; fines used as fund against poaching and illegal activities.
- Propaganda regarding new restrictions and consequences.
- Extraction of NWFP species to be done after zone wise species assessment and identifying potential, degenerated and threatened areas.
- NWFP extraction should be limited to

trained, skilled and knowledgeable personnel.

- Documentation of NWFP extraction process (area, species, quantity collected, reasons for high/low collection, changes noticed etc.) regularly.
- Documentation of fire frequency (monthly/yearly), area of occurrence. 'Zone Supervisors' will be responsible for the same.
- Alternative sources of fuel wood should be assessed and quantity should be restricted after assessing demand for each month.
- The ecotourism activities should be based upon restricted entry.
- Extraction of resources other than NWFPs needs to be curtailed and environment regulations to be imposed.
- The documentation by Zone Supervisors will help in degraded area identification for enrichment planting.
- Conservation of germplasm; constant supply of saplings/seeds/seedlings including marketing of the surplus produce.
- The membership in VSS should be limited to tribes and role specification is necessitated.
- External activities including nursery, marketing, etc. should be managed as specified by the roles.
- The NWFP production policy needs to be evaluated and corrected after the documentation.
- Demand for each species (domestic/ export) needs to be assessed.
- Ensure demand for species before harvesting.
- Distributed collection throughout Kerala (through VSS) for a particular species.
- 'Area Specific Species Specialization' (activities wherein the forager constantly forages a particular area with a view to extract a particular species only, leading to species specific exploitation and biodiversity erosion) should not be encouraged.
- Market intelligence should be encouraged.
- Reduce marketing channels and price spread.
- Ensure value addition for better price.
- Quantity to be supplied should be in tandem with the conservation interests.
- Unlimited supply should not be encouraged.
- A part of the demand can be met from outside source, viz., homesteads, other areas through VSS.
- Godowns/storage areas need to be established.
- Potential for grading has to be assessed and evolved.
- Complete avoidance of middlemen.
- Improve transport facility by the VSS.

- Market and price policies should be developed after assessing the demand and supply situation in Kerala and outside markets as well.

7.11 Advantages over existing management system

Participatory management programme developed here for biodiversity conservation and sustainable use of NWFPs requires only some reorientation of the existing management, with more emphasis on grassroot level planning and implementation. However, this system has a number of advantages over the existing system of management. Most important feature of new system is that it recognizes the importance of participation of a variety of interest groups in the management, rather than one or two groups as in the case of PFM activities being implemented by the Forest Department. It considers the interlinkages between ecological and economic systems relating to NWFPs and develop programmes to strengthen the ecological health and enhance the income of the people. It suggests that this programme may be implemented in areas where it is needed and as far as possible homogeneous group may be included. It gives emphasis to activities like value addition, product substitution, enrichment planting and identification and maintenance of gene pool areas. Introduction of open market sale of products which are not marketed by the Federation is also suggested for better socio-economic conditions of the interest groups.

7.12 Constraints

The Forest Department and the Federation have monopoly control over collection and marketing of resources. Presently tribes are not allowed to sell the products to outside agencies. But illegal collection and sales prevail in the area. Data on the products sold in the open market were difficult to gather, as tribes do not keep any records. Though repeated cross checking with traders and tribes was done, only an approximation could be made regarding the sales in the open market, unlike the data for legal trade which are well documented. However, the study suggests that market for NWFPs may gradually be opened and tribes may be allowed to sell the products in the open market.

To study the impact of participatory management on vegetation, a more detailed ecological-economic study for a longer period of time is essential. Since the project was for three years, which is a very short period of time to draw very relevant conclusions on the vegetation dynamics, the attempt was directed towards predicting the cause effect relationship effecting changes in the vegetation based upon the economic and ecological theories. Further, participatory aspect of this study is based on one and a half year data. As the study used method of learning by doing to examine different aspects of participatory management, continuous observations of future activities would give more strategies/activities applicable to study area.

The economic incentive is the most

important factor, which attracts people to the participatory management, and there is a positive relationship between level of participation and income earned. Thus for a successful participatory work, sustained income may be ensured to the participants. And, if the tribal people get more income from other sources, they will be willing to reduce the collection of NWFPs and conserve the biodiversity.

Section 8

Conclusions and Recommendations

This section brings together major findings of the preceding sections. Some of the recommendations arising out of the study are also enumerated here.

8.1 Conclusions

The sustainable use of NWFPs precedes conservation of biodiversity. The impending danger of irreversible loss of species, leading to biodiversity loss is resultant of the unsustainable extraction/harvest of the NWFPs. The study finds that the sustainability of NWFPs depends upon the sustainability of forests and *vice versa*. Further, there is a close linkage between sustainable use of NWFPs and socio-economic status of the gatherers in the region.

Phytosociological analyses indicate that WWS is extremely an important ecosystem by virtue of high richness and diversity of NWFP species, with mixed dominance. Moreover, NWFPs constitute a significant subset of the biota (40% of the flora) at the natural forest sites of the Santcuary. However, only less than 40 per cent of the 151 NWFP species are commercially exploited. As far as plantations in WWS are concerned, not only their NWFP spectrum is low, but also productivity modest.

Empirical evidences and examples derived from the earlier investigations show that the Western Ghats' catastrophic scenario resulted partly from the unbalanced NWFP extraction methods. Commercialization and associated over-extraction, however, have led to serious erosion of the NWFP resources and with that, many NWFP yielding plants have moved closer to extinction. For example *Rauvolfia serpentina*, *Coscinium fenestratum*, *Saraca asoca*, etc. have become severely depleted in the Western Ghats. Further, regeneration potential of NWFP species declines as harvest intensity increases. Threshold level of harvesting that would not adversely affect regeneration is however, species-dependent.

Unsustainable extraction has long-standing adverse effects on the population structure which will be detected only in the long run. In addition, at the individual tree level, harvesting of NWFPs such as fruits, may also lead to changes in flowering and fruiting patterns and lowered yields. Resolution of such ecological hassles, however, may be possible by providing encouragement to the gatherers for conservation and better management of NWFP resources. Likewise, the economic uplift of the tribal people and providing institutional and public policy support are important.

Apart from natural forests, forest plantations are also a potential source of NWFPs. But there was profound variability in species occurrence and abundance between

plantations and natural forests. This can probably be explained by variations in sub-canopy photosynthetic photon flux densities and/or edaphic attributes. In comparative evaluations involving natural forests and teak plantations (35- year- old, regularly thinned), it was found that understorey PAR flux was lower. Concomitantly, floristic diversity was generally greater in the natural forests. Obvious linkages seemed to subsist between species richness and disturbance regimes.

The extraction behaviour of NWFPs is a function of the socio-economic status of the gatherers which again is dependent upon the NWFP collection and marketing. The underlying ecological and economic dimensions of these factors determine the sustainable use of the species. The gatherers in the study area, falling in below poverty line group, are collecting most of the species as a distress duty, since the opportunity cost of labour is very low in the area. This was mainly due the problems existing in the economic system relating to NWFPs. Quantity collected and collection charge given to the tribes have increased over the years but at a decelerating pace. The former could be attributed to the resource depletion leading to increased efforts in the form of greater distance traveled and increased time spent. The latter is resultant of the pricing inefficiency in the NWFP sector.

It was revealed that the actual share of sale value realised as collection charge by the tribes is less than the proposed share. The returns per unit effort are also very less. This has serious implications on the sustainability of NWFPs and biodiversity. Income from the collection could not sustain the gatherers, and this coupled with declining money value resulted in deterioration of their socio-economic conditions. Extraction ethics was not observed among the extractors. The study has identified three zones of NWFP extraction: the first and third being irrational and the second rational. The NWFP collection in WWS falls in the third zone viz., irrational zone where there is indiscriminate exploitation of species occur, driven by the poor socio-economic status of the gatherers.

Marketing of NWFPs is one of the important aspects, which influences both collectors and the institutions involved in the sector. There are two stages of sale of these products: between collectors and the Federation and between the Federation and the traders. In the first stage, a monopsony market situation exists which is not benefical to the collectors. In the second stage, market structure is more oligopolistic, which in the present circumstances, is not advantageous to the Federation. The net effect is that the Federation is not able perform well and to give proposed share of sale value to the collectors.

Further, the Federation collects only limited number of products due to marketing problems. This can be corrected if market demand assessment of different NWFPs is carried out at the domestic and global level. The study has assessed the export potential of different species and concludes that there is a huge margin between the collectors' price and the export price, even after deducting the processing cost. The market

imperfections and/or marketing inefficiency of the Federation have resulted in the illegal collection of both premium and non-premium products. This significantly affects marketability and price determination of the Federation. In these circumstances, the study suggests legalising open market of the products, encouraging products not traded / marketed by the Federation to enhance the income of the gatherers.

The low income obtained by the gatherers, due to several factors mentioned in the study, has resulted in species-specific exploitation. In Kerala, selection of NWFP species for harvesting is determined by the institutions working in the sector, which, to a great extent, is influenced by its marketability. The collection of these products does not give the gatherers enough to improve their socio-economic conditions since most of the species collected fetch a low price for them. Diversification of NWFPs using different combinations of species will prevent species-specific exploitation and also provide reasonable income for the tribes. The regeneration of the species harvested will not be affected if rotational method of harvesting is undertaken diversifying the NWFP species harvested. Further, constant foraging deteriorates the land whereby not only the NWFPs are lost but also the entire land ecosystem *en masse*. Hence the study suggests rotational foraging wherein the area foraged can also be rotated monthly/yearly so that further deterioration of the land can be prevented.

In view of the study results and reviewing problems in the ecological, economic and the present management systems of NWFPs, it is suggested that adoption of participatory management, involving the interest groups is the better option to solve the problems and conserve biodiversity in the sector. The participatory management programme developed was based on two assumptions: 1) there exists a close linkage between ecological and economic systems relating to NWFPs and 2) sustained income is one of the pre-requisites for the success of the management.

The study pointed out that, for the success of the programme, area selected should be need based and participating communities, as far as possible, homogenous. A blanket approach for all the local communities will exacerbate the existing conflicts among the communities and hence the most dependent and needy among the stakeholders should be involved in the programme. The forest dependency index worked out showed Kattunaickans to be the most dependent as compared to the other tribal groups and local communities.

Resource conservation in the forests (enrichment planting, preservation of gene pool area, species substitution in the harvesting regimes, etc.) and enhancement of income of the collectors (open market sale, value addition, species substitution,etc) were given thrust in the participatory management programme. The study also signified the linkage dynamics of ecologically vulnerable species and economic species and suggests that policy decisions should not be limited to the former and latter species alone, but should include the neglected species viz., orphan species for a long term

success of the participatory management programme. The programme also highlighted the importance of training and awareness creation among the interest groups for better conservation and sustainable utilisation of NWFPs. It was observed that the higher the income and benefit sharing the higher the participation of the stakeholders indicating a perfect positive correlation between these factors. Also, opportunity cost of labour and participation in the programme showed a perfect inverse relationship. The study has proved that effective implementation of NWFP based participatory management programme would enhance the income of the tribes thereby uplifting the socio-economic status resulting in reduced and sustainable collection of NWFPs, which is imperative for conservation of biodiversity in the study area.

8.2 Recommendations of the study

- Harvest/collection level of NWFPs should be reduced. This can be achieved to a great extent by controlling illegal collection.

- While trying to organize sustainable extraction procedures, availability of NWFP resources in the locality should be considered.

- A threshold level of disturbance may be determined at least in the case of premium items so that harvesting strategy that minimizes their depletion without significant loss of income to the gatherers may be formulated.

- The collectors should be encouraged to adopt harvesting techniques that minimise the resource depletion through management interventions and participatory resource monitoring involving the local people, the non-governmental agencies and forest personnel.

- Spatial distribution of NWFP extraction (over a large area), i.e., the forest area may be divided into "compartments". Attempt should be made to prevent further depletion of the resource by extracting a few compartments at a given time so as to allow the forest to recuperate following extraction.

- NWFP collectors should be sensitized about the resource availability and harmful extraction methods such as cutting trees and lighting fires to stimulate resin flow. Awareness should be created among the collectors on sustainable extraction methods to prevent further depletion of resources through effective training.

- Attempts to integrate NWFP yielding plants with forest plantations and agricultural tree crops on cultivators' fields should be made so that reasonable supply levels are maintained.

- Domestication of some of the more demanded NWFPs in integrated land use systems such as agroforestry needs to be promoted for reducing pressure on NWFPs in the forest.

- Marketing is one of the weakest links of the NWFP management in the state and this should be done more scientifically

and professionally with the help of trained managers. Market demand for each NWFPs (state, national and global) needs to be assessed before harvesting, for mitigating the uncertainty regarding the product demand and extraction. Some of the NWFPs have high demand in the foreign market. The Federation can explore the possibility of exporting some items, which will help to enhance the income of the tribes.

- Imperfection in the market should be minimized through market intelligence, reduction of price spread, etc.

- The activities of all resource management committees (VSS) formed in the State are to be co-ordinated by the Forest Department for the success of the programme and the Federation can act as facilitator in the programme.

- The livelihood security of the collectors should be strengthened and uplifted by encouraging them to undertake various income-generating activities in and outside the purview of the forest.

- Value addition of the NWFPs through improved post-harvest processing guarantees higher profits to the collectors.

- To promote NWFP extraction as a livelihood option for the forest dwellers, two points need to be stressed: (1) maximum profit is realised by, marketing of processed or value-added NWFP and (2) majority of the profit reaches the forest people.

- More co-operation among the interest groups, more institutional and official support and minimum political interference may be ensured for the success of the NWFP based management programme.

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Appendix 1

Population
Neduthana Colony

Particulars	Number (%)
Male	75 (46)
Female	88(54)
Total	163 (100)

Age group

Particulars	Total No.
<5	80 (49)
15-30	46 (28)
31-45	20 (12)
46-60	8 (5)
760	9 (6)
Total	163 (100)

Education (Children upto three years numbered to 17)

Particulars	Total No.
Illiterate	28 (19)
Primary (upto 7th)	116 (80)
Highschool (8-10th)	2 (1)
Total	146 (100)
(146+17) (C.3 years))	163

Crops grown

Particulars	No. of households (Total 33 (100)
Banana	20(61)
Pepper	30(91)
Coconut	15(45)
Tuber crops	28(85)

Housing structure

Particulars	Type of material
Floor	Mud
Walls	Bricks, bamboo
Roof	Tiles, thatches
Rooms	3
Doors	Bamboo and other locally available materials

Main Occupation
NWFP collection
Forestry - Weeding, boundary, firework
Loading
Fire wood collection
Kodagu (Agrl. work) a. Orange b. Coffee c. Chilli d. Ginger

Income from work in Kodagu

Particulars	Income (Per person)(Rs)
Coffee	864.00
Orange	3000.00
Pepper	3000.00
Ginger	2500.00
Total	9364.00

Income from other sources

Particulars	Income (Rs)
Loading	500.00
Forestry	960.00
Society	3000.00
Total	4460.00

Total annual income

Particulars	Income
Seasonal work in Kodagu	9364.00
Other work	4460.00
Total	13824.00

Average monthly income per person: (an approximation)

Rs 1152/person (Rs. 38.4/day)

Begur Colony

Population

Particulars	Number
Male	65 (49%)
Female	68 (51%)
Total	133 (100%)
Family size (mean size)	4.1

Age group

Particulars	No.
<15	54 (41)
15-30	31 (23)
31-45	25 (19)
46-60	15 (11)
>60	8 (6)
Total	133(100)

Education

Literate	Number
Male	31 (23%)
Female	14 (10%)
Children(below5years)	26 (20%)
Illiterate	62 (47%)

Cropping Pattern

Crops grown	Number of households
Ginger	115 Nos. (87%)
Paddy	133 (100%)
Tuber crops	125 (94%)

Housing Pattern

Government houses	20
Others	12

Others: houses built by tribes with bamboo and leaves.

Live stock ownership pattern of households

No.of livestock	Household	Type of livestock		
		Cattle	Goat	Poultry
Nil	32	26 (81%)	15 (47%)	27 (84%)
1-2		5 (16)	11 (34)	2 (6.2)
3-5		1 (3)	6 (19)	3 (9.4)
		32 (100)	32 (100)	32 (100)

Major employment activities of the selected tribes

Activities	Number of people			
	Male	Total	Female	Total
NTFP	38 (58%)	65	4 (6%)	68
Forestry work	42 (65%)	65	32(47%)	68
Kodgu work	46 (71%)	65	27(40%)	68
Others	13 (20%)	65	2 (3%)	68

Others: includes petty work in local houses.

Income per family (Begur colony)

Sl.No.	Income per family	Number (%)
1	Below 600	1 (3)
2	600 - 1000	20 (63)
3	1000 - 1500	87 (22)
4	1500 - 2000	2 (6)
5	>2000	2 (6)
	Total	32 (100)

Appendix 2

List of commercially important NWFPs collected from the forests of Kerala

SL. NO.	MALAYALAM NAME	SCIENTIFIC NAME
1	Adapathian	*Holostemma ada-kodien*
2	Athithippali	*Raphidophora pertusa*
3	Amalpori (red)	*Rauvolfia serpentina*
4	Amalpori (white)	*Chassalia ophioxyloides*
5	Adalodakam	*Adhatoda zeylanica*
6	Edampiri/Valampiri	*Helicteres isora*
7	Eenthappana	*Cycas circinalis*
8	Urinchikai	*Sapindus laurifolius*
9	Eramkol (grade 1)	*Pseudoxytenanthera ritcheyi*
10	Eramkol (grade 2)	*Pseudoxytenanthera ritcheyi*
11	Elakkai	*Elettaria cardamomum*
12	Odamaram	*Sarcostigma kleinii*
13	Orila	*Desmodium gangeticum*
14	Kacholam	*Kaempferia galanga*
15	Kadukka	*Terminalia chebula*
16	Kadukkathode	*Terminalia chebula*
17	Kannadivella (low quality)	*Vateria indica*
18	Kannadivella (low quality)	*Vateria indica*
19	Kannadivella (high quality)	*Vateria indica*
20	Kakkumkai	*Entada rheedei*
21	Kayyonni (kunjunni)	*Eclipta alba*
22	Karinkurinji	*Strobilanthes ciliatus*
23	Karinkurinji	*Strobilanthes ciliatus*

SL. NO.	MALAYALAM NAME	SCIENTIFIC NAME
24	Karinthen	
25	Kalpasam	*Parmelia dilatata*
26	Kasthoorimanjal	*Curcuma aromatica*
27	Kazhanji	*Caesalpinia bonduc*
28	Kattar vaazha	*Aloe vera*
29	Kaanjiram	*Strychnos nux-vomica*
30	Kaattinchi	*Zingiber zerumbet*
31	Kaatukurumulaku	*Piper nigrum*
32	Kaattuthippali	*Piper longum*
33	Kaattuthulasi	*Ocimum gratissimum*
34	Kaattupayar	*Phaseolus trilobus*
35	Kaattupavakka	*Momordica charantia*
36	Kaattupunnakka	*Calophyllum inophyllum*
37	Kaanthaarimulaku	*Capsicum minimum*
38	Kaattumanjal	*Curcuma pseudomontana*
39	Kaattumulaku	*Piper species*
40	Kiriyaatu	*Andrographis paniculata*
41	Keezhanelli	*Phyllanthus amarus*
42	Kungillyam, Kungiliam	*Boswellia serrata*
43	Kudampuli (unakka)	*Garcinia gummi-gutta*
44	Kudampuli (pacha)	*Garcinia gummi-gutta*
45	Kunthirikkom (grade I)	*Canarium strictum*
46	Kunthirikkom (grade II)	*Canarium strictum*
47	Kunthirikkom (grade II)	*Canarium strictum*
49	Kurunthotti	*Sida rhombifolia ssp. retusa*
50	Kodithuva	*Tragia involucrata*
51	Koduveli	*Plumbago indica*
52	Kopuvella	*Vateria indica*
53	Kolarakku	
54	Kolinchi	*Alpinia galanga*
55	Garudakodi (eswaramooli)	*Aristolochia indica*
56	Changalamparanda (green)	*Cissus quadrangularis*
57	Chappanga	*Caesalpinia sappan*
58	Chittirapoovu	*Euphorbia thymifolia*
59	Chittaratha (dry)	*Alpinia calcarata*

SL. NO.	MALAYALAM NAME	SCIENTIFIC NAME
60	Chittamruthu (green)	*Tinospora cordifolia*
61	Chittelam	*Heracleum ringens*
62	Cheevakkai/shekkakkai	*Acacia concinna*
63	Chemparathi	*Hibiscus rosa-sinensis*
64	Cheruthekku	*Clerodendrum serratum*
65	Jeevakom	*Malaxis rheedei*
66	Jnaaval	*Syzygium cumini*
67	Thakara	*Cassia tora*
68	Thazhuthama	*Boerhavia diffusa*
69	Thaṅni	*Terminalia bellirica*
70	Thanikka	*Terminalia bellirica*
71	Thanarakizhangu	*Nelumbo nucifera*
72	Honey	*Honey*
73	Honey wax crude	*Honey wax crude*
74	Honey wax processed	*Honey wax processed*
75	Thepprakkayu	*Semecarpus anacardium*
77	Darbha	*Desmostachya bipinnata*
78	Naruneendi, Nannari	*Hemidesmus indicus*
79	Naankinkuru	*Mesua ferrea*
80	Naaykkuruna	*Mucuna pruriens*
81	Neela amari	*Indigofera tinctoria*
82	Neeruvalakkuru	*Croton tiglium*
83	Nellickka (dry)	*Phyllanthus emblica*
84	Nellickka (green)	*Phyllanthus emblica*
85	Nellickka (fruit wall)	*Phyllanthus emblica*
86	Panjikkaya	*Ceiba pentandra*
87	Padavalam	*Trichosanthes cucumerina*
88	Pattincha	*Acacia caesia*
89	Paachotti	*Symplocos cochinchinensis*
90	Paadakizhangu	*Cyclea peltata*
91	Paathiripoovu (Ist quality)	*Myristica dactyloides*
92	Paathiripoovu (IInd quality)	*Myristica dactyloides*
93	Paali	*Palaquium ellipticum*
94	Paalmuthukku	*Ipomoea mauritiana*
95	Peenari	*Nothapodytes nimmoniana*

SL. NO.	MALAYALAM NAME	SCIENTIFIC NAME
96	Putharichunda	*Solanum indicum*
97	Punnapoovu	*Dillenia pentagyna*
98	Pulthylum	*Cymbopogon flexuosus*
99	Puli (with seed)	*Tamarindus indica*
100	Puli (without seed)	*Tamarindus indica*
101	Poovanathari	*Schleichera oleosa*
102	Pollakkaya	*Anamirta cocculus*
103	Plassu (Poovum, Kaayum)	*Butea monosperma*
104	Manjakkoova	*Curcuma zedoaria*
105	Mattippal	*Ailanthus triphysa*
107	Marotti (seed)	*Hydnocarpus pentandra*
108	Marotti (oil)	*Hydnocarpus pentandra*
109	Muthanga	*Cyperus rotundus*
110	Mullilam	*Zanthoxylum rhetsa*
111	Moovila	*Pseudarthria viscida*
112	Ramacham	*Vetiveria zizanioides*
113	Vankurumthotti	*Sida acuta*
114	Vayampu	*Acorus calamus*
115	Vazhana	*Cinnamomum verum*
116	Veluthavanakku	*Ricinus communis*
117	Vellathumba	*Leucas aspera*
118	Sathavari	*Asparagus racemosus*
119	Sithari (Vithari)	*Embelia ribes*

Appendix 3

Total collection (Kg) and collection charge (Rs) of NWFPs during 1996-97 to 1998-99: Wayanad District

NWFPs		1996-1997		1997-1998		1998-1999	
Local name	Scientific name	Quantity	Collection charge	Quantity	Collection charge	Quantity	Collection charge
Amalpori	*Rauvolfia serpentina*	78	3510	17	805	0	0
Athithippali	*Raphidophora pertusa*	5300	9800	7081	53425	4793	42980
Avanakku	*Richness communis*	6800	36350	7000	10500	0	0
Cheevakkai	*Acacia sinuata*	72003	717680	144874	959933	22073	197734
Cherutheain	*Apies* sps.	684	68400	767	76700	2092	209200
Cherutheku	*Clerodendrum serratum*	879	1758	24	54	0	0
Chunda pacha	*Solanum indicum*	153377	230065.5	77272	125155	208663	397427
Chundaveru	*Solanum indicum*	0	0	0	0	20000	40000
Kakkumkai	*Entada rheedii*	0	0	5823	32489	8406	57923
Kalppasam	*Parmelia dilatata*	5686	274463	7299	323280	2990	126320
Karimkurinji	*Strobilanthes ciliatus*	39470	39470	79500	97000	18000	70000
Kasthurimanjal	*Curcuma aromatica*	0	0	0	0	1261	3783
Kattumanjal pacha	*Curcuma aromatica*	0	0	0	0	51761	207044
Katumulakuveru	*Piper sps.*	0	0	0	0	10750	75250
Kudampuli	*Garcinia gummi-gutta*	0	0	0	0	3600	272500
Kunthirukkam Podi	*Canarium strictum*	0	0	0	0	125	3125
Kunthirukkam I	*Canarium strictum*	2701	4218	1783	53715	6	195

Kunthirukkam II	*Canarium strictum*	5500	14500	2884	80630	1566	48356
Kunthirukkam IV	*Canarium strictum*	233	4660	0	0	0	0
Kunthirukkan III	*Canarium strictum*	3371	56775	25	375	7505	165110
Kurumthotti pacha	*Sida rhombifolia ssp. retusa*	157020	276596	249468	498936	221969	453357
Kurumthotti dried	*Sida rhombifolia ssp. retusa*	4494	28664	9605	67235	1143	8001
Manjakuva	*Curcuma angustifolia*	1350	3200	2500	5000	0	0
Manjal pacha	*Curcuma sp.*	0	0	53174	159522	0	0
Maramanjal	*Coscinium fenestratum*	0	0	300	2400	0	0
Mezhuku	*Apies sps.*	279	17559	275	19547	175	13720
Moovila pacha	*Pseudarthria viscida*	14526	40249	23302	83726	17052	53046
Nellikka pacha	*Phyllanthus emblica*	118686	377679	220914	675144	8371	41885
Orila Pacha	*Desmodium velutinum*	500	1375	0	0	4416	11040
Pachottitholi	*Symplocos cochin-chinensis*	125	750	25576	198820	13000	117000
Padakizhangu	*Cyclea peltata*	80	2000	0	0	0	0
Palmudukkin-kizhangu	*Ipomoea mauritiana*	0	0	442	884	0	0
Soapukaya	*Sapindus laurifolius*	0	0	127	652	0	0
Theain	Honey	39891	1830241	11524	519633	20352	1017405
Urinjikkai	*Sapindus laurifolius*	711	3555	785	4940	0	0
Total		**633743**	**4043516**	**932341**	**4050500**	**650069**	**3632401**

Appendix 4

NWFP Species in the three study areas, their parts used and uses

Family/Species	Habit	Useful parts	Uses
Acanthaceae			
Adhatoda zeylanica Medic.	Shrub	Leaf & Root	M
Hygrophila auriculata (K. Schum.) Heine	Herb	Root	M
Justicia simplex D. Don	Herb	Leaf	M
Strobilanthes ciliatus Nees	Shrub	Root	M
Strobilanthes sp.	Shrub	Root	M
Amaranthaceae			
Achyranthes aspera L.	Herb	Entire plant	M
Aerva lanata (L.) Juss. ex Schult.	Herb	Root	M
Anacardiaceae			
Holigarna arnottiana Hook. f.	Tree	Root	M
Mangifera indica L.	Tree	Fruit	F
Annonaceae			
Uvaria narum (Dunal) Wall. Ex Wt. & Arn.	Shrub	Young stem & root	M
Apiaceae			
Centella asiatica (L.) Urban	Herb	Entire plant	M
Hydrocotyle javanica Thunb.	Herb	Whole plant	M
Apocynaceae			
Holarrhena pubescens (Buch.-Ham.) Wall. ex G. Don	Shrub	Bark	M
Ichnocarpus frutescens (L.) R. Br.	Climber	Root	M
Rauvolfia serpentina (L.) Benth. Ex Kurz	Herb	Root	M
Araceae			
Lagenandra toxicaria Dalz.	Herb	Root	M
Remusatia vivipara (Roxb.) Schott.	Herb	Root	M
Aristolochiaceae			
Aristolochia indica L.	Climber	Entire plant	M
Asclepiadaceae			
Cryptolepis buchananii Roem. & Schult.	Climber	Latex	M
Hemidesmus indicus (L.) R. Br.	Climber	Root	F/M

Holostemma ada-kodien Schult.	Climber	Root	M
Asteraceae			
Acanthospermum hispidum DC.	Herb	Fruit	M
Ageratum conyzoides L.	Herb	Leaf	M
Blainvillea rhomboidea Cass.	Herb	Leaf	M
**Chromolaena odorata* (L.) King & Robins.	Shrub	Leaf	M
Eclipta alba (L.) Hassk.	Herb	Entire plant	M
Elephantopus scaber L.	Herb	Root	M
Emilia sonchifolia (L.) DC.	Herb	Entire plant	M
Spilanthes acmella (L.) Murr.	Herb	Flower	M
Vernonia cinerea (L.) Less.	Herb	Entire plant	M
Balsaminaceae			
Impatiens sp.	Herb	Entire plant	M
Bignoniaceae			
Radermachera xylocarpa (Roxb.) K. Schum.	Tree	Fruit & bark	M
Stereospermum colais (Buch.-Ham. ex Dillw.) Mabber.	Tree	Flower & bark	M
Bombacaceae			
Bombax ceiba L.	Tree	Fruit	H/C
Caesalpiniaceae			
Bauhinia racemosa Lamk.	Tree	Bark	M
Cassia fistula L.	Tree	Bark	M
**Cassia tora* L.	Herb	Entire plant	M
Campanulaceae			
Lobelia nicotianifolia Roth ex Roem. & Schult.	Herb	Leaf & young flower	M
Combretaceae			
Anogeissus latifolia (Roxb. ex DC.) Wall. ex Guill. & Perr.	Tree	Bark	M
Terminalia bellirica (Gaertn.) Roxb.	Tree	Fruit	M
Terminalia chebula Retz.	Tree	Fruit	M
Terminalia crenulata Roth	Tree	Bark	M
Commelinaceae			
Commelina benghalensis L.	Herb	Entire plant	M

Convolvulaceae			
Evolvulus alsinoides (L.) L.	Herb	Entire plant	M
Ipomoea pes-tigridis L.	Herb	Root	M
Cucurbitaceae			
Trichosanthes cucumerina L.	Climber	Fruit	M
Dioscoreaceae			
Dioscorea oppositifolia L.	Climber	Tuber	F
Dioscorea spicata Roth	Climber	Tuber	F
Dipterocarpaceae			
Vateria indica L.	Tree	Resin	I
Euphorbiaceae			
Bischofia javanica Blume	Tree	Bark	M
Briedelia retusa (L.) Spreng.	Tree	Seed	P
Euphorbia hirta L.	Herb	Entire plant	M
Macaranga peltata (Roxb.) Muell.-Arg.	Tree	Leaf	C
Phyllanthus emblica L.	Tree	Fruit & bark	F/M
Ricinus communis L.	Shrub	Seed & root	M
Fabaceae			
Abrus precatorius L.	Climber	Seed	M
Atylosia goensis (Dalz.) Dalz.	Herb	Entire plant	M
Butea monosperma (Lam.) Taub.	Tree	Bark	M
Crotalaria pallida Dryand.	Herb	Root	M
Dalbergia latifolia Roxb.	Tree	Bark	M
Desmodium heterophyllum (Willd.) DC.	Herb	Root	M
Desmodium motorium (Houtt.) Merr.	Herb	Root & leaf	M
Desmodium triquetrum (L.) DC.	Herb	Root	M
Desmodium velutinum (Willd.) DC.	Herb	Root	M
Flemingia semialata Roxb.	Herb	Root	M
Indigofera cassioides Rottl. Ex. DC.	Shrub	Leaf & flowers	M
Pseudarthria viscida (L.) Wight & Arn.	Herb	Root	M
Rhynchosia rufescens (Willd.) DC.	Climber	Root	M
Tephrosia purpurea (L.) Pers.	Herb	Root	M
Uraria hamosa Roxb.	Herb	Root	M
Flacourtiaceae			
Hydnocarpus pentandra (Bunch.-Ham.) Oken	Tree	Seed	M/I

Hypoxidaceae			
Curculigo orchioides Gaertn.	Herb	Rhizome	M
Lamiaceae			
Colebrookea oppositifolia Sm.	Shrub	Bark	M
Leucas hirta (Heyne ex Roth) Spreng.	Herb	Entire plant	M
Lauraceae			
Cinnamomum malabatrum (Burm. f.) Blume	Tree	Bark	S/M
Persea macrantha (Nees) Kosterm.	Tree	Bark	M
Leeaceae			
Leea wightii Clarke	Shrub	Root	M
Liliaceae			
Asparagus racemosus Willd.	Climber	Tuberous root	M/F
Gloriosa superba L.	Herb	Tuber	M
Loganiaceae			
Strychnos nux-vomica L.	Tree	Seed	I
Loranthaceae			
Dendrophthoe falcata (L. f.) Etting.	Parasitic shrub	Flowers & bark	M
Lythraceae			
Lagerstroemia parviflora Roxb.	Tree	Bark	M
Malvaceae			
Abutilon indicum (L.) Sweet	Shrub	Root	M
Kydia calycina Roxb.	Tree	Bark	H
Sida acuta Burm. f.	Herb	Root	M
Sida cordifolia L.	Herb	Root	M
Sida rhombifolia L. ssp. *retusa* (L.) Borss.	Herb	Root	M
Thespesia lampas (Cav.) Dalz. & Gibs.	Shrub	Bark	M
Urena lobata L.	Herb	Root	M
Melastomataceae			
Memecylon umbellatum Burm.f.	Shrub	Root & flower	M
Meliaceae			
Naregamia alata Wight & Arn.	Herb	Whole plant	M
Menispermaceae			
Cyclea peltata (Lam.) Hook. f. & Thoms.	Climber	Root	F/M
Diploclisia glaucescens (Blume) Diels	Climber	Root	M

Tinospora cordifolia (Willd.) Hook.f. & Thoms.	Climber	Entire plant	M
Mimosaceae			
Xylia xylocarpa (Roxb.) Taub.	Tree	Seed & bark	M
Entada rheedii Spreng.	Climber	Seed	M
Mimosa pudica L.	Herb	Entire plant	M
Moraceae			
Artocarpus hirsuta Lam.	Tree	Bark	M
Ficus beddomei King	Tree	Bark	M
Myrtaceae			
**Eucalyptus grandis* Hill ex Maiden	Tree	Leaf	M
Syzygium cumini (L.) Skeels	Tree	Bark	M
Oleaceae			
Jasminum sp.	Shrub	Root	M
Olea dioica Roxb.	Tree	Bark	M
Orchidaceae			
Acampe praemorsa (Roxb.) Blatt. & McCann	Herb	Root	M
Cymbidium aloifolium (L.) Sw.	Epiphytic herb	Root	M
Habenaria sp.	Herb	Tuber	M
Malaxis rheedii Sw.	Herb	Entire plant	M
Nervilia aragoana Gaud.	Herb	Root tuber	M
Oxalidaceae			
Biophytum sensitivum (L.) DC.	Herb	Entire plant	M
Oxalis corniculata L.	Herb	Entire plant	M
Pandanaceae			
Pandanus tectorius Parkinson	Shrub	Leaf	H/C
Parmeliaceae (lichen)			
Parmelia dilatata Vainio	Epiphyte	Entire plant	S
Piperaceae			
Piper argyrophyllum Miq.	Climber	Stem, fruit & root	S/M
Piper longum L.	Climber	Stem, fruit & root	S/M
Piper spp.	Climber	Stem, fruit & root	S/M
Poaceae			
Bambusa bambos (L.) Voss	Bamboo	Stem & young shoot	H/C/F

Cymbopogon flexuosus (Nees ex Steud.) Wats.	Herb	Entire plant	M
Heteropogon contortus (L.) P. Beauv. Ex Roem. & Schult.	Herb	Entire plant	M
Imperata cylindrica (L.) Raeusch.	Herb	Entire plant	M
Polygalaceae			
Polygala arvensis Willd.	Herb	Root	M
Pontederiaceae			
Monochoria vaginalis (Burm. f.) Presl	Herb	Leaf	M
Ranunculaceae			
Clematis gouriana Roxb. ex DC.	Climber	Entire plant	M
Rhamnaceae			
Ziziphus mauritiana Lamk.	Tree	Fruit	M
Ziziphus rugosa Lam.	Climber	Root	M
Rubiaceae			
Mitragyna parvifolia (Roxb.) Korth.	Herb	Root	M
Mussaenda laxa (Hook. f.) Hutchinson ex Gamble	Shrub	Leaf	M
Pavetta indica L.	Shrub	Bark	M
Rubia cordifolia L.	Herb	Root	M
Rutaceae			
Acronychia pedunculata (L.) Miq.	Tree	Root	M
Glycosmis pentaphylla (Retz.) DC.	Shrub	Bark	M
Murraya paniculata (L.) Jack.	Tree	Bark	M
Naringi crenulata (Roxb.) Nicolson	Tree	Bark	M
**Ruta graveolens* L.	Herb	Leaf	M
Zanthoxylum rhetsa (Roxb.) DC.	Tree	Bark & seed	B
Sapindaceae			
Schleichera oleosa (Lour.) Oken	Tree	Bark & seed	M
Scrophulariaceae			
**Scoparia dulcis* L.	Herb	Entire plant	M
Solanaceae			
Solanum indicum L.	Shrub	Root	M
Sterculiaceae			
Helicteres isora L.	Shrub	Fruit	M
Sterculia guttata Roxb. ex DC.	Tree	Bark	M

Sterculia villosa Roxb. ex DC.	Tree	Bark	H
Tiliaceae			
Grewia abutilifolia Juss.	Shrub	Bark	M
Grewia tiliifolia Vahl	Tree	Bark	M
Verbenaceae			
Callicarpa tomentosa (L.) Murr.	Shrub	Root	M
Clerodendrum viscosum Vent.	Shrub	Bark	M
Gmelina arborea Roxb.	Tree	Root	M
**Lantana camara* L.	Shrub	Leaf & root	M
Tectona grandis L.f.	Tree	Young shoot	M
Violaceae			
Viola betonicifolia J.E. Smith	Herb	Entire plant	M
Viscaceae			
Viscum orientale Willd.	Parasitic herb	Stem & bark	M
Zingiberaceae			
Costus speciosus (Koenig) Sm.	Herb	Rhizome	M
Curcuma aromatica Salisb.	Herb	Rhizome	S/M
Globba ophioglossa Wight	Herb	Rhizome	F/M

Note T- Toiletries, M- Medicinal, H- Household articles

*exotics