USE OF NON TIMBER FOREST PRODUCTS (NTFPs) AND ITS ECOLOGICAL IMPACT ON THE CONSERVATION OF NYUNGWE FOREST RESERVE IN RWANDA.

BY

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DECLARATION

This thesis is my original work and has not been presented for award of a degree in any other university

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ABSTRACT

The study was conducted in and around Nyungwe Forest Reserve, a mountain forest situated in the South West of Rwanda. The aim of the study was to identify Non Timber Forest Products used and their ecological impact on the conservation of Nyungwe Forest reserve. The objectives of the study were to assess the attitude and perception of local community towards forest conservation, to find out specific forest resources used by local communities, to assess their socio-economic value and the resulting impact of their harvesting to the forest. The factors affecting the use of NTFPs in the study area were also examined. To achieve this, questionnaires and Participatory Rural Appraisal (PRA) tools were used. Data gathered were analysed using descriptive statistics and inferential statistics such as analysis of variance (ANOVA), linear regression and logistic regression using Statistical Package of the Social Sciences (SPSS).

From the study, it was established that 87 % of the interviewees were for the conservation of the Nyungwe Forest Reserve because of its role in improving rainfall. The study indicated that NTFPs such as crop stakes and firewood contributed significantly to the lives of the local community. It was also established that 104 indigenous and exotic plants were being used for various purposes. The most widespread NTFPs used in the study area were crop stakes (98 %), firewood (96 %) and medicine (44.4 %) among others.

The results indicated that most of forest products were being used for subsistence since the market of NTFPs was not well developed in the study area. In spite of the importance of plants collected, many of these activities were not compatible with the ecological integrity of the forest and posed a threat to conservation. This is for example the case of cutting some trees species for woodcarving and beehive making. The size of the family and size of the farm as well as the level of income were found to have significant influence on the use of NTFPs.

The study recommended promotion of sustainable use of NTFPs with little minimum impact on the forest such as use of medicinal plants. Agroforestry and a conservation educational programme were also recommended for the people living around the Nyungwe Forest.

TABLE OF CONTENTS

Declaration		i
Acknowledgement		ii
Abstract		iv
Table of Contents		vi
List of Tables		x
List of Boxes		xi
List of Figures and Plates		xii
List of Acronyms and Abbreviations		xiv
CHAPTER ONE	**INTRODUCTION**	1
1.1	Background to the Study	1
1.2	Statement of the Problem	5
1.3	Objectives of the Study	6
1.4	Significance of the Study	7
1.5	Definition of Operational Terms	8
CHAPTER TWO	**LITERATURE REVIEW**	10
2.1	Non-timber Forest Products (NTFPs)	10
2.2	Role of Non Timber Forest Products	11
2.2.1	*Biodiversity Conservation*	11
2.2.2	*Limitations of NTFPs use in Tropical Forests*	13
2.2.3	*Importance of NTFPs to the Rural Community*	15
2.3	Value of Forest Resources	21
2.3.1	*Holistic value of Forest Resources*	21

2.3.2	*Economic value of Non-timber inTtropical Countries*	23
2.3.4	*Socio-cultural Value of NTFPs*	26
2.4	Concept of Indigenous people	27
2.5	Threats of Tropical Forests	30
2.6	Conclusion	33
CHAPTER THREE	**BACKGROUND OF THE STUDY AREA**	34
3.1	Brief Introduction to Rwanda	34
3.2	Nyungwe Forest Reserve	35
3.2.1	*Physical Environment*	35
3.2.2	*Biodiversity*	38
3.2.3	*Trends of Forest Degradation*	39
3.2.4	*History of Forest Conservation*	44
3.3	Background of Cyangugu Prefecture	45
3.3.1	*Population*	45
3.3.2	*Rainfall and Climate*	46
3.3.3	*Soil*	46
3.3.4	*Land use and Farming in the Area*	47
CHAPTER FOUR	**RESEARCH DESIGN AND METHODOLOGY**	49
4.1	Introduction	49
4.2	Data Collection	49
4.2.1	*Exploratory Visit*	49
4.2.2	*Reconnaissance Survey*	50
4.2.3	*The Main Survey*	50
4.3	Sampling Method and Population Survey	55
4.4	Statistical Analysis	56

CHAPTER FIVE	**RESEARCH FINDINGS AND DISCUSSION**	60
5.1	Introduction	60
5.2	Socio-economic Characteristics of Surveyed Households	60
5.2.1	*Household Characteristics in the Study Area*	60
5.2.1	*Land Tenure, Land Siize and Land Use*	62
5.2.2	*Source of Income and Income Levels*	64
5.3	Attitude and Perception of Local Community Towards Nyungwe Forest Reserve	65
5.3.1	*Status of Nyungwe Forest Reserve Conservation*	65
5.3.2	*Benefits of the Forest Reserve Perceived by Local Community*	66
5.3.4	*Cost of Forest Conservation*	67
5.4	Forest Utilisation	68
5.4.1	*Types and Origin of Plant Use*	68
5.4.2	*Identification of Plant Species Used*	70
5.4.3	*Use of Crop Stakes*	71
5.4.4	*Firewood*	72
5.4.5	*Medicinal Plants*	77
5.4.6	*Food Plants*	87
5.4.7	*Building Material*	88
5.4.8	*Household Items*	94
5.4.9	*Plant Species Used for Fodder*	
5.5.	Valuation of Forest Products Used	94
5.5.1	*Value of Products Sold*	94
5.5.2	*Contribution of Forest Products to the Batwa Households*	98

5.6	Assessment of Ecological Impacts of Resource Harvesting	99
5.6.1	*Unsustainable Harvesting*	99
5.6.2	*Plant Species Threatened by Over-exploitation*	106
5.7	Factors Affecting Forest Use	107
5.7.1	*Forest Use in Three Local Communes*	107
5.7.2	*Effect of Wealth Categories on Forest Use*	110
5.7.4	*Factors Affecting Firewood Consumption and Bean Stakes Use*	111
5.7.5	*Factors Affecting Use of Medicinal Plants*	116
CHAPTER SIX	**CONCLUSIONS AND RECOMMENDATIONS**	119
6.1	Summary of Findings	119
6.2	Conclusions	122
6.3	Recommendations	123
BIBLIOGRAPHY		126
APPENDICES		145

List of Tables

Table 2.1:	Characteristic of non-timber forest products	11
Table 2.2	General contribution of NTFPs to human nutrition	19
Table 2.3	Estimation of habitat conservation in Sub- saharan Africa	32
Table 3.1	Trends in reduction of Nyungwe Forest reserve	39
Table 4.1	Key informants and their activities in the study area	51
Table 4.2	Indicators of wealth in the study area	55
Table 5.1	Households characteristics	62
Table 5.2	Levels of income of respondents	65
Table 5.3	Benefits of Nyungwe Forest Reserve	67
Table 5.4	Cost of forest conservation	68
Table 5.5	Number of species used per categories of NTFPs in the study area	71
Table 5.6	Forest plant species used for bean stake in the study area	73
Table 5.7	Forest plant species used for firewood	74
Table 5.8	Forest plant species used in traditional medicine	77
Table 5.9	Plant species used for food	84
Table 5.10	Value of NTFPs used in the study area	95
Table 5.11	Annual contribution of some NTFPs collected by Batwa in the study area	100
Table 5.12	Different categories of plant parts harvested	101
Table 5.14	Target plant species for making beehives	104
Table 5.15	Plant species threatened by unsustainable harvesting	106
Table 5.16	Prevalence of forest uses in the three communes	108
Table 5.17	ANOVA results of NTFPs used by wealth categories in the study area	111

Table 5.18	NTFPs used wealth categories	110
Table 5.19	Anova results of NTFPs used by wealth category	110
Table 5.20	Results of correlation matrix	112
Table 5.21	Linear regression equations	113
Table 5.22	Parameters of logistic regression	116

LIST OF BOXES

Box 2.1	Classification of forest values	22
Box 2.2	Examples of cultural and social values of forest resources	27
Box 2.3	The Batwa of Rwanda	30

List of figures and Plates

Figure 2.1	General markets of NTFPs	24
Figure 3.1	Map of montane forest in Rwanda and location of Nyungwe Forest Reserve	37
Figure 5.1	NTFPs harvested from Nyungwe Forest Reserve	69
Figure 5.2	Annual income distribution of NTFPs sold in the study area	96
Figure 5.3	Influence of family size on firewood consumption	114
Figure 5.4	Influence of farm size in bean stake use	115
Figure 5.5	Relationship between income level and medicinal plant use	117

List of Plates

Plate 3.1	Gold mining in Nyungwe forest in Tangara river (Busozo)	41
Plate 3.2	Pit-sawing at the edge of Gatare *commune*	42
Plate 3.3	Landslide in Nyungwe Forest Reserve.	43
Plate 5.1	Bean stakes in a farm in Gatare *commune*	71
Plate 5.2	Children carrying firewood gathered from buffer zone in Kirambo *commune*	75
Plate 5.3	Batwa with firewood gathered from the natural forest in Gatare	76
Plate 5.4	Stretcher with mat	89
Plate 5.5	Mats used for bedding and sitting in the study area	91
Plate 5.6	Mortar used for pounding and grinding in the study area	92
Plate 5.9	Beer boat used for brewing beer in the study area	92

List of abbreviations and Acronyms

CAR : Centre African Republic

CERAI : Centre d'Enseignement Rural Artisanal Intégré
Dbh : Diameter at Breast Height

DRC : Democratic Republic of Congo

Frs : Rwandese Francs

IRST : Institut de recherche Scientifique et technologique (Institute of Scientific Research and Technology)

KEFRI : Kenya Forestry Research Institute Indigenous

NTFPs : Non Timber Forest Products.

ORTPN: Office Rwandais des Parcs nationaux (Rwandan Office of National Parks)

PCFN : Projet Conservation de la Forêt de Nyungwe (Conservation Project of Nyungwe Forest

PRA : Participatory Rural Appraisal

RRA : Rapid Rural Appraisal

SPSS : Statistical Package for the Social Sciences

SSI : Semi Structured Interviews

TMPs: Traditional Medical Practitioners

UNESCO: United Nations Educational Scientific and Cultural Organisation.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Throughout the world, forest resources are utilised in order to meet short-term socio-economic needs at the expense of long-term ecological conservation. Consequently, a significant proportion of terrestrial plant species that form the basis of land based ecosystems is threatened. Biodiversity reduction is increasing today largely through the destruction of natural habitats and the greatest loss occurs in tropical forests. For example, in 1989, approximately 142,200 square kilometers of tropical rainforests were completely destroyed and a further 200,000 square kilometers were severely degraded (Colchester and Lohmann, 1995). Such loss of plant species does not only drive many other organisms to extinction but could also seriously deplete the resource base on which evolutionary processes will operate in future (Whitmore and Sayer, 1992).

The problems facing tropical forests are partly a consequence of the increase in human population whose daily livelihood depends on these resources. The use of forest resources has in many cases exceeded the level of sustainable utilisation. The resultant severe and rapid forest degradation has led to much greater concern, hence the urgent need for conservation of these critical resources (Walter and Kenton, 1989). The creation of several new tropical forest reserves and parks throughout the world has helped to redress this situation. However, the primary objectives of the national reserves and parks

have rested on their ecological value and the maintenance of diverse species habitat without consideration of their economic value to the local people. In so doing, little attention has been given to the importance and utilisation of non-timber forest products (NTFPs) that have a great value to local populations.

Nowadays, many plants suffer extinction as a result of over-harvesting (Freese, 1997; FAO, 1986). However, baseline data such as local and scientific species identification, both, as well as information on local uses of a majority of these plants are inadequate. This lack of reliable and adequate baseline data has been identified as a major constraint to effective conservation of non-timber forest products (Crucible Group, 1994). This has been the case, not only in Rwanda but also in other countries. Therefore ethno-botany defined as "a discipline, which tries to find out how people have traditionally used plants and continue to use them for whatever purposes " may provide a better approach for conservation of these plants which are of great importance (Cotton, 1996). People living in and around tropical forest areas represent the key to the understanding, utilisation and protection of tropical plant species.

The understanding of interactions between people and forest resources is of great importance for achieving long-term conservation of the forests but this link has not been completely explored. In Rwanda and other countries, the failure of linking modern scientific information with local traditional information is still a handicap to this understanding (Freeze, 1997; Martin, 1996). In addition, there is a growing realization that involvement of people in

decision-making is a fundamental basis for natural resource management. In the past, many conservation projects have failed due to lack of effective involvement of local people and disregard of the forest adjacent population's basic needs by policy and decision makers.

The consequences of restriction on the use of the forests by local people has been more deforestation rather than conservation. It has been recognized that allowing limited and controlled use of natural resources could lead to better management of the resources and thus ensuring biodiversity conservation (IUCN, 1993; Cunningham, 1996). This observation is relevant in the Rwandan context. It is estimated that nearly 30% of the country may have been forested in the past but only about 5% of the natural forest remains today (Schnitzler and Fourrier, 1993). During the colonial period, the importance of conservation was recognized and vast areas were designated as reserves and parks. These included the reserves of the Nile – Zaire Divide; Mukura, Gishwati, Nyungwe Forest Reserve, Volcanoes National Park and Akagera National Park. Despite the biological benefits in setting aside these reserves and parks, there was an opportunity cost incurred by the local population who could no longer use the forest resources as this land became restricted and controlled.

However, in Rwanda a high population growth rate and a high population density (306 inhabitants per square Km) exerted extreme pressure on these reserves due to lack of non-farm employment for the rural communities of whom 95% depend

on farming. Communities surrounding Nyungwe Forest Reserve are largely poor peasants who depend on subsistence agriculture and on the forest resources. Furthermore, the land around the reserve is densely populated and intensively cultivated (Clay and Lewis, 1990). As a result of land shortage due to increasing population, Nyungwe Forest Reserve has been deforested by farmers who lack other alternative sources of livelihood other than subsistence agriculture. However, tropical soils are usually susceptible to rapid erosion particularly in Nyungwe Forest where the soils are very acidic and are covered by a thin layer of organic matter (Schnitzler and Fourrier, 1993). Since the terrain is steep and the soil fragile and poor, after three to five years of cultivation, there is a decline in soil productivity and the adjacent area is often cleared to increase yield. As a result, many areas of the forest have already been cleared. A large part of the forest has thus been converted to agricultural land. This, together with poaching and pit sawing, are the main causes of forest degradation.

It is against this background that the Rwanda government launched an Action Plan (Plan d'Action) in 1984, to improve the conservation and management of the natural forest of the Zaire- Nile Divide to improve the management of Nyungwe and other forest reserves. This Action Plan called for a multiple-use strategy intended to reduce the socio-economic cost of protecting natural reserves. According to this approach, the strictly protected area (core zone) was to be surrounded by a zone managed for limited and specific use. In reality, the Action Plan failed to work as this approach proved difficult to implement until all people were evicted from the forest. The Nyungwe forest management has reverted to a

total ban of all forest activities. This control mechanism, often insufficient and ineffective, has not deterred the local community from illegal exploitation of forest resources. The Action Plan failed because it did not sufficiently take into account of local needs and interests. A study of NTFPs used in Nyungwe Forest is essential in order to know the ecological impacts and ensure that future plans for conservation take into consideration of the needs of local people in order to achieve long term conservation.

1.2 Statement of the Problem

Nyungwe Forest Reserve has been designated as one of the world's top priority forests for the conservation of birds and primates. It has 275 bird species, 24 of which are endemic to the Central African Highlands and 14 species of primates, which comprise one-fifth of all African primates. The flora is also quite diverse including more than 190 tree species and 100 orchid species (Schnitzler and Fourrier, 1993). Furthermore, Nyungwe Forest Reserve is very important in maintaining and protecting watersheds of the various rivers in this region, the highly fragile soils and in contributing to regulation of the local climate. In addition, the forest supports adjacent communities in various ways such as provision of food, fuelwood, building material, medicine and other products.

Despite its importance, Nyungwe Forest Reserve faces many threats such as habitat loss and ecosystem degradation due to various human activities (Schnitzler and Fourrier, 1993). Due to lack of alternative economic activities,

local residents engage in gold mining, poaching and illegal tree felling in order to supplement their income. Moreover, the forest is being put under pressure through encroachment by agricultural activities. All these activities are most disruptive to the forest ecosystem and their consequences are very difficult to reverse (Swanson, 1996).

Given the intense pressure from the human population surrounding Nyungwe Forest Reserve, there is need for a new management approach. Sustainable harvesting of NTFPs is seen as an effective management approach that allows local people to meet and sustain their livelihoods while contributing to forest conservation.

1.3 Objectives of the Study

The overall objective of this study was to investigate the use of Non Timber Forest Products and its ecological impact on the conservation of Nyungwe Forest Reserve. Specific objectives were to:

i) Assess the attitudes and perceptions of the local community towards conservation of Nyungwe Forest;

ii) Identify the NTFPs and their use by the adjacent communities;

iii) Determine the socio-economic value of the different NTFPs harvested from Nyungwe Forest Reserve on the local communities;

iv) Assess the resulting impact of the continued harvesting of NTFPs.

1.4 Significance of the Study

The conservation of forest resources can be improved by promoting the sustainable use of NTFPs as these products play a crucial role in the local communities' lives by providing basic needs. Consequently, forest conservation depends mostly on the people surrounding and living in them. For this reason, it has been shown that forest protection can be improved if needs of adjacent communities are taken into account in decision making (Bruenig, 1998). The study could provide a foundation upon which forest management can be designed advocating for multiple forest use.

The data obtained in this study could also be used when involving communities in forest resource management. Information and practical results will be used for making decisions to improve the livelihoods of the local communities while ensuring sustainable harvesting of the NTFPS without jeopardizing the long term conservation of biodiversity (Cunningham, 1996; Emerton, 1996 a.). The study will also help in identifying the useful plants, which require additional research for medicinal and dietary purposes as well as promoting domestication of useful plants.

1.5 Definition of Operational Terms

Biodiversity: It is the variability among living organisms from all sources including *inter alia*, terrestrial, marine and aquatic ecosystems together with the ecological complexes of which they are a part.

Buffer zone: These are areas peripheral to National Parks or Reserves, which have restrictions placed on their use to give an added layer of protection to the reserve itself and to compensate villagers for loss of access to the strict reserve.

Committee of council: It is a group of people elected at the sector level with a mandate to rule in the study area.

Conservation of biodiversity: Is the management of human interactions with the variety of life forms and ecosystems so as to maximize the benefits they provide today and maintain their potential to meet future generations' needs and aspirations.

Ethnobotany: Refers to a discipline, which tries to find out how people have traditionally used plants and continue to use them for whatever purpose.

Key informants: These are people with particular specialization or who may represent a particular point of view in this study.

Non-timber forest products (NTFPs): The term non-timber forest products encompasses all biological material other than timber which are extracted from natural forests for human use.

Prefecture: is the largest administrative area in Rwanda which is subdivided into communes (The prefecture is equivalent to a district in Kenya).

Protected areas: is the legally established area under either public or private ownership where the habitat is managed to maintain a natural or semi-natural state.

Land tenure: Applies to land holding rights through inheritance according to Rwandese customs, purchase or lease. The inheritance system disadvantages the Batwa people (See Box 2.2) since they own no land and women who according to Rwandese customs are not allowed to inherit land .

CHAPTER TWO

LITERATURE REVIEW

2.1 Non-timber Forest Products (NTFPs)

Local communities around the world make vast and varied use of forest resources many of which are Non-timber forest products or Non-domesticated resources (Posey, 1999). The NTFPs are defined as all biological material, other than industrially exploited timber, sawn timber and pulp, that may be extracted from natural ecosystems, managed as well as plantations. Table 2.2 gives the different categories of NTFPs. The products may be utilised within the household, be marketed or have socio- cultural or religious significance (Unasylva, 1992). Thus NTFPs include food, fodder, fuelwood, medicine and bush meat among others. Wood carving, canoe and house construction are all wood consuming activities but are considerably lower in wood consumption than timber logging and have the ability to meet criteria for traditional sustainable forest use and therefore can be included in the NTFPs category (Belcher, 1997)

NTFPs have also been classified by foresters as "minor forest products." This appellation often refers only to those products for which there is an industrial market such as gums, resins and tannins (Falconer, 1990). There is no agreed definition of NTFPs, some organisations such FAO (1995), prefer using the term "Non-wood forest products" NWFPs but this term is unsatisfactory in that it excludes important resources, such as fuelwood, building poles and other

forms of non-processed wood. Non-marketed products including many NWFPs fall into the category of direct consumptive use. Consequently, NTFPs may include fuelwood and charcoal according to some definitions (Arnold and Perez, 1998). Some of the fauna are also considered as NTFP and constitute important products for many people. However this study focused only on plant aspects of NTFPs.

Table 2.1 Characteristics of Non-timber Forest Products

Category	Example
Food	Bush meat, fish, fruit, edible oils, edible plants, honey
Medicinal products	Animal and plant products
Woodfuel	Fuelwood, charcoal
Structural material	Rattan, bamboo, wood pole, various fibres
Animal products	Honey, eggs, birds nests, reptile skins, feathers and other decorative wildlife products
Live animals	Animals such as rabbits, antelopes, rats, birds, fish
Ornamental plants	Orchids

Source: Appasamy, 1993

2.2 Role of Non Timber Forest Products

2.2.1 Biodiversity Conservation

In the past two decades there has been concern among conservationists on how best to protect the rapidly disappearing biodiversity and natural habitats (Brandon *et. al.*, 1998). Traditionally, national parks and other categories of strictly protected areas have not been the most effective means of achieving the conservation objectives where people lack other alternatives. This has mostly created serious land use conflicts. As forest conservation goes hand in hand with the well being of the population concerned, NTFPs can be used as a tool

to improve livelihood options for these people. The use of forest resources, which generate a substantial income to the local community, is likely to give local people a stronger incentive for conservation (Wollenberg and Ingles, 1998).

The interest in NTFPs as a tool in conservation and development has its origin in a number of assumptions for example NTFPs contribute much more than timber in improving the livelihoods and welfare of people living adjacent to the forests. They provide them with food, medicine and other material inputs. These products play a crucial role in supporting community welfare as a significant source of income. Many of these forest products have the potential of being marketed and thus providing rural people with cash income without the need of clearing the forest. On the other hand, exploitation of NTFPs is usually less destructive than timber harvesting and therefore it provides a more sound basis for sustainable forest management (Wollenberg and Ingles, 1998).

With careful harvesting and management, many NTFPs can cope sustainably with little damage to the biological function of the tropical forest (Sayer, 1991). The sustainable utilisation of NTFPs provides a unique way to use the rich tropical forests species for profit and still conserve most of the biological diversity. No other uses practiced in the tropics have the potential to do so (Peters and Mendelson, 1989). Increasing commercial harvest of NTFPs could add to the perceived value of the tropical forests at both local and national

levels, thereby increasing the need to retain the forest resources, rather than changing the land to agricultural use for example.

Another reason for the particular attention to NTFPs is their potential in resolving conflicts around protected areas. Conflicts exist in most protected areas at varying levels and degree between communities and park authorities, and among communities over resources and their uses (Brandon, *et al.*, 1998). Establishing a good relationship and winning the trust of local communities has been shown to contribute significantly to conservation (Mutebi and Wild, 1996). Sustainable use of forest products by the local community can be seen as a possible means of reconciling the conflicting objectives of the managers and local residents living in and around tropical forests. Therefore the controlled exploitation of NTFPs holds great potential as a method of conservation of tropical forests in linking protected area management with the needs of nearby communities through limited and controlled use.

2.2.2 Limitations of NTFPs Use in Tropical Forests

As a renewable resource, wild species have the potential to be utilised sustainably. For this to be achieved, the rate of harvesting must not exceed the generative capacity of the resource given the considerable uncertainties about population dynamics of many species. Tropical forests are characterised by the low growth and difficulties in their re-establishment once they have degraded and destroyed. Once more, one of the most fundamental characteristics of tropical forests is the larger number of species that grows in a given area. The

consequence of diversity of species in tropical forests is that these species occur at very low densities (Whitmore and Sayer, 1992; Boerboom and Wiersum, 1983). Low density means that many species are probably subjected to elimination. Certain species of trees for example are low density and dioecy (occurrence of male and female flowers on separate plants) hence causing vulnerability of tropical forest species. For example, over harvesting of fruits or seeds of a tree species can dramatically reduce regeneration to the point of local extinction without any visible effect. Large individuals 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 damage become evident (Peters, 1997; Kruk, 1988).

In addition, the community of animals that depend on those trees can be considerably affected, depending on the extent to which the trees are important as a source of food for particular species (Peters, 1996). Therefore, harvesting should not exceed the resource's ecological carrying capacity and should be planned to maintain the diversity of local biological resources to maintain viable breeding populations.

Sustainable harvest of NTFPs requires careful selection of species, resources and sites. It requires controlled harvesting and periodic monitoring of the regeneration and the growth of the species being exploited (Peters, 1997). Use of NTFPs, to meet the objectives of forest conservation, has to satisfy certain criteria. According to FAO (1996), sustainable NTFPs utilisation aimed at

conservation requires that there is a market for the products and there is a substantial amount of NTFPs (species abundance). The collection must also be profitable both in the short and long term, ensuring that the net present value of NTFPs is at least as great as the opportunity cost for other land uses and the collection is as well biologically sustainable.

In all cases, controlled NTFPs harvesting offers the potential for sustainable economic yields, while maintaining forest biomass and considerable biodiversity. It can be viewed as the best way to ensure long-term effective biodiversity conservation as well. The fastest profits are obtained by clear-cutting which decimate a whole range of forest resources. In contrast, the exploitation of many NTFPs depends on maintaining large protected areas with a sustainable human use. For this reason, sustained yield harvest from the forest can compete with other major land uses which destroy the forest.

2.2.3 *Importance of NTFPs to Rural Communities*

2.2.3.1 Provision of Medicine

One way in which forest biodiversity contributes to local socio-economic welfare is the provision of affordable health care. A wide range of human and animal diseases are treated using forest plants. About eighty percent of the world's population is at least partly dependent on traditional medicine and medicinal plants to treat illnesses (Akelele and Synge, 1992). More than two thirds of the world's plant species, 35,000 of which have potential medicinal

value originate from developing countries (Crucible Group, 1994; Ayensu, 1983). It has been estimated that 75 to 90 % of the world's rural people rely on traditional forms of medicine for their primary health care needs (Posey, 1999). Traditional health care services constitute the most abundant and in many cases the most accessible and affordable. In Africa, it is estimated that the ratio of modern doctors to villagers is 1:100,000 while the ratio of traditional healers to villages is 1:200 (IUCN, 1993; Wanjau, 1998). Many people first seek the help of local traditional healers before they go to formal health services.

This is also true in Rwanda where modern health facilities are located in towns and along major roads. For this reason many rural people rely exclusively on the services of local healers (Campbell and Hu, 1992). In Rwanda, provision of health services is limited, especially in the study area. For example in Banda, one of the villages, bordering the forest, people walk for 30km over steep terrain to reach the closest medical facility. In addition, majority of people cannot afford modern health care services and therefore turn to medicinal plants for treatment.

Tropical rainforests still represent a great reserve for medicinal genetic resources. These may yield important drugs to treat a number of diseases. The importance of medicinal plants in the healthcare system is enormous, but detailed information on these plants is lacking.

2.2.3.2 Source of Energy

In rural areas in Africa, fuelwood is the major source of household energy for cooking and heating. It is estimated that over 99% of domestic energy in rural areas comes from fuelwood, charcoal, crop and wood residues as energy sources. As electricity, gas and paraffin are neither available nor affordable, fuelwood is produced primarily to meet consumption needs (Hall and Mao, 1994; Bentley and Gowen, 1994). About 83 percent of all wood extracted from the tropical forest is consumed as fuelwood (Kramer *et al.*, 1995). In no other continent is the dependence on biomass energy so prevalent as in Africa where 91 % of all woods supplies are used as source of energy. In Kenya, more than 16 million tonnes of fuelwood were consumed in 1990 mainly by rural communities (Wanjau, 1998).

As in most developing countries, biomass constitutes Rwanda's major energy resource. Biomass is also used as a source of energy in industrial and crafts related activities such as brick and tile burning, bakeries and tea factories (Hategeka, 1997). In rural areas and for almost all the population in the country, it is used for cooking whether in the form of fuelwood, charcoal or crop residues. The rural population relies mainly on fuelwood supplemented by agricultural residues for its energy needs. About half of the biomass presently used, comes from forests (Hategeka and Karenzi, 1990).

2.2.3.3 Source of Food

NTFPs contribute to the food security of the rural population. An assessment of local dependence on NTFPs for food security must consider local product sales as well as direct contribution to food and nutrition (FAO, 1995b). The wild edible plants provide a vast range of food especially at times when other food sources are unavailable (FAO, 1995). They are very important in overcoming food shortages experienced during hunger periods when agricultural production is low. They are also essential additions to human diet (Table 2.3). For example it has been estimated that 91 % of South Africans rely on wild grass as a source of essential proteins. Widespread use of wild fruits and wild cereals is reported from Madagascar, Liberia and Kenya (Wanjau, 1998).

Originally plants were gathered from the wild and this still occurs today in rural areas. An estimated half a billion people depend on forests for food. Wild plants are therefore an essential component of the diet for many people throughout Africa. The edible plant resources in Rwanda are seasonally used as dietary supplements or as a source of subsistence income such as the sale of mushrooms and other plant products.

Table 2.2: General Contributions of NTFPs to Human Nutrition

Types of forest foods	Nutrient
Fruits and berries	Carbohydrates (Fructose and soluble sugars), Vitamins (especially C), minerals calcium, magnesium, potassium), some provide protein, fat
Nuts	Oils and carbohydrates
Young leaves, herbaceous plants	Vitamins (beta-carotene, C), calcium, iron
Gums and saps	Proteins and minerals
Vertebrates (fish, birds, mammals)	Proteins, fat, vitamins
Invertebrate (insects, snails)	Protein, fat

Source: FAO, 1994 and FAO, 1995 (b)

2.2.3.4 Use of Bamboo

Bamboo is a fast growing and high yielding renewable natural resource. Its qualities have made it the most universally useful plant known to man. The strength of the culms, the lightness, great versatility and ease in working it with simple tools have made bamboo more suitable for a variety of purposes in human cultural evolution than any other plant (FAO, 1990). It is, for example, known as "the wood of the poor" in India, "the friend of the people" in China and "the brother" in Vietnam (Farrelly, 1984). Investigations of the uses of bamboo listed 1,048 uses in Japan alone (Farrelly, 1984). These uses with variations can be found in Asia as well as in several regions of the world.

The bamboo in Nyungwe Forest Reserve is mostly dominated by *Arundinaria alpina* and *Sinarundinaria alpina* species. It is traditionally used for construction, as fuel, and to produce chairs, baskets and other household items.

Even though bamboos are plants of enormous importance to the rural people in several regions of the world, certain aspects of the properties and utilisation of bamboo have been unexplored and neglected.

2.2.3.5 Bee-keeping

Bee-keeping for honey in Rwanda is mainly a forest-based activity. It is seen to be a form of land use compatible with the conservation of tropical forests. It has many benefits and advantages as an occupation for rural people. Compared with other agricultural activities, the extension of beekeeping in developing countries has the advantage that little land, which could even be of a poor quality, is required to provide the site for hives with inexpensive equipment.

It can then be practiced by small holders and the landless for it occupies little space and hives can be on the edge of forests or woodlands. In addition, bee-keeping does not compete for resources with other agricultural activities hence producing food from otherwise unused resources.

Bees also improve pollination of many tropical crops thereby increasing production. Finally, income can be generated at any level of operation in the production of honey and wax as well as many products of the hives (Crafter *et al*, 1995). In Rwanda, communities living adjacent to the forest harvest honey which they trade in as either raw honey or as its alcohol derivative.

2.3 Value of Forest Resources

2.3.1 Holistic Value of Forest Resources

Tropical forests provide a wide variety of services to humankind. They are important for the conservation of biodiversity and are believed to contain more than half of all the world 's fauna and flora. About half of all vertebrates and vascular plant species occur in tropical forests (Shiva, 1995). Given the value of tropical forest resources, it is of serious concern that these forests are being destroyed at a high rate. This is mainly because conservation is widely viewed as the less profitable option than converting the forest to other uses that are more profitable in the short term to the society.

The short-term benefits have made the forest to be valued primarily as a source of commercial timber (Dasgupta and Maler, 1997). More often than not, environmental resources are allocated an economic value lower than their real holistic value (Box 2.1). It has been assumed that the current practice of incomplete valuation of forest resources has reinforced perceptions that forests have no other worth other than for timber. The forest sector may be undervalued for example by excluding the value of NTFPs, which are rarely traded in the commercial market (Shanley *et al.*, 1996). The economic value of non-timber forest products is significant but it often remains underestimated because these products are difficult to value. Even though the value of NTFPs are not fully quantified using market prices as they do not pass through the

formal market, they are of particular significance to the rural subsistence economy (Emerton, 1996 a; Freese, 1998; Koppell, 1995).

Box 2.1: Classification of Forest Values

1 USE VALUES	
A.	**Direct use values (Associated with the following benefits)**
A.1	Consumptive uses
A.1.1	Commercial / industrial market goods (Fuelwood, timber, pulpwood, poles, fruits, animals, fodder, medicines, commercial non-wood products like rattan.
A1.2.	Indigenous non-market goods and services (Fuelwood, non-commercial non-wood products, animals, skins, poles, fruits, nuts, medicinal plants and others), food security.
A.2	Non-consumptive uses
A2.1	Recreation (jungle cruises, wildlife photography, trekking)
A.2.2	Science/education (forest studies of various kinds)
B.	**Indirect use values (associated with the following benefits)**
B.1	Watershed protection.
B.2	Soil protection, nutrient recycling and soil fertility, agricultural productivity enhancement.
B.3	Gas, like carbon dioxide and oxygen exchange, contribution to climate stabilization and carbon storage.
B.4	Protection of habitats, biodiversity and species
B.5	Aesthetic, cultural and spiritual values
2.	**NON- USE VALUE**
C.	**Optional values**
C.1	People may value the option to use a forest in the future. Although such values are difficult to measure in economic terms, they should be recognized as contributing to human welfare. This concern can contribute to the conservation and preservation of the forests.

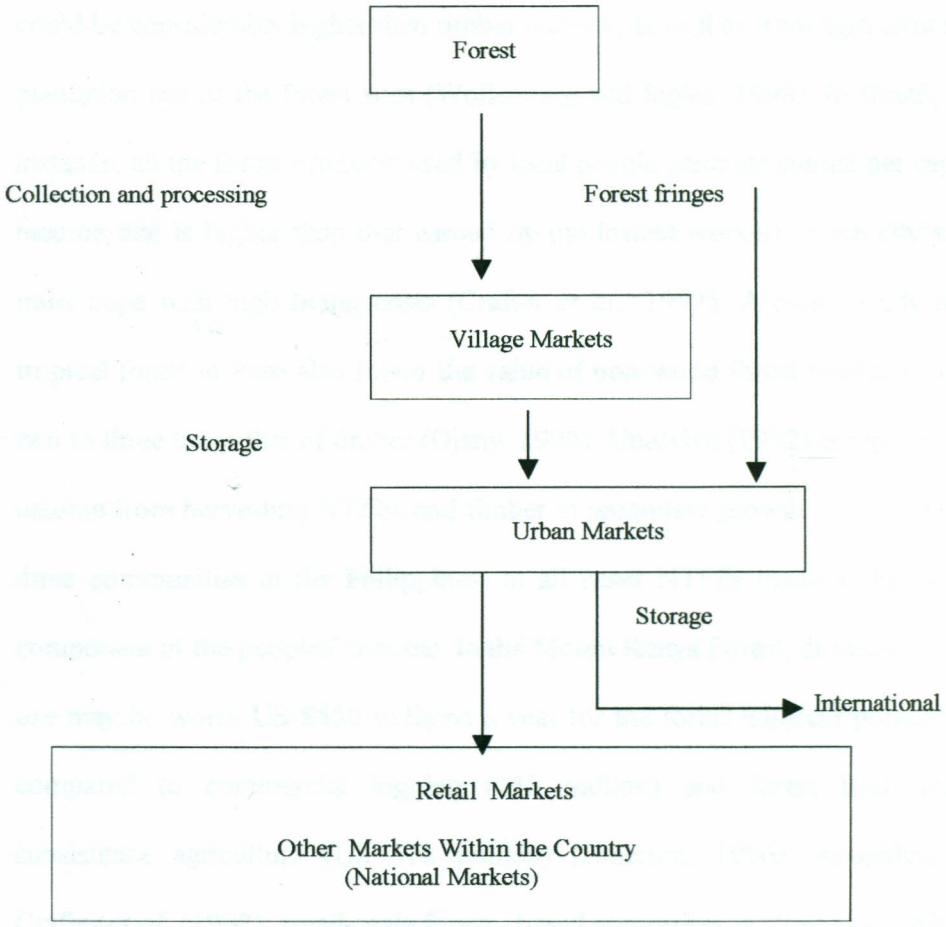
D	**Existence and bequest values**
D.1	People may value a forest or resource complex purely for its existence and without any intention to directly use the resource in the future. This includes intrinsic value
D.2	People may value a forest as bequest to their descendents or others.

Adapted from Swanson and Barbier, 1992; Kramer *et. al,* 1995

2.3.2 Economic Value of NTFPs in Tropical Countries

Forests have usually been valued mainly for timber production. More recently however, the belief that forests are of value only for wood production in a macro-economic context has been modified. Besides timber, NTFPs are also extremely important in many countries and their value may sometimes exceed that of traditional timber products (Unasylva, 1992; Broekhoven, 1996; De Beer and McDermott, 1989; Falconer, 1990). However, it is difficult to determine the values of many NTFPs in use throughout the world. The commercial extraction of NTFPs is usually poorly reflected in national statistics because the market systems are underdeveloped and the values of NTFPs often focus on products sold at national level and international level ignoring the different channels of NTFPs market as a whole (Ndoye *et. al.*, 1997). Figure 2.1 presents the channels of NTFPs marketing.

Figure 2.1: General Markets of NTFPs



Source : Ndoye *et al.*, 1997

A large number of forest products are consumed locally or traded informally. In spite of this, tropical forests produce NTFPs such as food, firewood, medicine and other commodities that may provide a range of income generating possibilities for the local people. The value of non-timber forest products is therefore much greater than it is generally assumed.

From Tropical Rainforests in the Amazon and in Asia, where considerable progress has been made in the area of NTFPs development, valuation of forest

sites indicated that the potential income from sustainable harvesting of NTFPs could be considerably higher than timber income, as well as from agriculture or plantation use of the forest sites (Wollenberg and Ingles, 1998). In Brazil, for instance, all the forest products used by local people generate annual per capita income that is higher than that earned by the lowest workers in the city who must cope with high living costs (Crafter *et al.,* 1997). A recent study in a tropical forest in Peru also found the value of non-wood forest products to be two to three times that of timber (Ojany, 1998). Unasylva (1992) compared the income from harvesting NTFPs and timber in secondary growth forest used by three communities in the Philippines. In all cases NTFPs made a significant component of the peoples' income. In the Mount Kenya Forest, domestic forest use may be worth US $550 millions a year for the forest adjacent population compared to commercial logging (153 million) and forest land under subsistence agriculture (US $18 million) (Emerton, 1996). According to Crafter *et al.* (1997), small-scale forest –based enterprises in Zimbabwe, which are mostly based on NTFPs, employed 237,000 people in 1991, compared to 16,000 employed in conventional forestry for the same year.

In Rwanda, Nyungwe Forest Reserve generates sufficient income to the surrounding population. Clay and Lewis (1990) estimate that basket making yielded US $ 75,000 per year while apiculture is estimated to earn US $180, 000 per year from honey and alcohol derivatives. The real value of wild species, however may be more than what the monetary value may indicate. A multi-resource inventory is therefore a priority as various NTFPs are mainly

used for domestic consumption, therefore their harvesting, mode of distribution and quantities used are neither well known nor well documented.

2.3.3 Socio-cultural Value of NTFPs

Most NTFPs are very important to various communities for their cultural value rather than for the money they bring. Culture is defined as a combination of language, beliefs, religion, knowledge systems, dress, food habits and social structure (Crafter *et al.*, 1997). The local population places a cultural value to activities and places in the forest. Forests and trees are also important serving as temples, cultural symbols, gathering places and locations for social rites such as initiation ceremonies (Falconer, 1990). Box 2.2 gives some examples of cultural values of forest resources. In many cultures, communities maintain certain areas as sacred groves where harvesting is banned or carefully controlled (Arnold, 1995).

Although the cultural and spiritual value of forests are loosing their importance in Rwanda, there are still some places where harvesting is prohibited and valued as places of cultural importance. These cultural values of forest-dependent societies usually support conservation, yet cultural value is passed on less and less to succeeding generations hence modern society is loosing the connection with nature and forests.

Box 2.2 Examples of Cultural and Social Values of Forest Resources

1. Trees

Cultural and social values of trees include:

- Certain tree species in the Amazon region may not be cut because of a local belief that the trees act as a link between the physical and spiritual world
- Another belief, also from the Amazon region, suggests that if a person cuts certain tree species he/she will be eaten by a crocodile
- Trees may represent mediators in decision-making
- Trees are used to demarcate property. They can play a role in land tenure systems and in establishing land rights (e.g. planting and/or harvesting a tree in a certain area can constitute proof of possession of the tree and the land surrounding it).

2. Forest locations

Forest sites with social and cultural significance include:

- Sacred groves
- Sites of initiation ceremonies
- Venues for political and social meetings

Source: Adapted from Crafter *et al.*, 1997

2.4 Concept of Indigenous People

The term "Indigenous people" has got different definitions according to different organisations. According to a special report of the United Nations Economic and Social Council Sub-Commission on Prevention of Discrimination and Protection of Minorities, indigenous people are defined as those communities who have a historical continuity with pre-invasion and pre-

colonial societies that have developed on their territories and consider themselves distinct from other sectors of society (UNESCO, 1996); while the International Labour Organisation (ILO, 1989) Convention 169 concerning Indigenous Peoples in Independent Countries identifies Indigenous peoples as

> "Tribal peoples in countries whose social cultural and economic conditions distinguish them from other sections of the National community and whose status is regulated wholly or partially by their own customs or traditions or by special laws or regulations".

As a general orientation to the concept, indigenous people can be defined as distinct people, with their own languages, cultures and territories, who have lived in a country since time prior to the formation of the current nation states. They have become disadvantaged and vulnerable as a result of colonial invasion of their territories, either by colonisation, or by groups within the countries in which they live. Box 2.3 gives in summary the life style of Batwa, indigenous people of Rwanda.

More than 300 million people in the world are indigenous, speaking 4,000-6,000 languages (Posey, 1999). They are culturally distinct and live differently from one locality to another. According to IUCN (1993), between 70 and 80 percent of all cultures are indigenous. Despite their diversity and differences, all indigenous people are linked by the fact that they have always been dependent on natural resources for their livelihood since time immemorial and have developed a traditional system of conserving biodiversity especially in tropical forests. According to Caufield (1982) and IUCN (1993), tropical

forests support unique cultural systems of societies of indigenous people which are not only an integral part of the forest in balance with the stability of the ecosystem, but also the most intelligent guardians, capable of being the most important asset for future sustainable and profitable use of tropical forest.

Disappearance of natural resources mainly in tropical forests has not only led to loss of biodiversity but has also affected the rights and livelihood of the local communities and indigenous people as shown by the statement below made by "International Alliance of Indigenous and Tribal People" of the tropical forest which include the Batwa of Rwanda, the hill tribes of Thailand, the people of the Amazon, the Adivasis of India, among others.

> "I speak today for the indigenous and tribal people of the tropical forests who have come together in response to the global destruction of our forests. The movement arose in response to the destruction of our forests to feed the unsustainable consumption and production patterns of the rest of the world. All over the word indigenous people are suffering the negative effects of the development on the environment."

As pointed out by Bruenig (1998), deforestation and forest degradation is exacerbated by a lack of understanding of the holistic world views and ways of life of indigenous people and other forest dependent peoples. The failure of government and other institution to recognise and respect the right of indigenous peoples and other forest dependent peoples to their territorial lands, forest and other resource is one of the causes of deforestation and forest degradation. More than three quarters of the world's population both indigenous and local depend directly on forest products, many of them extracted from tropical forests.

Box 2.3: The Batwa of Rwanda

The Batwa are the smallest ethnic group in Rwanda with a population estimated at 1% of the total population of Rwanda (Nyagahene, 1985). This community is also living in the tropical forest that covers the south-western part of Uganda and is also found in the DRC (Cunnigham, 1996) They have a long history of association with the forest and their lifestyle is different from that of other communities. To date they still depend heavily on forest products. Traditionally, Batwa lineages depended directly on the Kings of the country, for whom they acted as political spies and executioners. They also used to provide leopard skins as these were part of the traditional costume of the King (Gibbs, 1965). Two subgroups may be distinguished with respect to their occupation. The first group consists of hunters and gatherers who used to live in the mountain forests of western and northern Rwanda while the second, the potters, lived scattered among other inhabitants of the country, especially in central Rwanda. In the study area, they are concentrated in Busozo and Gatare. Today none of them lives in the forest. Rather, they live in the environs of the forests among other communities where they are given space to build their huts in exchange for some services such as collecting firewood and providing manual labour. Since they own no land, they depend directly on the harvest and barter of forest products. They still hunt and collect vegetables as well as firewood in order to make a living.

2.5 Threats to Tropical Forests

Tropical forests face severe environmental problems, which threaten the ecosystem and the well being of individuals and populations. One of the major causes is the conversion of tropical forests to other land use types on a massive scale whether by national policies or for local livelihood needs, especially the

conversion into agricultural lands (Serageldin, 1990). Between 1976 and 1980, an estimated 7.3 million hectares of closed tropical forests were converted to other land uses each year and an additional 4.4 million hectares are logged annually (Ojany, 1998). Table 2.1 shows the rate of natural habitat conversion into other uses in Sub-Saharan Africa. The single greatest cause of species extinction in the next half-century will be tropical deforestation. Scientists estimate that roughly 5-10 % of closed tropical forest species will become extinct per decade at the current rate of tropical forest conversion into other land use types (Perrings, 2000).

The loss of biodiversity has also significant economic and social implications. The uncontrolled and unregulated deforestation now threatens biological resources which the local communities depend on for their livelihood. The destruction of the forest ecosystem hence has a severe consequence at both local and global level. Throughout the world more than 250 million indigenous people and local communities remain substantially dependent on traditional modes of production to fulfil their basic requirements of food, medicine, fuel wood and even shelter (Posey, 1999). It is, therefore, understandable that the loss of biodiversity is not only a threat to the ecology of the planet but also a more immediate threat to the livelihood and security of indigenous people and the rural community. Biodiversity conservation is therefore of immediate relevance to communities dependent upon it.

Table 2.3: Estimation of Habitat Conversion in Sub-saharan Africa

Country	Original wildlife habitat (1000 km^2)	Amount Remaining (1000km^2)	Habitat Loss (%)	Country	Original wildlife habitat (1000 km2)	Amount Remaining (1000km^2)	Habitat Loss (%
Angola	1247	761	39	Malawi	94	40	57
Botswana	585	258	56	Mali	754	158	79
Burkina Faso	273	55	80	Mauritania	389	74	81
Burundi	26	4	86	Mozambique	783	37	57
Cameroon	469	192	59	Namibia	823	444	46
CAR	623	274	56	Niger	566	128	77
Chad	721	173	76	Nigeria	920	230	75
Congo	342	172	49	Rwanda	25	3	87
Côte d'Ivoire	318	67	79	Senegal	196	35	82
Djibouti	22	11	49	Sierra Leone	72	11	85
Eq.Guinea	26	13	51	Somalia	638	376	41
Ethiopia	101	30	70	South Africa	1237	531	57
Gabon	267	174	35	Sudan	1703	511	70
Gambia	11	1	89	Swaziland	17	8	56
Ghana	230	46	80	Tanzania	886	505	43
Guinea	246	74	70	Togo	56	19	66
Guinea-Bissau	36	8	78	Uganda	193	43	78
Kenya	570	296	48	DRC	2336	1051	55
Lesotho	30	10	68	Zambia	752	534	29
Liberia	111	14	87	Zimbabwe	390	171	56
Madagascar	595	149	75				

Source: Perrings, 2000 pp 14

2.6 Conclusion

The emerging information from the literature cited indicates that forest resources in Rwanda, in particular, and Africa in general support large communities. However there is a substantial lack of research information on the exact quality and quantity of resources harvested. The absence of such vital data and information has seriously impeded appropriate management and monitoring as well as evaluation of the supply and demand dynamics of forest resources in Rwanda. The study was supposed to fill the information gap with specific respect to NTFPs harvested from Nyungwe Forest Reserve.

CHAPTER THREE

BACKGROUND OF THE STUDY AREA

3.1 Brief information about Rwanda

Rwanda is a small, landlocked country bordering Uganda to the North, Burundi to the South, Tanzania to the East and Democratic Republic of Congo (DRC) to the West. Situated between latitude 1° and 3° South at a distance of 1200 km from the Indian Ocean and 2200 km from the Atlantic Ocean, Rwanda occupies a section of approximately 150 Km span of the watershed between the Congo and the Nile, extending from the 4500m high from Virunga Volcanoes in the north to the source of the White Nile in the South (Kleinert, 1985).

The steep westward slope towards Lake Kivu, at an altitude of 1460m, the highest of the lakes in the Great Rift Valley of East Africa contrasts with a much gentler eastward slope towards the Akagera river. This river is the main headstream of the Nile, at an altitude of approximately 1000m. The Western part of this latter area forms the 15000-2000m high "Central highlands" whose deeply incised valleys and accented relief have given the country the name of the "Land of the Thousand Hills". In the East, the Highlands give way to the lowest–lying part of the country, a gently undulating plain, sprinkled with swamps and lakes, situated at an altitude of 1000m –1500 m and bounded in the East by the Akagera (Kleinert, 1985).

Rwanda covers 26,000 square kilometres of which 10% were protected reserves until recently when the migrations in the country led to serious depletion and reduction of natural resources as a consequence of new settlements after the 1994 genocide (MINAGRI, 1997) .

3.2 Nyungwe Forest Reserve

3.2.1 Physical environment

Figure 1 shows the location of Nyungwe Forest Reserve . It is one of the montane forest islands along the Zaire-Nile divide situated in South West of Rwanda. It comprises 970 square km and is one of the single largest forest blocks in Africa (Webber 1993; Schnitzler and Fourrier, 1993). It is described as a tropical montane rainforest ranging in elevation from 1600 m to almost 3000 m, with an average daily temperature of 15.5°C and an average annual rainfall of 2250 m (Runyinya, 1986).

As a result of the steep topography, abrupt altitudinal changes, variable soil types and different human activities, there is a great variety of microhabitats within Nyungwe Forest Reserve. Habitats include tall primary forests, secondary forests, and open areas of dense herbaceous vegetation, bamboo thickets, flooded forests and marshes. The eastern part of the reserve is underlain with granite rock and very poor soils characterized by secondary forests whereas the western parts are especially rich biologically due to the richer soils. Other distinct habitats include a large homogenous stand of bamboo forest in the south-central and south-eastern sectors of the forest, and

the large marsh at Kamiranzovu swamp (13 Km^2) in the West (Bahigi and Vedder, 1987). Some areas are burnt resulting in vegetation dominated by bracken fern (*Pteridium aquilinum*) or Kosso (*Hagenia abyssinica*). Other degraded sites are overgrown with *Sericostachys scandens*. Both bracken and Serichostachys appear to inhibit regeneration.

3.2.2 Biodiversity

Nyungwe Forest Reserve hosts a diversity of life due to its highly variable habitat. During the Ice Age (Pleistocene) these montane forests along the East African Rift Valley served as a moist refuge for tropical fauna and flora. Nyungwe Forest Reserve is also an area of overlap between several large bio-geographical zones including the Guineo-congolian, the Zambezian and the lake Victoria phytochoria (White, 1983; Webber, 1993). All these make Nyungwe Forest a unique biodiversity.

This montane forest supports a population of several hundred chimpanzees and a spectacular association of more than 300 black-and-white Colobus monkeys (*Colobus angolensis ruwenzorii).* In addition, groups of blue monkeys *(Cercopithecus mitis)* and the Grey – chieked mangabeys (*Cercopithecus albigena*) also inhabit an array of habitats, from marshes to exposed rocks (Bahigi and Vedder, 1987; Fimbel *et. al.,* 2001). The flora is diverse with a dynamic mosaic of closed forest with the dominant species being *Parinari excelsa, Strombosia schefferi, Chrysophyllum sp., Entandrophragma excelsukm, Symphonia sp, Newtonia buchananii, Podocarpus sp* and *Ocotea sp.* The are aslo drier forest ridges and forest swamps dominated by *Carapa grandiflora, Syzygium guineense and Anthocleista grandiflora.*

3.2.3 Trends of forest degradation

Forest resources in Rwanda have steadily decreased over time, especially since the beginning of last century due to rapid population growth, a limited land base and increasing competition for resources. Ever since Rwanda became independent in 1962, the forest has receded at a rapid rate, despite the protective regulations, which have been in force from the days of the Belgian colonial administration to the present. In the period from 1958 to 1998, the mountain forest of Nyungwe shrunk from 114, 000 to 89,150 ha (MINAGRI, 1997). Table 3.1 shows approximately the trends of forest reduction in Nyungwe Forest Reserve from 1958 to 1998.

Table 3.1: Trends in Reduction of Nyungwe Forest

Period	Area (ha)	Reduction (ha)	Reduction(%)
1958	114,000	_	_
1970	108,800	5,325	4.7
1975	99,00	9,800	8.6
1980	97,000	2,000	1.8
1992	94,000	3,000	2.6
1996	90,000	4,000	3.5
1998	89,150	850	0.7

Source: MINAGRI, 1997

The current annual loss of 600 ha in the border zones is compounded by additional losses caused by felling and mining in the interior of the forest (Kleinert, 1985). The population pressure in outlying areas has encouraged farmers to seek alternative sources of income by turning to the forest. The main forms of encroachment include:

a) Reclamation of new land by carrying out planned and unplanned clearing of the forest. This is because when Nyungwe Forest Reserve was first designated as a reserve, population densities were low. Agriculturists were probably not present in the newly designated reserve area as the terrain was steep and the soil fragile and poor. But the population has increased due to a high local birth rate and largely due to immigration from other areas of Rwanda (Clay, 1998). This has led to the creation of the new arable land required for farming and settlements. The major problem is therefore the systematic conversion of part of Nyungwe Forest Reserve into agricultural land.

b) Mining activities: While agricultural activities have been a significant problem in the past leading to shrinkage of over 10 % of the reserve area, gold mining is another very destructive activity. Prior to the forest being designated as a national park, mining was widespread in the forest. With the new status of the forest, mineral prospecting and mining were not permitted. However, illegal mining of gold is still reported in the forest.

This activity has been the most challenging threat to the forest's conservation. Fifty percent of all the stream length evaluated in a study by Kristensen and Fimbel (1994) in Nyungwe Forest Reserve was negatively impacted upon by gold mining especially around watersheds.

Apart from the obvious destructive effects to the local hydrology and stream ecosystems, the miners engage in other destructive activities such as

poaching and illegal tree felling in order to supplement their incomes. Plate 3.1 shows a site degraded by gold extraction in Nyungwe Forest Reserve.

Plate 3.1: Gold mining in Tangara river in Nyungwe Forest

c) Illegal tree felling and selective wood harvesting especially the " creaming" of valuable hardwoods by pit-sawers have been practiced throughout the Reserve's history. Plate 3.2 shows a pit-sawing site at the edge of Nyungwe Forest Reserve. Although hand-cutting and pit-sawing of timber trees has been suggested as a more effective use of the resources because it would cause little damage to the forest given low labour cost (Serageldin, 1990), the selective small-scale logging has led to the over-exploitation of a number of species such as *Olea hochstetteri* and *Entandrophragma excelsa* even though there has been no commercial logging.

Plate 3.2: A pit-sawing site at the edge of the forest in Gatare commune

d) Poaching is having a major impact on the population of large mammals in Nyungwe Forest Reserve. Many animals such as buffalos are reportedly extinct. The last population of elephants was estimated at about ten since this animal was the most targeted (Gapusi, 1999). Poaching not only leads to reduction or disappearance of fauna but also to the alteration of forest ecosystem. Most plant species occur at low densities in tropical forests and some depend on animals for pollination and seed dispersal (Freedom, 1990). In addition, animal populations are important as pests predators and they provide other ecological services. Unfortunately the animals which are mostly hunted in Nyungwe Forest Reserve are also the most important seed

dispersers. The most poached are *Tragelaphus scriptus*, *Cephalophus sp*, *Hylochoerus meinertzhageni* and *Atherus africanus*.

Besides human encroachment, natural disturbances such as landslides are also contributing to Nyungwe forest's degradation. Steep slopes in the forest are especially vulnerable and the roads bisecting the reserve also contribute significantly to the initiation of landslides. Large quantities of soil are eroded during rainy seasons leaving the soil bare with the possibility of invasion of *Pteridium aquilinium and Sericostachys scandens* which pose a challenge to ecological rehabilitation. Plate 3.3 shows a landslide in Nyungwe Forest along the road.

Plate 3.3: Landslides in Nyungwe Forest

3.2.4 History of forest conservation

Conservation initiatives started in 1933, when Nyungwe Forest was declared a reserve and clearing of the forest for agricultural and construction purposes was prohibited (Schnitzler and Fourrier, 1993). This restriction was only marginally effected since regulations were undefined and enforcement minimal. Very little changed in the level and extent of the exploitation from the time when Nyungwe was declared a reserve until the early 1980's.

In order to prevent further destruction of the natural forests, including Nyungwe Forest Reserve, an action plan (*Plan d'Action)* was drawn. The action plan called for multiple use defined as follows:

a) Nature Reserve taken as a core unit with 40% of the reserve's total coverage with the intention of protecting the greatest biological and ecological importance. In this area, only non-extractive activities such as tourism and research were proposed.

b) Multiple use zones: Two multiple use zones border the natural reserve on both sides. These zones comprise 50% of the reserve's total area. They were some of the most degraded lands. Although they had been initially delineated, these zones had not yet been defined in this action plan.

c) Buffer zone: this is a buffer plantation of trees surrounding most of the reserve consisting largely of exotic species such as *Pinus patula*, *Eucalyptus spp* and *Cypressus lusitana*. The buffer covers the remaining 10%.

Currently, Nyungwe Forest Reserve is managed by the Rwandan Office of Tourism and National Park (ORTPN) in collaboration with the Nyungwe forest Conservation Project (PCFN). This project focuses on different aspects of conservation and research such as eco-tourism, local education and extension programmes as well as the general inventories of plant and animal species. It also engages in the training of the Rwandese people in all aspects of forest conservation.

3.3 Background of Cyangugu Prefecture

Nyungwe Forest Reserve is surrounded by Gikongoro, Kibuye and Cyangugu prefecture. The study was carried out in Cyangugu Prefecture which occupies an area of 2330 km^2 with 684 km^2 covered by forests and water. Located in the South- western part of the country, it is subdivided into 11 communes with 115 sectors (Delepierre, 1980).

3.3.1 Population

Prior to the civil war of 1994, which resulted in the death of thousands of people and the migration of many more, Rwanda was one of the most densely populated countries in Africa and still is up to now. The census of 1991 gave a population of 7.2 million (Campbell *et al.*, 1994).

The population size in Cyangugu as in many parts of Rwanda has increased dramatically. The population of Cyangugu was estimated at 514.656 in 1991, 472,000 in 1996 and 575,000 in 1997 with a density of 289 persons/ km^2 (Service National de Recensement, 1991; MINAGRI, 1998).

3.3.2 Rainfall and Climate

The Zaire –Nile Divide region is covered by mountain forests with rainfall being higher in the west (1,800mm/year) and lower in the east (1,500mm/year)(Gotanègre *et a.l.*, 974). A seasonal regime characterised by a major dry season from June to September, a short rainy season from October to December, a relatively dry season from January to February and a long rainy season from March to May is found over most of the country.

3.3.3 Soils

Soils in Cyangugu are mostly derived from volcanic and metamorphic rocks. They are generally deficient in nutrients and are moderately to strongly acidic (PH 3.7- 4.8). The region is mountainous with steep slopes. As a result, there is a high rate of erosion due to reduction in protective vegetation cover and viable soil structure (Gotanègre *et al.*, 1974).

Hillsides are so steep that rainfall causes surface run-off from areas devoid of vegetation or ground cover. The slopes are not only steep but also frequently quite long.

3.3.4 Land use and farming in the area

There are two major land use zones in the area:

3.3.4.1 Zone between altitude of 1,850 to 2,600m

In this zone, soil fertility is generally low as indicated by the yield obtained at the end of each season. In Rwanda generally, the steepest area have traditionally been reserved for pasture, woodland and minor crops and frequent fallow periods were commonly required (Den Biggelaar, 1996).

Population growth and increase in land scarcity has forced farmers to depart from their traditional system and cultivate in areas of low production. A consequence of farming on these steep slopes is the high

incidence of soil loss due to erosion with the effect of a decline in soil fertility. Once food crops are planted on freshly cleared forest soil, the yields are high only for the first and second season then they decline. In this belt crops such as Irish potatoes, peas, barley, wheat, tea and yam are grown. In the central zone with a high altitude, sweet potatoes and cassava are cultivated on marginal soils. A big part of non-cultivated land is covered by grass and herbs which are not palatable to either livestock or wild animals. These grasses and herbs are dominated by *Eragrostis boehmi* and also occur in cultivated areas as weeds (Delepierre, 1980).

3.3.4.2 The zone between 1,600m - 1,850 m

Yields in this part are higher than in other parts of the prefecture. This is because the relief is more gentle and this zone is characterised by clay soils of moderate acidity. On these fertile soils, beans, sorghum, corn, soya beans, bananas and coffee grow well (Den Biggelaar, 1996).

3.3.4.3 Livestock keeping

Livestock mainly include cattle, sheep, goats, pigs, poultry and rabbits. Few households in Cyangugu have large animals such as cattle due to the fact that they are labour intensive and require more land. Cattle are rarely sold because they act as a store of wealth, a mark of prestige, provide milk and manure and are needed for social activities mainly dowry. However, the rearing of small animals (goats, sheep and pigs) which require less land, labour and food is also not well developed. Economically crops are more important than livestock.

CHAPTER FOUR

RESEARCH DESIGN AND METHODOLOGY

4.1 Introduction

This study was conducted in Cyangugu Prefecture around Nyungwe Forest Reserve. The purpose was to collect data on non-timber forest products (NTFPs) obtained from the forest. The study was undertaken using a combination of qualitative and quantitative data gathering methods. The methods used in the field were largely based on PRA tools in addition to a survey of households. A household in this study comprised of parents, children and other members who live under the same roof.

4.2 Data Collection

The study was carried out in three stages between October 1999 and March 2000. The first was an exploratory visit, the second was reconnaissance survey and finally the main survey.

4.2.1 Exploratory Visits

Exploratory visits around the forest were used to verify the different problems facing the forest through direct observation and discussion with the staff of the Rwandan Office of National Parks (*Office Rwandais des Parcs Nationaux*) (ORTPN) and Nyungwe Forest Conservation Project (*Projet de la Conservation de la Forêt de Nyungwe*, PCFN). This was deemed essential to getting an overall picture of the situation in the survey environment.

4.2.2 Reconnaissance Survey

Following the exploratory visit, a reconnaissance survey was undertaken. An open meeting was held with the Council Committees at each sector (Location) level. The objectives of the reconnaissance survey were to establish rapport and provide information about the study to the local community in the areas the survey was to be carried out, to pre-test questionnaires used in this survey and to identify key informants. At this stage, the aim was to identify groups or individuals using the forest for various purposes.

The different key informants identified were traditional medical practitioners (TMPs) including general traditional healers, veterinary traditional practitioners and midwives. Wood-carvers, beekeepers, children as well as the Batwa (see box 2.3) were also interviewed. Children were considered as key informants because they are the main firewood collectors from the forest in the study area while the Batwa were interviewed because of their extensive knowledge of the forest.

4.2.3 The Main Survey

After identification of the main user groups of NTFPs, the questionnaire and participatory rural appraisal tools were used to collect detailed information. Questionnaires enabled the researcher to gather socio-economic information about households and the general use of the forest. Because of the high level of illiteracy, the questionnaires were administered as interviews at the

respondents' homesteads and lasted an average of one hour. A household was used as the sampling unit.

Members of the households selected were interviewed to obtain detailed qualitative and quantitative data about the use and collection of forest products as well as their marketing. The data collected from the households included literacy level, family size, the size of land holding and the number and type of animals reared by the family (Appendix 1).

For qualitative data collection, PRA methods were utilised as described by Theis and Gradys (1991) with the different key informants in the study area. Table 4.1 presents the key informants in the study area and their activities.

Table 4.1: Key informants and their activities in the study area

Key informants	Gender	Activities
Children	Male and female	Collection of firewood and edible plants mainly fruits
Basket makers	Female	Basket and mat weaving
Traditional medical practionners (TMPs):		
Midwives	Female	Care of pregnant women and the new borns.
General TMPs	Male (and to a less extent female)	Human health care
Traditional veterinary	Male	Veterinary health care especially for cattle.
Wood carvers	Male	Beer boats, mortars and bee hives
Batwa	Male	Collection of firewood for sale and edible plants
Beekeepers	Male	Beekeeping and making of bee-hives

Source : Field work 1999/2000.

According to Casley and Kumar (1988), PRA is a technique that adopts a rapid approach to data gathering and actively promotes participation of the

stakeholders. It relies heavily on the local community and indigenous knowledge. PRA is derived from Rapid Rural Assessment (RRA) and is based on the assumption that researchers and local people can gain considerable insights on the opportunities and constraints by analysing community resource management. During PRA, information was gathered from selected participants in order to understand the use of NTFPs around the forest through different PRA tools described below.

4.2.3.1 Semi Structured Interview (SSI)

SSI is an interview technique where only some questions and topics that need to be covered are predetermined. New questions can arise in the course of the interview (Theis and Gradys, 1991). SSIs were held with 18 TMPs to get information on plants used by these key informants because these specialists were not willing to discuss their activities in a group. A list of topics and questions used as an interview guide to be followed during the interview is shown in Appendix 2.

4.2.3.2 Focus Group Discussion

Focus group discussions, also called in-depth interviews are tools of participatory research conducted to obtain specific types of information from clearly identified sets of individuals. By bringing together individuals with similar backgrounds, it adds depth to the responses obtained in the structured survey (Steward and Shamdasani, 1990). Conducting the focus group discussion is a basic participatory research technique and it is especially useful

as part of "participant observation" approach, where the researcher spends time with the community, making direct observation and discussing with the community (Borrini-Feyerabend and Buchan, 1997).

In each commune, 2 focus group discussions were conducted in groups of 8 people either male or female for every key informant type. Groups of mixed gender often give rise to different outcomes and group dynamics than do single sex groups (Steward and Shamdasani, 1990).

4.2.3.3 Transect Walks

Transect walks were an efficient and simple participatory tool that enhanced the knowledge of local issues among all participants and was used to identify features not previously noted because local informants may have assumed the researcher knew about them (Borrini-Feyerabend and Buchan, 1997). This was done in the village to identify some aspects of the environment like physical and social features among others. It helped the researcher to verify the information gathered previously through direct observation and discussions with people met along the way.

4.2.3.4 Forest Walk

Forest walks consisted of observation walks in the forest accompanied by a number of selected forest users while recording how plants were harvested and which parts were being removed. The species used were collected for identification. At the same time, the different disturbances in the forest were

noted. The identification was made using taxonomic literature (Troupin, 1982). The specimens were deposited at the herbarium of the Institute of Scientific Research and Technology "*Institut de Recherche Scientifique et Technologique*"(IRST).

4.2.3.5 Market Survey

Market surveys were conducted in two different seasons to find out which plants collected from the forest were harvested for commercial purposes and to assess the economic value of forest products sold. The prices were found out at the local market and during interviews for products sold seasonally.

NTFPs which were not marketed but exchanged through the system of gifts, barter or used for subsistence required other assessment (Lampietti and Dixon, 1995; Emerton, 1996). According to these authors, the best method of valuation was to make use of prices that exist for equivalent products of the commodity concerned. For example a product which had no market price but may be bartered for a product on sale. Alternatively the value of a close substitute which had a price was used. In addition to the use of the prices in the markets, PRA was also used to assess socio-economic valuation.

4.3 Sampling Methods and Population Survey

Nyungwe Forest is surrounded by a total of five *communes* which are Kagano, Karengera, Busozo, Gatare and Kirambo in Cyangugu *prefecture*. The first two *communes* were excluded from the sample area with the assumption that since they were located near the conservation headquarters, they were utilising the forest less for fear of being arrested. Figure 4.1 presents the three communes (Busozo, Gatare, Kirambo) where the study was carried out.

Within each *commune*, two *secteurs* (Locations) were randomly selected. To achieve broad representation, households were stratified on the basis of wealth using selected indicators as recommended by *Secteur's* Council (Table 4.2).

Table 4.2: Indicators of wealth in the study area

Rich	**Poor**
More than 10 cattle	No cattle
With land	Landless
Cash crop (coffee)	Labourers
Salaried employed	Unemployed

Source: Field work, 2000

A household that fell neither in the rich nor poor category was taken as intermediate. A total of 90 households were sampled, 30 from each commune. Households were selected with an equal number in each category of wealth using simple random sampling in which every category has an equal chance of being selected. A simple random sample is generally said to be statistically efficient in that it generates a representative sample by giving an equal chance to every element of the sample (Barnett, 1991).

4.4 Statistical Analysis

Data analyses were divided in two categories: Descriptive and inferential statistics.

4.4.1 Descriptive Statistics

Descriptive statistics were used to summarise the respondent characteristics and the socio-economic situation of the 90 households surveyed in the study area as well as the plants identified and their uses. Graphs, tables and descriptive numbers such as frequency, percentages were used.

4.4.2 Inferential Statistics

The purpose of inferential statistics was to provide an idea about whether the patterns described in the samples were likely to apply to the population from which the samples were drawn (Freund and Wilson, 1993). In this regard, regression analysis (linear and logistic regression) and correlation analysis were used to assess the relationship between socio-economic factors and NTFPs uses while ANOVA was used to test whether there was variation in mean of forest use between different localities and different wealth categories.

4.4.2.1 Analysis of Variance (Anova)

The ANOVA using SPSS programme was done to test 2 hypotheses:

1. There was no significant variation in use of NTFPs between the three localities.

2. There was no significant variation in use in NTFPs between the three groups of wealth.

F-significant was used to calculate whether the null hypothesis would be rejected at confidence level $P<0.05$ representing 95 % confidence level. If F-significant was less than or equal to 0.05, the Ho was rejected and the alternative hypothesis (population means being unequal) was accepted. The significance of the computed F-value was then assessed by comparing with tabulated critical value of F for P = 5 %. Differences existed only if the calculated F-value exceeded the critical value.

4.4.2.2. Pearson Correlation

Correlation coefficients (r) were calculated when variables could not be designated as being either X (independent) or Y (dependent). The correlation was used in this study to assess whether the use of the forest was correlated to any of the characteristic such as size of the family, household income, education level among others. In a correlation matrix which presented in summary the relationship between different variables, pearson correlation coefficient was used to measure the direction and the strength of relationship between two variables and to indicate whether the two variables were related across the sample of units.

The coefficient of determination (R^2) described as a measure of variation on the dependent variable as explained by the independent variable (s) in a regression equation.

4.2.2.3 Linear Regression

This was used to predict the different variables having influence on the quantity of firewood consumption and bean stake use. A linear relation between the two variables y and x was expressed using the simple linear regression model:

$$y = a + b\,x$$

Where a : is intercept

b : is the coefficient measuring the slope of the line that represents the relationship.

4.2.2.4 Logistic Analysis

Because the data of medicinal plant use was dichotomous, binary choice models were used which assumed that individuals are faced with a choice between two alternatives and the choice they make depends on the characteristics of the individuals ((Freund and Wilson, 1993).

Therefore, logistic regression was used to investigate the relationship between household variables and the households' dependency on medicinal plants. The purpose of this model was to determine the odds (probability) of whether a

household was to use medicinal plants or not, given certain characteristics such as land size, age, education level and income. The model involved the dependent variable assuming a binary (1) and (0). The response variable only has (1) if the response is yes (use of medicinal plants) and (0) if the response is no (no use of medicinal plant). The predicted equation used was:

$$\log \frac{\prod(x)}{1-\prod(x)} = \alpha + \beta xi$$

In the curve displayed by the logistic model, the parameter β determines the rate of increase or decrease of the curve. As x increase, Πx approaches (1) if $\beta>0$ or approaches (0) if $\beta<0$, Πx being the probability of the event occurring (Freund and Wilson, 1993).

The logistic equation was transformed in alternative logit model that refers directly to the probability that a randomly selected subject makes the responses "Yes", this probability may vary according to the value of the independent variables (Freund and Wilson, 1993).

$$\prod = \frac{\exp(\alpha + \beta xii)}{1 + \exp\ (\alpha + \beta xi}$$

CHAPTER FIVE

RESEARCH FINDINGS AND DISCUSSION

5.1. Introduction

This chapter presents results of the fieldwork carried out in Nyungwe Forest Reserve. The results are presented in five sections. The first part deals with socio-economic characteristics, giving an overall picture of the situation in the study area. The second part assesses attitude and perception of the local people toward conservation of Nyungwe Forest Reserve. This was done to assess the importance of the forest to the local people. The third part details the forest resources harvested and their uses. Finally the value of the most commonly used NTFPs and the ecological impact of harvesting are presented. The different factors that influence the use of NTFPs are also examined.

5.2. Socio-economic Status of Households in the Study Area

5.2.1 Household Characteristics in the study area

Two thirds of the household heads interviewed were between 25-50 years while 29% were between 51-75 years old and 4% were between 76-90 years old. The average age of the respondents was 43 years. From the survey, 41.1% of the respondents had no formal education, 46.7% had gone to primary school and only 12.2% had reached secondary school with none of them having more than 3 years of secondary education. None of the interviewees had gone beyond secondary school.

However, from group discussions, it was established that most educated people migrated to urban areas in pursuit of employment opportunities. The socio-economic characteristics of households surveyed are summarised in Table 5.1 below.

Table 5.1: Household characteristics

Variable	Number of households (n)	Percentage (%)
Age of household head		
25 - 50	60	66.7
51 - 75	26	28.9
75 – 90	4	4.4
Education level of household head		
None	37	41.1
Primary level	42	46.7
Secondary level	11	12.2
Post secondary	0	0
Origin		
From the region	69	76.7
From outside	21	23.3
Family size		
Below 5 persons/family	47	52.2
Between 5-10 persons /family	39	43.4
Above 10 persons /family	4	4.4

Source: Field work (2000)

In other rural parts of Rwanda, in Gikongoro Prefecture, for example, Den Biggelaar (1996) found that about 70% of the respondents had only 4 years of primary education.

Most respondents (76.7%) were original inhabitants of the study area while 20.3% emigrated from Gikongoro on the eastern side of Nyungwe Forest Reserve and 4% were from Burundi, in the South.

The average family in the survey area had 5.51 members with 52.2% of families having less than 5 people, 44.4% between 5-10 people and 4.4% consisted of more than 10 members.

5.2.2 Land tenure and land use systems in the study area

The results of land tenure and land use are based on a household survey and were verified by observations during the transect walks. Almost all farmers (96.7%) got land through inheritance and 2.1% had bought more land in addition to what they inherited from their parents. The few cases of land transactions are due to the fact that the lands outside the individual farm *(urugo)* holdings belong to the government. This land cannot therefore be bought or sold by individuals. In addition, the inherited land is barely sufficient for subsistence. Land leasing is not common; only 1.1% of the households leased their land. Those without land offer casual labour in order to get money or food in return.

The land sizes in the area were generally small. On average one household cultivated 1.7 ha. The majority (65.6%) of farms were less than 1.5 ha and 1.4% of respondents were reported to be landless. This scarcity of land was also observed by Den Biggelaar (1996) who reported that more than 55.5 % of the households surveyed cultivated less than 0.25 ha of land with only 14 % of the household cultivating more than 1.5 ha in Maraba *commune,* of Butare *Prefecture.*

Farming and livestock were the major forms of land use. Farming was predominant with nearly all households (97%) engaged in farming. One fifth of the households (21%) raised cattle and two thirds (62%) of respondents kept small domestic animals such as sheep, goats, pigs and poultry. The major crops identified in the fields were bananas (*Musa sp*), beans (*Phaseolus vulgaris*), sweet potatoes (*Ipomoea batatas)*, cassava (*Cassava esculenta*), arrowroots (*Maranta arundinaceae*) and sorghum (*Sorghum bicolar*). Only 12% of the households grew vegetables. The smallholder agriculture and livestock farmers are frustrated by severe land scarcity and degradation, and complained about declining land productivity.

From group discussions, it was established that the use of fertilisers was rare. The study results concur with a report of the World Bank (2000) which indicated that the use of fertilisers at the national level was exceptionally low in Rwanda compared to other countries. The report further observed that in 1997, it was estimated that only 100g were used per hectare per year compared to 6,100g used in Burundi and 27, 800g in Kenya. The use of organic manure was also reported to be exceptionally low. This can partly be explained by the low number of cattle raised by the local community.

5.2.3 Source and levels of income

The income levels in the study area were very low with almost half the population (46.7%) earning less than 1000 FRW (3 USD) per month and 22.2% between 1000-5000 FRW (3-15 USD) per month. Only 3.3 % earned more than 15,000 FRW (45 USD).

Table 5.2: Levels of income of respondents

Level of income	Percentage (%)
1,000 FRW (3 USD)	46.7
1,000- 5,000 FRW (3-15 USD)	11.1
5,000-10,000 FRW (15-30 USD)	8.9
10,000-15,000 FRW (30-45 USD)	7.8
15,000-2,000 FRW (45-60 USD)	3.3

Source: Field work (2000)

Most households interviewed grow food crops for subsistence and only a few (10%) sold small quantities of their produce. Agriculture and livestock keeping, although unreliable and on small scale, were considered the major sources of income. The results are similar to those from other parts of Africa where farming is the predominant activity for rural populations. In Kitui district, Kenya, it was found that 37.8% of respondents reported subsistence farming as the major source of income (Kaudia, 1996) while in Malawi, most of the farmers (67.6%) reported to derive their income from agricultural produce (Kaaria, 1998).

However, in the study area, gold mining was reported to have been a major income generating activity, principally in Busozo. From group discussions, it was reported that from 1994, security controls were

intensified due to insecurity in the region. This activity has never been legal, but prior to the war in 1994, mining was an important economic activity with a high number of miners reported in the Nyungwe Forest Reserve. According to Kristened and Fimbel (1994) more than 2500 miners were found in the forest in 1993.

5.3 Attitudes and Perceptions toward Nyungwe Forest Reserve

The responses are from 90 households surveyed and are presented in three categories which are conservation status of the forest reserve, benefits of forest conservation and costs of conservation as perceived by the local community surrounding the forest.

5.3.1. Status of Nyungwe Forest Reserve Conservation

The study found that 87% of respondents were in favour of conservation of Nyungwe Forest Reserve. The results are consistent with other studies regarding the attitudes of local people towards the establishment of protected areas in Rwanda and other parts of Africa. Harcourt *et al.*, (1986) state that over three-quarters of farmers living adjacent to Virunga National Park in Rwanda were opposed to the government making forestland available for cultivation.

Similarly Infield (1988) found that only 6% of the local people living adjacent to the Umfolozi/ Hluhluwe/Corridor Complex Game Reserve in Natal, South Africa supported the degazettement of this conservation

area. Additionally, Pennington (1983), in a survey of 527 Tanzanian secondary school students reported that 81% of the students were opposed to using national park land for crop cultivation. In the same area, Newmark (1991) found that 84% of the local people surveyed were against the degazettement of Kilimanjaro National Park and Forest Reserve. Mworia (2000) in a study carried out in Upper Imenti Forest Reserve (Meru, Kenya) also found that 85% of the respondents interviewed were for the management of the indigenous forest while 15% were for the sub-division of the forest for settlement and cultivation.

5.3.2 Benefits of Nyungwe Forest Reserve as perceived by local popultion.

Table 5.3 presents the results of benefits of the forest reserve as perceived by the local community.

Table 5.3: Benefits of Nyungwe Forest Reserve.

Benefits of the forest	Busozo N= 30	Gatare N= 30	Kirambo N= 30	Frequency N=90	Percentage (%)
Improvement of rain fall	28	22	20	70	77.7
Source of income for government	9	6	7	22	24.4
Stabilisation of the climate	4	3	6	13	14.4
Source of medicine	1	-	8	9	9.9

Source: Field work, 2000

From the field survey, it was found that there was a high level of awareness of the key role of the forest in environmental protection, especially in improving rainfall (77.7%), generating revenue through tourism (24.4%) and improving microclimate (14.4%).

Similarly, Newmark (1991) reported that the protection of Kilimanjaro Forest was supported by 55.1% of the local people because it influenced rainfall and protected the watersheds. Similar findings were given in Ruwenzori where 70% expressed their desire to have large forests nearby because they improve rainfall while 20 % stated that it was because they stabilise the climate (Sayer *et al.*, 1992). In a study done by Kajembe and Kessey (2000) in the Urumwa Forest Reserve (Tanzania), the local community surrounding the reserve ranked rainfall first as contributing to household livelihoods. However, in South Ghana the forest was seen as a source of rainfall only by 15 people out of 226 respondents (Arnold, 1995).

5.3.3 *Cost of forest conservation*

Table 5.4 summarises the cost of the conservation borne by the local community, particularly through the loss of access to forest resources.

Table 5.4: Cost of forest conservation as perceived by the local Community in the study area

Cost of forest conservation	Busozo	Gatare	Kirambo	Frequency	Percentage
Lack of bush meat	8	10	12	30	33.3
Lack of gold	20	-	5	25	27.7
Lack of firewood	4	5	15	24	26.6
Lack of agricultural land	10	8	6	24	26.6
Lack of bean stakes	4	5	14	23	25.5
Lack of bee hives	5	8	7	20	22.2
Lack of beer boat	12	3	4	17	18.8
Lack of mortar	7	5	3	15	16.6
Crop damage	_	_	14	14	15.5
Lack of honey	_	6	4	10	11.1
Lack of medicinal plant	_	_	2	2	2.2

Source: Field work (2000)

The lost opportunity of obtaining bush meat was the most mentioned by the local community (33.3%), followed by the prohibition of gold extraction (27.7%), lack of agricultural land (26.6%) and firewood (26.6%). The local community also recognised problems associated with living close to the forest of which the most severe was raiding of crops by wild animals (15.5%).

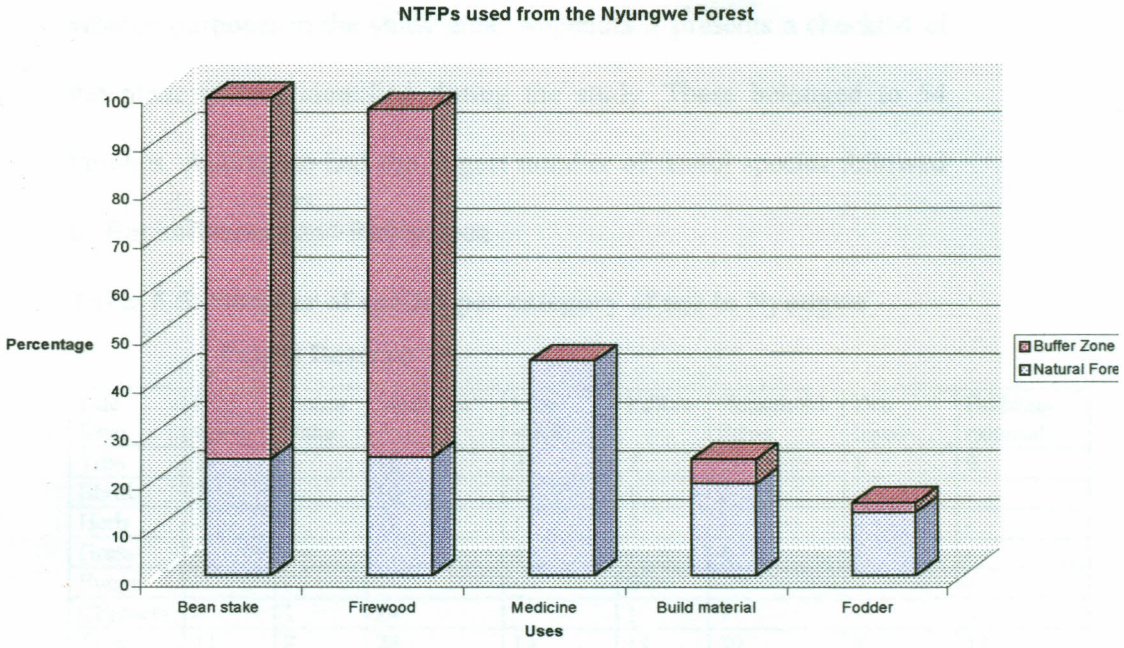
The same situation was found in Uganda in Mgahinga Gorilla National Park and Bwindi Impenetrable National Park where local farmers surrounding those parks perceived park management as ineffective because it was making little effort to help communities whose crops were damaged by baboons, gorillas and buffalos (Wild and Mutebi, 1996). In Kakamega District, the destruction of crops by wild animals such as monkeys and baboons was given as a reason for converting swamps in Mumias to agricultural land in order to clear the remnant habitats for these animals (Nambiri,1996).

5.4 Forest Utilisation

5.4 1. *Types and origin of plant uses*

The survey established that local people relied on Nyungwe Forest for a variety of uses. Figure 5.1 shows NTFPs collected from two management categories within Nyungwe Forest Reserve.

Figure 5.1: NTFPs harvested from Nyungwe Forest Reserve



The most common NTFPs used were crop stakes (98%) followed by firewood (96%) and medicinal plants (44.4%). Other uses included materials for handicrafts such as baskets and sleeping mats as well as fodder for livestock and beekeeping. These products were extracted from the natural forest and the buffer zone planted with *Eucalyptus spp, Pinus patula, Cupressus lusitanica* and *Grevillea robusta.*

5.4.2 Plant species used

The study recorded 104 indigenous and exotic plant species used for various purposes in the study area. Appendix 3 presents a checklist of the plant species identified during the study. These belonged to 54 families. Asteraceae had the largest number of useful species followed by Euphorbiaceae and Rubiaceaea.

Table 5.5: Number of species per category of use in Nyungwe Forest Reserve

Life form	Fire wood	Beans stake	Medicine	Live stock	Edible	Household items	Bee hives	Building material
Tree	19	3	18	8	2	11	8	9
Shrub	2	4	10	1	1	2	-	-
Herb	-	-	22	1	2	1	-	-
Grass	-	-	-	4	-	4	-	-
Fungi	-	-	-	_	6	-	-	-
Climbers	-	1	24	_	1	7	-	3
Total	21	8	74	14	12	30	8	12

As shown in Table 5.5, in terms of the number of species extracted, medicinal plants were the most extracted from the forest followed by plant species used for household items. These findings are not far from those of other similar studies. Waiganjo (1998) found 175 forest species used for NTFPs in Ragati forest, Mt. Kenya Natural Reserve and most of them were medicinal plants (77 species). Beentje (1990) found 40% of plants identified in the same area as having medicinal value for the local community. Furthermore, out of 84 plant species identified as regularly used by forest dwellers in South West Mau, 65 different plant species were used as medicinal plants (Lubanga, 1991).

5.4.3 Use of crop stakes

The results found that crop stakes were mainly used to support beans (*Phaseolus vulgaris*). Plate 5.1 shows crop stakes used in a farm in the study area.

Plate 5.1: Bean stakes in a farm in Gatare *commune* in the Study area

Beans are a staple food in Rwanda and most households cultivate the climbing bean because it is more productive than the bush bean. Therefore bean stakes are very important for propping beans. Nearly all households (98%) interviewed used bean stakes obtained from the buffer zone. The species mostly used were *Pinus patula* (74.7%), *Grevillea robusta* (34.1%), *Cupressus lusitanica* (23.1%) and *Eucalyptus spp* (19 %). It was also noted by Twahirwa (1992) that, *Grevillea robusta* and *Pinus patula* were the most utilised by several farmers in other rural areas of Rwanda since the introduction of climbing beans in 1987. In addition, other species from the natural

forest were used. Table 5.6 shows the different plant species from the forest used as bean stakes.

Table 5.6: Indigenous species used for bean stakes in the study area

Scientific name	Vernacular name	Part used	Percentage (%)
Alchornea hirtella	Uruvobo	Stem	22,4
Macaranga neomildbraediana	Umusekera	Stem branch	19.8
Aeschynomene schimperi	Imihunga	Stem branch	6.2
Pycnostachys eminii	Imitsinduka	Branch	4.4
Albizia gummifera	Umusebeya	Branch	3.9
Syzygium parvifolia	Umugote	Stem	2.2

As shown in Table 5.6, the species *Alchornea hirtella* was found to be the most preferred (22.4%) species from the forest for bean stakes followed by *Macaranga neomildbraediana* (19.8%). Similarly *Alchornea hirtella* was also found to be widely used by Bakiga surrounding Bwindi Impenetrable Forest in Uganda (Cunningham, 1993; Muhwezi, 1997).

5.4.4 Firewood

Firewood was found to be the major source of energy for cooking by the local communities around Nyungwe Forest. During the survey, it was found that all households were using firewood for fuel. Of all the respondents, 75.6% extracted firewood from the buffer zone while 24.4% obtained it from the natural forest. The species mostly collected for firewood in the buffer zone were *Eucalyyptus spp* (50%), *Pinus patula* (46.9%), *Grevillea robusta* (25%) and *Cupressus lusitanica* (20%).

In a similar study by Waingajo (1999), it was observed that the exotic plants were heavily utilised as non-timber forest products for fuel wood in Ragati Forest. The study further indicated that *Eucalyptus spp* was the most extracted for this purpose. This is also supported by Cunningham (1992) who showed that most of the firewood used by the local community surrounding Bwindi Impenetrable Forest was from cultivated trees and only a small portion (7.5%) was extracted from the natural forest.

Firewood from the buffer zone was supplemented by dead wood collected from the bush and the forest. This was supported by field observation made elsewhere by Hamilton and Bensted (1989). It was noted that only dry wood was collected from the forest in East Usambara Reserve in Tanzania.

However, some indigenous species were preferred since they burn longer. It was found that 18 species were particularly valued as firewood. Table 5.7 lists the species collected from the forest for firewood and the percentage of users.

Table 5.7: Forest plants used for firewood (N=90) in the Study area

Scientific name	Local name	Percentage (%)
Faurea saligna	Imititi	17.2
Myrica salicifolia	Imisengese	15.6
Macaranga neomilbreadiana	Imisekera	15.5
Ficalhoa laurifolia	Imihumbo	10.9
Albizia gummifera	Imisebeya	6.3
Parinari excelsa	Iminazi	6.3
Olea hochsterri	Intobo	4.7
Agauria . salicifolia	Imikarakara	4.7
Syzygium parvifolium	Imigote	3.1
Dichaenomene corymbusa	Imihube	3.1
Carapa grandiflora	Umushwati	3.1
Alchornea hirtella	Uruvobo	1.6
Bridelia micrantha	Imigimbu	1.6
Harungana Montana	Imishayishayi	1.6
Ocotea michelsoni	Umuganza	1.6
Entandophragma excelsum	Imiyove	1.6
Maesa lanceolata	Imihanga	1.6

From the table above, it was found that the predominant species preferred for firewood was *Faurea saligna* (17.2%) followed by *Macaranga neomilbreadiana* (15.5%) and *Myrica salicifolia* (15.6%). Felling trees for firewood was rare. Instead, pruning of branches was much practised by children since they could not be arrested. Plate 5.2 shows children carrying firewood.

Plate 5.2: Children carrying firewood gathered from the buffer zone in *Kirambo commune (Cyangugu).*

study also indicates that the Batwa were involved in gathering firewood mainly from the natural forest for exchange with food from other communities. This was also observed in Bwindi Impenetrable Forest (Namara, 2000). Plate 5.3 shows Batwa from Nyungwe Forest Reserve with firewood.

Plate 5.3: Batwa with firewood gathered from the natural forest in *Gatare (Cyangugu)*

During the survey, it was observed that firewood was mainly for home consumption though it was also sold in the market or near shopping centres to a lesser extent. In almost all cases (97.7%), individual families gathered their own firewood from the bush, communal lands, in the buffer zones and to some extent from the natural forest. The same situation was observed in other rural areas in the country by Hategeka (1997), who found that generally wood for heating in these areas was not bought or sold. He further found that only 1.8% of households surveyed were selling wood for heating at local markets along the roads and near restaurants while 2.9% bought it. This supports the observation of Kaale (1990) that use of rural domestic fuel is informal and largely non-commercial.

5.4.5 Medicinal plants

The natural forest plays an important role as a reservoir of medicinal plants. During the study, 76 plants of medicinal value for the local population were recorded. The medicinal plants identified were used to treat 14 ailments in addition to providing protection against evil spirits. The diseases treated were intestinal diseases (49.3%), skin diseases (19.4%), birth related problems (11.6%) and illnesses believed to be caused by evil spirits (10.3%). Table 5.8 summarises plant species used for medicinal purpose.

Table 5.8: Plants used in traditional medicine

Scientific Name	Local name	Part used	Reported in treatment of
-	Umudomo	Leaves	Liver illness
-	Kamaramahano	Bark	Skin disease
-	Ubugomboro	Leaves	Snake bite
Alangium chinense	Intogota	Leaves Bark	Poison
Albizia adianthifolia	Umusange	Leaves	Intestinal disease
Ancylobotris amoenahua	Umukamira	Leaves	Intestinal disease
Anisopappus africanus	Umuretezo	Leaves	Delay in delivery
Basella alba	Indarama	Leaves	Intestinal disease
Begonia meyeri-Johannis	Irebe	Leaves	Skin disease, evil spirit
Bidens pilosa	Inyabarasanya	Leaves Stem	Delay in delivery Diarrhoea
Bridelia brideliifolia	Umigimbu	Bark, Roots	Skin disease, Poison
Canthium oligocarpum	Umushabarara	Bark	Intestinal worms and general stomachache
Carapa grandiflora	Umushwati	Bark, Fruits	Intestinal worms, Dysentery
Carduus nyussanus	Mugaboudasumirwa	Leaves	Skin disease

Clematis hirsuta	Ubugomboro,Umunkamba	Leaves	Poison, Snake bite, Intestinal worms
Clerodendrum johnstonii	Igikumbuguru	Leaves	Intestinal worms
Clerodendrum myricoides	Umukuzanyana	Leaves, Roots	Skin disease, Dysentery Diarrhoea
Zanthoxyrum abyssinica	Umutarisonga	Leaves	For rapid delivery
Cordia africana	Umuvuzangoma	Bark, Leaves	Decrease in potence for males
Crassocephalum picridifolium	Isununu	Leaves	Intestinal disease
Crassocephalum sp	Igifuranindi	Leaves	Intestinal disease
Croton megalocarpus	Umunege	Leaves	Delivery of cattle
Dichapetalum heudelotti	Umumenamabuye	Roots, Leaves	Intestinal worms, Liver illness
Dracaena afromontana	Umuhati	Leaves	Diarrhoea
Embelia abyssinica	Umukaragata	Leaves	Abortion, skin disease
Entandrophragma excelsum	Imiyovu	Bark	Dysentery
Fagara chalybea	Intareyirungu	All the plants	Skin disease, Women delivery
Ficus thonningii	Umuvumu	Bark Leaves	Evil spirit , Dysentery
Garcinia volkensi	Umusuli,Urungutu	Leaves	Intestinal disease
Gouania longispicata	Umubimbafuro	Leaves	Intestinal disease
Impatiens purpureo	Indondori	Leaves	Intestinal disease
Ixora burundensis	Ikinesha	Leaves	Skin disease
Harungana madagascariensis	Umushayishayi	Leaves Bark	Diarrhoea
Hygrophila auriculata	Buganga Bugari	Leaves	Skin disease
Lagenia sp	Umutanga	Leaves	Evil spirit
Leucas alluaudii	Akanyamapfundo	Leaves	Delivery
Lobelia anceps	Ubwungu		Snake bite
Lobelia giberroa	Intovu	Leaves	Constipation for cattle
Lobelia kiwoensis	Ubwungu	Leaves	Snake bite
Lysimachia ruhmeriana	Umuyobora	Leaves	Rapid delivery
Mikania cordata	Umugwantakara	Bark	Evil spirit
Mikania capensis	Umunkamba	Leaves Roots	Skin disease, Intestinal disease
Microglossa pyrifolia	Umuhe	Leaves Bark	Epilepsy
Mikaniopsis sp	Urugozi	All plants	Intestinal disease
Mikaniopsis tedlei	Umuhokoro	Leaves	Constipation

Maytenus acuminatus	Umunembwe	Leaves	Intestinal disease
Magnistipula butayi	Umunganza	Bark Leaves	Stomach-ache, Skin disease, Poisons
Maesa lanceolata	Umuhanga	Leaves	Skin disease, women delivery
Mimulopsis solmsii	Umunayu	Leaves	Intestinal disease, Skin disease
Mitragyna rubrostipulata	Umuzibira	Bark, Roots	Skin disease, intestinal disease
Momordica foetida	Umwishwa	Leaves	Skin disease
Myrianthotaxis orophila	Umuhashya	Leaves	Evil spirit
Myrica salicifolia	Umusengesi	Roots, bark	Skin disease, poisons
Ocotea usambarensis	Umutake	leaves	Dysentery
Olea hochstetteri	Intobo	Bark	Dysentery, delivery
Pendadesma reyndersi	Umwasa	Leaves	Liver illness
Pentas decora	Isagara	Leaves	Intestinal disease
Plectranthus luteus	Uruhahe	Leaves	Broken bones
Prunus africana	Umwumba	Bark, Leaves	Stomach-ache disease
Pycnospora lutescens	Agahisha	Leaves	Dysentery, taken by pregnant women
Senecio kanzibiensis	Ingurukizi	Leaves	Increase of potency for male, complicated pregnancy
Senecio nyungwensis	Imbatura	Leaves	Skin disease
Sericostachys scandens	Umukipfu	Leaves and stem	Abortion
Smilax anceps	Insuri	Leaves	Back-ache
Solanum nigrum	Isogo	Leaves	intestinal worms
Strombosia scheffleri	Umushyika	Leaves	Liver illness
Swertia calycina	Ubugomboro	Leaves	Against snake bite
Syzygium parvifolium	Umugote	Bark	interstinal worms
Rauvolfia mannii	Ikinesha	Leaves	Against evil spirit
Rapanea melanophloeos	Uruneke	Leaves, bark	Intestinal disease, cholera
Ryncostigma racemosa	Umushebeshebe	Bark	Against evil spirit
Rytigynia sp	Umushabarara	Bark	Intestinal disease

Tabernaemontana johnstonii	Umubalibali	Leaves	Intestinal disease
Thunbergia alata	Nkuriyumwonga	Leaves	Skin disease
Vernonia conferta	Umwerangabo	Bark, leaves	Dysentery, liver illness, evil spirit
Virectaria major	Urukiryi	Leaves	Skin disease
Volkensia glomerata	Uruhashi	Leaves	Intestinal disease
Zanthoxylum gilletii	Umuturirwa	Leaves	Skin disease

Source: Field work (2000)

From Table 5.8, it is apparent that the natural forest provides essential plants for traditional health care in the region. Although modern medicine was also trusted and used, certain illnesses were however almost exclusively treated with traditional medicine, 56.7% of the people interviewed revealed that they consult the traditional medical practitioners (TMPs) while 44.4% used medicinal plants to treat themselves. The study found that TMPs treated specific illnesses, including madness, snake bites, poisoning and hepatitis.

From Semi Structured Interview (SSI), it was found that the community believed that modern medicine is not as effective in treatment of some illnesses when compared to medicinal plants. The use of traditional medicine in the study area was built on such beliefs. Treatment of diseases was socio-culturally specific and was based on empirical knowledge. This shows strong links between medicinal use and cultural values in many societies (Posey, 1999). For example in Amazonia, Mats (1996) observed that Polynesian communities in the Samoan Rainforest, Peru, believed that some ailments were derived from supernatural powers and therefore could only be treated by traditional medicine.

Such values often underlie the division between use of modern and traditional medicine that was widely observed in the study area. When a disease was considered to be caused by natural factors, it was treated either by modern or traditional medicine while diseases believed to be caused by spirits are exclusively healed by traditional medicine. In such cases, plants acquired symbolic importance as treatment in conjunction with ritual practices. Therefore in most cases, the people of Cyangugu consult both modern medicine and traditional healers.

The same situation was noted in other parts of Rwanda by Puyvelde *et al.* (1982). The study found that the greatest part of the population initially consults the traditional healer before going to hospital. This was also pointed out by Kyoshabire (1998) in Uganda. She noted that patients occupied hospital beds while at the same time consulting traditional healers.

The traditional health care in the study area was divided into three groups: Simple illnesses that are normally treated in the family such as headaches, intestinal diseases and skin diseases. Plant species used to treat these ailments are commonly known and used by the majority. Similar findings were also observed by Falconer (1990). The study indicates that medicinal plants were widely used by non-healers to treat what the local community describes as simple illness commonly known by almost all households in the West African

humid forest zone. Caniogo and Sierbert (1998) found similar results in Kalimantan, Indonesia.

Another category of traditional health care was pre-natal care and child illnesses which were treated by midwives. Their services include antenatal care with medicinal plants widely used during the last months of pregnancy, assistance during delivery and postnatal care and treatment of childhood illnesses. The study indicates that most medicinal plants used by midwives in the study area were collected from fallow lands and from the bush. The role of weeds commonly found in disturbed areas in traditional medicine was highlighted by Stepp and Moerman (2001) in Chiapas, Mexico.

The fact that midwives in the study area harvested plants from outside the forest could be partly attributed to myths in the region which prevent women from going to the forest because it is said to be dangerous. The same situation was noted in South-Western Uganda (Kyoshabire, 1998).

Finally, illnesses which were believed to be complicated and could not be treated in the family required consultation of specialist traditional healers. Medicinal plants used by these specialists were dominated by plants collected from the forest because some illnesses such as poisoning were said to be healed by plants collected only from deep inside the forest as they were thought to be more effective than those collected from outside the forest.

The same situation prevails elsewhere in African societies. Medicinal plants collected by TMPs in the West African Humid Forest Zone were believed to be more effective than those collected near the homestead (Falconer, 1990). A good example is the herbaceous weed *Euphorbia hirta* used in the treatment of amoebic dysentery (Falconer, 1990). The plant collected in the wild was found to contain higher concentration of active constituents than that collected from cultivated areas.

The study established through SSI that in preparation of drugs for almost all ailments, the traditional healers used a combination of small quantities of several plants in which at least one had to come from the forest. This is in agreement with several studies; Puyvelde *et al.*, (1982) found that all the plants used to cure diarrhoea in Rwanda were used in combination. Similarly, Lebbie Guries, 1995 indicated that most medicinal plants were used in mixtures for particular afflictions in Kpaa Mende community in Sierra Leone. A study by Cunningham (1993) in Uganda showed similar results.

5.4.6 Food plants

Table 5.9 presents edible plant species identified in the field. The study found that the edible plant products harvested from the forest were mainly vegetables, fruits and mushrooms. The study also indicated that edible plants in the region represented a seasonal resource gathered by children, while collecting firewood and by the Batwa community. Earlier studies on forest food plants indicated that the collection of wild food was an opportunistic activity. For example, in

Kenya, Mworia (2000) found that most collectors were children and women looking for firewood inside the forest. Furthermore, Njoroge (2000) observed that children and herd boys were the consumers of wild fruits as snacks. Similar findings were supported by Riley and Brokensha (1988) among the Mbeere community in Kenya. Maundu *et al.* (1999) also observed that the most common use of food from the wild is consumption as snacks when herding cattle or working in the field.

Table 5.9: Plant species used for food in the Study area.

Family	Scientific name	Local name	Part used
Amaranthaceae	*Amaranthus sp*	Dodo	Stems and leaves
Basellaceae	*Basella alba*	Indarama	Stems and leaves
Dioscoreaceae	*Dioscorea sp*	Ibikoro	Tuber
Moraceae	*Ficus sp*	Umuvumu	Fruits
	Myrianthus holstii	Umwufu	Fruits
Passifloraceae	*Passiflora edulis*	Amatunda	Fruits
Rosaceae	*Rubus sp*	Inkeri	Fruits
Sapindaceae	*Pancovia golungensis*	Intiritiri	Fruits
Solanaceae	*Solanum nigrum*	Isogo	Leaves
Lentinaceae	*Lentinus prolifera*	Ibihumyo	Fungus
	-	Intyabire	Fungus
	-	Ubufu	Fungus
	-	Imegeri	Fungus
	-	Ibigote	Fungus
	-	Ubunyinya	Fungus

Source: Field work (2000)

The gathering of wild plants was found to be very important to the local community for several reasons. The study indicates that they are a source of income since some products such as mushrooms are sold. The sale of mushrooms was common in Busozo where they were bought by neighbours from Burundi. It was found that the most valued species was *Lentinus prolifer* which was said to taste like meat. *Myrianthus holstii* was also seasonally sold

near schools. This species was also found to be used in several communities adjacent to natural forests. In Upper Imenti Forest Reserve, Meru District in Kenya, Mworia (2000) noted that *Myrianthus holstii* not only acts as a source of food to the local communities but also as a source of income. Such observations were also reported from Bwindi Impenetrable Forest in Uganda where this species is used both as a dietary supplement as well as a source of income (Cunningham, 1992).

From the study wild foods play a significant role in the diet of children in the study area. Although nutrition was based on agricultural crops, forest plants are an important source of vitamins and minerals. Though the relative importance of these products in the diet has not been quantified, it is evident that wild fruits are sometimes the main source of vitamins and minerals. As noted by Cunningham (1996) in Uganda fruits are taken as a snack by children and in so doing they complement their diet in providing essential minerals and vitamins such as vitamin C from *Myrianthus holstii*. It was also noted that forest plants were consumed during periods of food shortage when agricultural crops are not sufficient. This was observed after the 1994 war when people resorted to using *Amaranthus sp* as vegetables. The same case was found by Njoroge (2000) in a similar study in Kenya where most of the respondents used leaves of *Amaranthus sp* during times of famine. Results of Cunningham (1996) also support the observation that the use of wild plants is generally limited to famine periods in Uganda. Maundu *et al.* (1999) also observed that food from a

wide range of traditional food plants makes seasonal emergency contributions to households food supplies.

The field survey revealed that forest foods such as vegetables and mushrooms are important in the lifestyle of the Batwa who barter them for staple food. The same observation was noted in Uganda in Bwindi Impenetrable Forest where the Batwa lived on foodstuffs exchanged with other communities (Cunningham, 1996; Muhwezi, 1999).

Finally, some wild vegetables were believed to have medicinal properties. This is the case of *Solanum nigrum* which was thought by the local community to have healing qualities for intestinal illness and was highly valued in the region. This practice is widespread in many African cultures whereby the distinction between what is consumed as food or medicine is not well defined. This observation is supported by Etkin (1997) who noted that the Hausa of Nigeria use certain plants as both food and medicine, including plants identified as having anti-malarial effect. Similarly, Balik *et al.* (1996) observed that the Maasai of East Africa cook the bark of *Acacia goetzei* (Mimosaceae) and *Albizia anthelmintica* (Mimosaceaee) with boiled meat, milk and blood for its cholesterol lowering effect. In a study carried out in West Africa, Falconer (1998) found that the popular vegetables such as *Vernonia amygdalina* (Asteraceae), *Piper guineensis* (Piperaceae) and *Pterocarpus spp* (Fabaceae) had wide application as anti-malaria drugs, while seeds of *Garcinia kila*

(Clusiaceae, bitter cola) were reputed as poison antidotes and were useful in the treatment of coughs and hepatitis.

5.4.7 Building Material

The field survey established that wood used for building traditional houses was usually found outside the reserve. It was found that only 8% obtained wood for building material from the buffer zone while 11% extracted plant species from the natural forest. Plant species from the buffer zone and outside the forest were dominated by *Eucalyptus sp* and *Arundinaria alpina.* These species were used to erect house frameworks while thatching was done with dry banana fibre or corrugated iron sheets. These observations are supported by results of Kanongo (1990) in Uganda where the author found that many houses were built using exotic plants, *Eucalyptus sp* being the most preferred. Cunningham (1993) further reported that harvesting from Bwindi Impenetrable Forest for thatching was negligible. Many houses were thatched with banana fibre or *Cyperus latifolius.*

However, this study established that some respondents preferred tree species from the natural forest for the framework. These forest plants are dominated by *Parinari excella*, *Entandrophragma excelsum*, *Macaranga neomildbreadiana*, *Ficalhoa laurifolia*, *Faurea saligna*, *Ocotea michelsonii* and *Symphonia globulifera.*

The building material almost exclusively collected from the natural forest were ropes while wood was extracted to a lesser extent. Species used for ropes included *Triumfetta sp*, *Dombeya goetzenii* and *Loeseneriella apocynoides*. Kessey (1998), in East Usambara, Tanzania also noted that in building materials, natural forests were mainly used to provide traditional ropes with *Dombeya sp* being the most utilised.

5.4.8 Household Items.

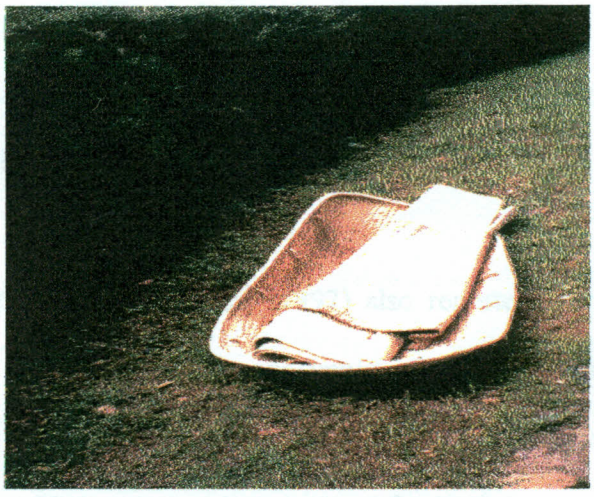
All households visited during the survey used at least one household item made from indigenous plants. A range of traditional household items included traditional beds, plates, winnowing baskets and traditional chairs, among others. According to several respondents, some traditional household items were losing their importance and were instead being replaced by plastic and sisal products.

However, the study indicated that there were some traditional items that were socially and culturally important according to the local community. For example, it was reported that mortars and mats could not be substituted because they play a significant role during wedding ceremonies. The most important items found in the study area are discussed below and Appendix 4 gives in details plant species used for household items in the study area.

5.4.8.1 Stretcher

Plate 5.4 shows a stretcher found in the study area. Although they were common in the study area, these stretchers originated from *Gikongoro* where bamboo is abundant in the forest. Stretchers were mainly made of *Arundinaria alpina* and *Smilax anceps.*

Plate 5.4: Stretcher with mat



These stretchers were socially important for transporting sick and weak people because modern medical facilities are far apart and transport network is not well developed in the study area. The role of stretchers was also highlighted by Cunningham (1993) and Muhwezi (1997) in the rural communities of Kigezi highlands, Uganda. They were referred to by the local communities as " "ambulances" for their role in carrying sick people to the hospital.

5.4.8.2 Mats and Baskets

The study found that there were several types of baskets ranging from those for harvesting, drying, winnowing and tea baskets for storing crops. All these baskets were handicrafts made by men except small baskets used as decoration which were weaved by women. Group discussion revealed that the forest was the main source of lianas used for basketry. Although baskets from bamboo were widespread, they were made in *Gikongoro* prefecture. The plants most commonly used in the study area were *Smilax anceps* (*Insuri*) and *Loeseneriella apocynoides* (*Imigega*). Besides basket making, these species were also used for making pot covers.

Cunningham (1993) and Muhwezi (1997) also reported that lianas such as *Smilax anceps* and *Loeseneriella apocynoides* were NTFPs mostly used as weaving plant material in communities around Bwindi Impenetrable Forest Park in Uganda. They were used as cordage, for binding, weaving outside of pots, making granaries and basketry. Both authors further noted that weaving of baskets was mainly done by men and rarely by women.

Mat weaving was also found to be very important in the study area. It was found that almost all households used mats as bedding and for sitting on. Plate 5.5 shows one the type of mat used in the study area. The importance of mats in rural society was also highlighted by Mats (1998) in a similar study in

Polynesian communities. He found that besides its role as bedding, it also had an important role in the traditional gift exchange.

Plate 5.5: Mat used for bedding and sitting in the study area.

The study also found that plant species from swamps were very important in providing grasses and sedges used for weaving mats. In most cases grasses for this purpose were harvested outside the forest in several swamps, but during the dry season, th were collected inside Nyungwe forest in *Kamiranzovu* Swamp.

5.4.8.3 Carved products

Carved wooden items found in several households include beer boats as well as mortars and pestles. Plate 5.6 shows mortar and pestle used for grinding and pounding while plate 5.7 shows a beer boat for brewing banana beer used for commercial purposes and during various traditional ceremonies in the study area.

Plate 5.6: Mortar used for pounding and grinding in the study area

Plate 5.7: Beer boat used for brewing beer in the study area

The study noted that plant species such as *Ocotea usambarensis* and *Tabernaemontana johnstonii* and *Prunus africana* were favoured for making items mentioned above. *Myrianthus holstii.*, *Ficus spp* and *Polyscias fulva* were also reported to be used. The two last species were also reported for

making mortar and beer boats used for the same purpose in the region surrounding Bwindi Impenetrable Forest (Cunningham, 1996).

The study also indicated that exotic species such as *Grevillea robusta* were sometimes used to make mortars. However it was not preferred because according to the local community, items made from exotic tree species were said not to last as long as those from indigenous trees. The same observation was noted with the community around Bwindi Impenetrable Forest by Cunningham (1996) for *Eucalyptus spp* which was considered to be unsuitable for making beer boats because they crack easily.

5.4.8 Bee-keeping

This activity was mainly carried out in the past before people were evacuated from the forest. It was an important activity in the region socially and culturally for the local community. Nyungwe Forest Reserve was considered as a source of nectar, tree species for hives and habitat for bee colonies. Group discussions established that beekeepers favoured hills near sources of water such as *Kamiranzonvu* swamp as sites for placing bee hives.

Based on durability and productivity, there were some species preferred for making beehives. The most favoured species was *Polyscia fulva* (umwungu) which is a secondary forest species preferred for its soft wood and its ease to dig out. *Dichaetanthera corymbusa* (umuhube) and *Alangium chinense* (intogota) as well as *Syzygium parvifolium* are also sometimes used.

In the study area, the main use for honey was for making traditional wine and it was also used for medicinal purposes. Honey was also an important source of income. Several studies have observed that in addition to honey being of great value, it is used for brewing beer and as medicine (Mworia, 2000; Njoroge, 2000). Burrow (1996) also highlighted honey as a major source of income in semi-arid parts of Kenya.

5.4.9 Plants used for fodder

In the study area, livestock keeping is not widespread. People owning cattle were among the most intensive users of forest plants. The study found that fodder was mainly harvested when palatable grass was scarce in farmland during the dry season. It was found that *Panicum calvum, Drymaria cordota* and *Triumfetta cordifolia* were the most collected. In Mount Kenya, Meru District, a study by Mworia (2000) noted that the majority of farmers raising dairy cattle cut and carry fodder to their homes during the dry season. Similarly, Rocheleau (1988) found that during dry season in Kenya, seeds and pods of *Acacia nilotica* constituted up to 60 % of dry weight fodder intake in cattle.

5.5 Valuation of Forest Products Used

5.5.1: Value of NTFPs used in the study area

Table 5.10 shows the value of NTFPs which were sold in the market and exchanged in the village. The values of the NTFPs presented below were obtained from three

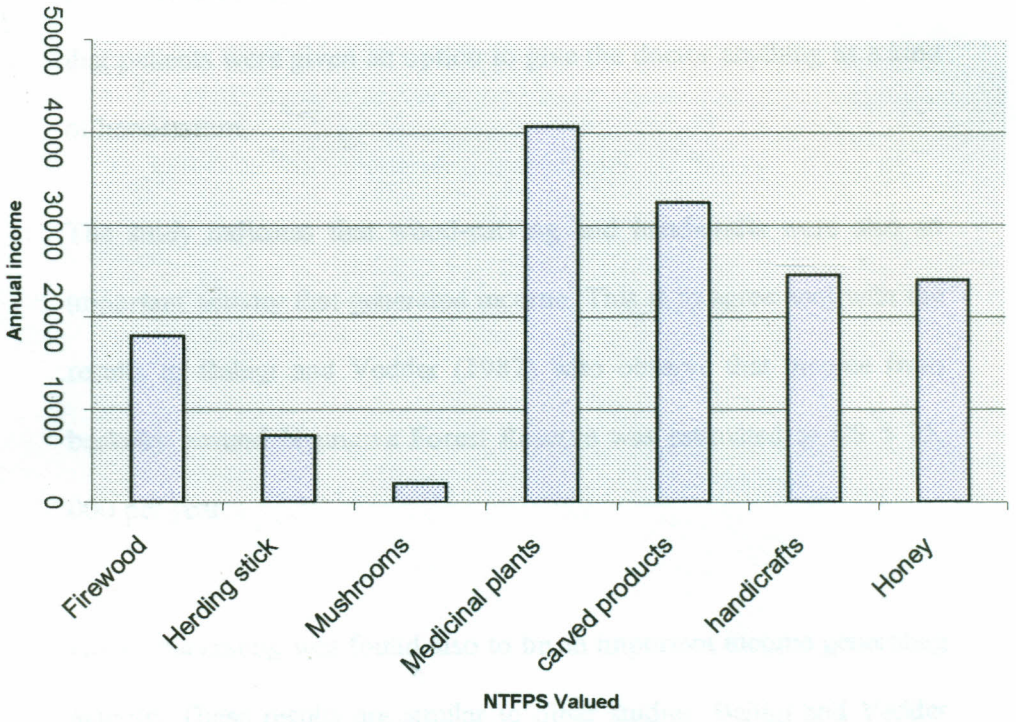
markets namely Kirambo, Busozo and Gatare and interviews with those selling in the villages. Appendix 5 presents NTFPs found during the survey while Appendix 6 gives detailed prices of medicinal plants.

Table 5.10: Value of NTFPs Used in the Study Area

Products	Unit price	Quantity sold per year	Gross value for each seller
Firewood	150 Frs	120 head loads	18000 Frs
Herding sticks	30 Frs	240 sticks	7200 Frs
Mushrooms	200 Frs	10 baskets	2000 Frs
Medicinal Plants	See appendix 6		40540 Frs
Mortar and pestle	400 Frs	36 mortars and pestles	14,400 Frs
Beer boats	1500 Frs	12 beer boats	18,000 Frs
Mats	600 Frs	24 mats	14,400 Frs
Big baskets	100 Frs	48 baskets	4800 Frs
Small basket	150 Frs	36 baskets	5400 Frs
Honey	400 Frs	60 litres	24, 000 Frs

It was found that NTFPs contribute significantly to the household income for sellers. Figure 5.2 shows the distribution of income of different products sold in the study area.

Figure 5.2: Annual Income Distribution of NTFPs in The Study Area



Key : Carved products include beer boats, mortar and pestle, while handicrafts include mats and basketry

Figure 5.2 shows that medicinal plants generate the highest income among NTFPs used. Their value may even be more than the figure indicates. This is because in the study area, it was found that most TPMs treat freely because the healing practice was considered to be a gift from God and healers were aware of the poverty in the region. It was found that 45% ask for money while 64% treat people free of

charge. Some were doing it depending on whether one was capable of paying or not. Once the patient is healed, it was up to him to show gratitude by giving a gift. This observation is supported by Ruffo *et al.*, (1989) in a survey in East Usambara, Tanzania, where it was reported that patients were given an option to give the doctor anything as a kind of honorarium.

The study indicates that wood-carving and handicrafts were also an important activity that generated income. This is in agreement with the results of Bahigi and Vedder (1987) who observe that income from basketry around Nyungwe Forest Reserve was estimated at US $ 75, 000 per year.

Honey harvesting was found also to be an important income generating activity. These results are similar to other studies. Bahigi and Vedder (1987) estimated US $ 180,000 per year from apiculture, honey sale and alcoholic derivatives around Nyungwe Forest Reserve. Njoroge (2000) found that bee keeping was an important income generating activity in Meru District (Kenya). The study further revealed that an individual could earn between Ksh 2000 and Ksh 3000 per hive while Lwoga (1993) found that honey generates substantial income to the bee-keepers in Tanzania. He further found that an individual could earn Tsh 45, 000 per hive.

5.5.2 Contribution of NTFPs to the Batwa households

Table 5.11 presents an average of annual gross income of NTFPs collected by the Batwa community. These results are from interviews with 5 members of the Batwa community. The study found that forest products contribute to the Batwa household income by an annual income estimated at around FRS 58, 200 (US $ 166.2).

Table 5.11: Annual contribution of some NTFPs collected by Batwa in the study area

Products	Quantity collected /Year	Unit price	Gross income value/ household
Firewood	384 head loads	160 FRS	57,600 FRS
Vegetable	4 sisal sacks	150 FRS	600 FRS
Total			58, 200 FRS (166.2 US $)

Source: Field Work (2000)

Note: Unit price corresponds to the cost of a basket of sweet potatoes and 1 Kg of beans exchanged with the NTFPs collected.

The total value of the NTFPs collected by the Batwa may be much higher given that these people depend wholly on forest resources; by hunting, collecting firewood and forest food. According to Shiva *et al.*, (1995) tropical forests play a significant role to indigenous people. This was highlighted by Marshall (2000) who found that the Piik Ap Oom Okiek, Kalenjin speaking group of Kenya, known as hunter-gatherers depended more on wild greens than other communities.

used leaves (83.1%), bark (24.6%) and roots (7.7%). They rarely used whole plants (3.8 %) and fruits (1.2%). Table 5.13 gives the different plant parts used for medicinal purposes.

Table 5.13: Different parts of forest plants used for medicinal purposes in the study area

Parts used	Herbs	Climbers	Shrubs	Trees	Total (N=77)
Leaves	20	18	10	18	66
Barks	-	3	3	13	19
Fruits	-	-	-	1	1
Roots	-	2	3	1	6
Whole plants	2	1	-	-	3

Source: Field Work (2000)

Given that the initial impact of resource extraction is determined largely by the specific type of plant tissue harvested (Bawa and Hall, 1993), collection of medicinal plants had little impact on the forest, with minimal effects on the Nyungwe Forest Reserve as the quantity of the plant species collected were found to be small.

Kamugisha *et al.* (1996) and Cunningham (1996) found the same results in the community living adjacent to Bwindi Impenetrable Forest Park. The studies further report that leaf material was the most important category used by traditional medical practitioners (TMPs) and traditional birth attendants (TBAs). They were collected from different categories of plant life such as trees, shrubs, climbers and herbs. Therefore the impact of harvesting medicinal plant was found to be low.

However, in the study area, it was found through SSI that there was a high harvesting of *Carapa grandiflora* bark. It was collected by most of the TMPs (85%) and 68.5 % of households using medicinal plants to treat themselves. As indicated by Cunningham (1992), there is a clear relationship between the part of plant being harvested and the impact on the plant. According to Peters (1997), harvesting leaves has less impact on the plant than harvesting the bark. The excessive harvest of the bark can reduce regeneration capacity and endanger the health of a target plant. This concern was also pointed out in Miombo woodland in Zimbabwe by McGregor (1991) who found that bark stripping was common, exposing *Brachystegia spp* and *Acacia spp* to fungal attack. Similarly, Mworia (2000) found that in Upper Imenti Forest Reserve (Meru, Kenya), the bark harvesting of *Fagaropsis angolensis* for medicine made the plant to dry up thereafter. In addition, Mugisha (1997) noted that *Rytigynia spp* started drying from the branches after a complete debarking for medicine.

5.6.1.2 Impact of wood harvesting

This mainly includes tree species used for firewood, bean stakes and bee hive making.

Impact of firewood consumption

The study found that firewood was mostly collected from the buffer zone and land outside Nyungwe Forest Reserve. Farm and fallow land in addition to the buffer zone seemed to meet the actual demand of firewood in the area such that

direct impact of demand for firewood on the forest was minimal. This was also pointed out by Emerton (1997) and Anders (1990) in similar studies in Mount Kenya. They observed that firewood collection did not contribute to plant destruction in the indigenous forest. However, Mworia (2000) found that firewood was the most significant product harvested from the forest therefore contributing most to forest degradation.

However, based on household firewood consumption, the amount of firewood demand was roughly estimated at 24, 943 tonnes per year in sectors adjacent to the forest. This amount of firewood cannot be sustained by the buffer zone for a long time with the total area of the buffer zone around the whole forest estimated at only 14, 592 ha by 1992 (MINAGRI, 1992). The situation could change with time since there was no proper planning and management of the buffer zone.

The local population might resort to the use of *Myrica salicifolia, Faurea saligna* and *Ficalhoa laurifolia* which were most preferred species from the forest for firewood. These species were reported to be used in localities adjacent to the forest but to a less extent. Uncontrolled harvesting could threaten these species. This was supported by the results of Kirubi *et. al* (2000) in Marsabit Forest of Kenya where farmers preferred *Olea spp* for firewood. Uncontrolled use of this species has resulted to its near extinction.

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Impact of bean stakes use

It was established that plant species used as bean stakes were mainly harvested from the buffer zone. During field observations, it was estimated that 12,000 bean stakes were used per hectare of bean field. Bean stakes last only four seasons (2 years) after which new ones are needed. This implies that the buffer zone might not be able to supply bean stake needs in the foreseeable future if not properly managed. The extraction of *Alchornea hirtella* and *Macaranga neomildraediana,* two forest species commonly used for this purpose might be of ecological concern. Beans, being the staple food for the local population, a farmer, in every season, will always need a considerable amount of bean stakes. The same case was observed in Uganda in the area surrounding Bwindi Impenetrable Forest where Cunningham (1996) noted that every year, crop stakes represent millions of saplings approximately 12,000-16,000 are required in that area per ha of bean fields. In addition to unsustainable use of these species for crop stakes, the impact of harvesting is also reflected in population structure of target species and the interrelationship with other species. For example the harvesting of *Alchornea hirtella* in Bwindi Forest was found to affect other species like *Loeseneriella apocynoides* which depend on it as trellis (Muhwezi, 1997).

5.6.1.3 Impact of bee-keeping

In the study area, the impact of bee keeping was supposed to be minimal as the practice consists of hanging beehives on the tree. However, the study revealed that some beekeeping practices had a negative impact. It was noted that the

first impact of bee keeping was the felling of trees used for making beehives which last between 3 to 5 years. The harvesting method was destructive with the entire plant being removed. The unsustainable removal of these trees consisted of felling trees of 30-50 cm diameter at breast height (dbh). Therefore without any measures such as maintaining trees that have reached sexual maturity or are abundantly fruiting to enhance forest regeneration, could lead to enormous ecological damage. In this case of tree felling, the selection procedure interferes with the forest composition through the preferential removal of certain species that are highly preferred. Table 5.14 gives the different species targeted for making beehives.

Table 5.14: Target plant species for making bee hives in Nyungwe Forest Reserve

Species	**Lasting period for bee hives**
Polyscia fulva	4-6 years
Ficus thonningi	10 years
Podocarpus milanjianus	6 years

Source: Field Work (2000)

Jama (1991) also observed that *Podocarpus spp* found in Mau forest, Kenya was being overused in making bee-hives.

The study indicates that the destructive impact of harvesting these species goes beyond the selective removal of slow growing tree species which could lead to a complete elimination. This harvesting method could affect the habitat in several ways: after tree felling, the occurrence of canopy gaps may affect the

regeneration of tree species. As pointed out by Abdulhadi *et al.* (1981), large gaps could stimulate the growth of pioneer tree species with less economic importance.

The other hazard of bee keeping was fire used for traditional harvesting of honey. As pointed out by Van Luyk *et. al.* (1993) fire not only kills seedlings and retards coppice re-growth but also damages the base of the trees and increases the chance of fungal infection. This ecological concern was noticed in several African Tropical Forests where fire was used during honey harvesting. For example, in Bwindi Impenetrable Forest, the conservation concerns about beekeeping was the possibility of fire outbreaks associated with honey harvesting (Cunningham, 1996). Fischer (1993) also identified the accidental spread of fire during honey collection as one of the most damaging effects of beekeeping on Miombo Woodlands. This was also observed in a similar study in Upper Imenti Forest Reserve where fire was identified as an important cause of forest destruction since traditional beekeeping used fire during honey harvesting (Mworia, 2000).

5.6.2 Plant species threatened by over exploitation

Table 5.15 presents tree species subjected to over exploitation in the study area.

Table 5.15: Plant species threatened by unsustainable harvesting in Nyungwe Forest Reserve

Scientific name	Phytogeography	Nyungwe Forest distribution	Use N1 = 8	Number of mentions N = 90
Ocotea Usambarensis Engl	SZ-ZTZ	NO,SO,GI,NE,SE	2	16
Entandrophragma Excelsum (dawe & Sprague) Sprague	SZ-S	NO,SO,GI,NE,SE	3	18
Syzygium Parvifolium(Engl.)	SZ-S	NO,SO,GI,NE,SE	4	44
Faurea saligna(Harv)	SZ-S	NO, SO,GI,NE,SE	1	23
Podocarpus milianjanus	SZ-S	NO. SO.GI.NE,SE	3	24

Key: **N1: Total number of uses**

Phytogeography		*Nyungwe Forest distribution*	
SZ-ZTZ	Sudanian –zambesia transition zone	NO	North _West
SZ-S	Sudano-zambezian of South	SO	South West
		GI	Gisovu-Muzimu (North)
		NE	North Est
	:	SE	South Est

Table 5.15 shows a number of tree species which were subjected to intense exploitation. Plant species used for multiple purposes become exploited more easily due to widespread demand. The higher the number of harvesters and

uses of a species, the scarcer a resource becomes. The observation was supported by Kristensen and Fimber (1994) in the same area. The study found that some of those species such as *Ocotea michelsonii*, *Entandropragma excelsum* and *Podocarpus milanjianus* of about 100 cm dbh were cut in almost 28 sites in the study area. The same species have again been identified as species with particular conservation importance due to their over exploitation in Uganda (Cunningham, 1996). Furthermore, a study carried out in Uganda's mountain forests pointed out the different species of Meliaceae which were subjected to over exploitation by pit sawers leading to genetic impoverishment of those plants because only the biggest trees were removed (Howard, 1991).

5.7 Factors Influencing NTFPS Used in the Study Area

5.7.1 Forest use in the three communes

Table 5.16 shows the major forest uses found in the three *communes*. The study revealed that the use of NTFPs was more prevalent in Kirambo and Busozo *communes* than in Gatare *commune*. In the first 2 communes, respondents used 6 categories of NTFPs from the natural forest and 4 from the buffer zone. In Gatare *commune*, only 2 categories of NTFPs from the buffer zone and the natural forest were used by respondents (Table 5.16).

Table 5.16: Prevalence of forest uses in the three communes of Cyangugu Prefecture

	Gatare		Kirambo		Busozo	
Uses	**Buffer zone**	**Natural forest**	**Buffer zone**	**Natural forest**	**Buffer zone**	**Natural forest**
Number of uses N= 6	2	2	4	6	4	6
Type of uses	FW, BS	FW, Med	FW, BS, BM, Fod	FW, BS BM, Fod Med, FF	BS, FW, BM, Fod	FW, BS BM, Fod Med, FF

Note : FW: Firewood**; BS:** Bean stake**; Med:** Medicinal Plants**; BM;** Building materials; **Fod**: Fodder; **FF**: Forest food

To examine whether there was any significant difference in the mean of NTFPs use in the three localities, Analysis of variance (ANOVA) was used. The results are shown in Table 5.17 below:

Table 5. 17: Results of ANOVA of NTFPS use in the three communes

	Source	Sums of square	Degrees of freedom	Mean square	F ratio	F significant
From natural Forest	Between group	37.62	2	18.81	13.16	0.000
	Within group	124.34	87	1.42		
From buffer zone	Between group	13.06	6.53	10.96		0.0001
	Within group	51.83	0.59			

Results presented in Table 5.17 show that there was a significant difference in the mean of NTFPs used in the three communes, the F-probabilty value being lower than the chosen significant level ($P<0.05$) both for buffer zone (0.0001) and natural forest (0.0000). This variation was significant between Gatare and the two communes of Kirambo and Busozo.

These differences in NTFP uses are probably due to the area's topography since *Gatare* households are far from the natural forest. From group discussions, it was realised that the nearest household was at about 45 min to 1h of walking while in Busozo and Kirambo the nearest household was directly adjacent to the forest. The distance has always influenced the dependence of farmers on forest resources. This observation is supported by Scott (1998) in Mont Elgon in Uganda. She found an average of 6.9 types of forest resources collected per household adjacent to the forest compared with only 1.7 in the farthest villages. Lubanga (1991), found a positive correlation between forest utilisation and proximity of households to the forest in the Mau Complex, Kenya. In nine major utilisation activities identified, six were dominated by households close to the forest.

In addition, *Gatare commune* receives high income from the production of coffee (Nsengiyumva, 2000). According to this report, the commune was ranked first in production of coffee in the whole prefecture. The income from other sources has resulted in less dependence on the NTFPs in Gatare. Hedge *et al.* (1998) reported similar observation in the Soligas community. The authors

report that income from other vocations has a negative influence on the extraction of NTFPs.

5.7.2 Effects of wealth categories on use of NTFPs

Table 5.18 presents the categories of NTFPs used by different wealth groups. The results show that there was little difference in terms of number and types of NTFPs used between wealth categories.

Table 5.18: NTFPs used by wealth categories in the study area.

	Poor households		Average households		Rich households	
Uses	**Buffer zone**	**Natural forest**	**Buffer Zone**	**Natural forest**	**Buffer zone**	**Natural forest**
Number of uses N= 6	3	5	4	6	3	5
Type of uses	FW, BS, Fod,	FW, Med BS, BM, Fod	BS, FW, BM, Fod	FW, BS BM, Fod Med, FF	BS, FW, Fod	FW, BM, Fod Med, FF

The results from ANOVA revealed that there was no significant difference in means between the three categories of wealth ($P>0.05$) regarding the use of NTFPs either in the buffer zone or natural forest. This could be partly accounted for by the generally low levels of income in most of the households and therefore most of the households still rely on forest products for basic needs such as firewood as they cannot afford other conventional energy substitutes. This is supported by the findings of Scott (1998) who found that there was no difference between the wealth categories among communities on

the base of Mt. Elgon due to the fact that all the households were of low income.

Table 5.19: ANOVA results of NTFPs used in the wealth category.

	Source	Sum of square	Degrees of freedom	Mean square	F ratio	F significant
From natural Forest	Between group	5,4185	2	2,7093	2,2021	,1167
	Within group	107,0370	87	1,2303		
From buffer zone	Between group	,8167	2	,4083	,5544	,5765
	Within group	64,0833	87	,7366		

There is no significant difference at 0.05 level

5.7.3 Factors influencing use of firewood and bean stakes

The study found that firewood and bean stakes were the predominant NTFPs used in the study area. Further analysis was carried out to identify the different factors influencing firewood consumption and the quantity of bean stakes. Bivariate correlation was used to identify the factors mostly influencing the consumption of firewood and the use of bean stakes required. Table 5.20 shows the correlation values for factors which influence the use of NTFPs in the study area. Family size was found to have a major impact on the consumption of firewood while the size of the field was found to influence the quantity of bean stakes used. The regression analysis equations were drawn based on correlation.

Table 5.20 Correlation matrix .

	FAM_SIZE	QTE_FIR	YRS_OCUP	LEV_INCO	QTE_BTAK	SZE_FIEL
FAM_SIZE	1,0000	,5775**	-,0313	,0832	,2766**	,3898**
QTE_FIR		1,0000	-,0893	,1374	,2107*	,3005**
YRS_OCUP			1,0000	-,1584	-,2179*	-,1712
LEV_INCO				1,0000	,4435**	,5114**
QTE_BTAK					1,0000	,6052**
SZE_FIEL						1,0000

* - Signif. less than .05 ** - Signif. less than .01 (2-tailed)

N of cases: 45

Key:

1. **FAM_SIZE: Family size**
2. **QTE_FIR: Average of quantity of firewood consumed per day**
3. **YRS_OCUP: Years of occupation in the area**
4. **LEV_INCO: Level of income**
5. **QTE_BTAK: Quantity of bean stake used**
6. **SZE_FIEL: Size of the field**

As the correlation matrix indicates, there is a positive correlation between family size and firewood consumption as well as a positive correlation between field size and bean stake consumption.

Linear regression was used to test the relationship between the dependent variables which were in this case firewood consumption and quantity of bean stakes; and independent variables which were size of the family and size of the farm. The results are shown in table 5.21 below:

Table 5. 21: Equations and parameters of linear regression

No	Regression Equation	Estimated parameters
1.1	FWD = 2. 8657 + 2. 9790 Fz	R2 = 0.3335 ; F = 44. 042; Sign F = 0. 000
1.2	BSQ = 10666 + 3328 SZF	R2 = 0. 3662 ; F = 50. 8515 ; Sign F = 0.000

FWD : firewood consumption **BSQ: Quantity of bean stake used**

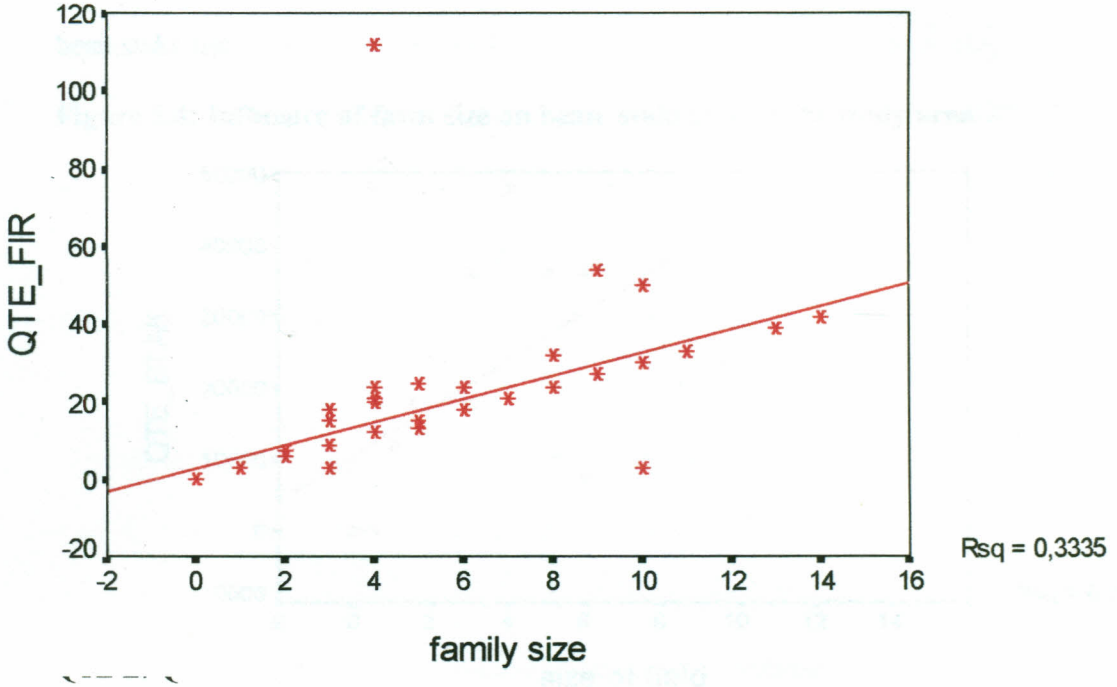
SF : Size of the family **SZF : Size of the farm**

5.7.3.1 Influence of family size on firewood consumption

As shown in Table 5. 20, the positive coefficient of $R^2 = 0.3335$ shows the presence of a positive relationship between family size and firewood consumption. The relationship however accounts for only 33.35 % of the variation showing that its linear contribution is small. Figure 5.3 shows the linear relationship between family size and firewood consumption.

Household size clearly plays a major role in determining domestic fuel use. A larger family would be expected to consume more firewood than a smaller one. The weak relationship implies that there are other factors besides household size which influenced the consumption of firewood, the family size accounting for only 33.35 %. The results are comparable with those of Kirubi (1998) in a study of wood fuel demand in Marsabit, Kenya. The household size was found to have a weak relationship with the fuel wood demand showing the intervention of other factors. However, Njenga (1998) found in Nyeri the household size alone to be the major factor influencing firewood consumption.

Figure 5.3: Influence of family size on firewood consumption in the study area



FWD = 2. 8657 + 2. 9790 Fz

N= 45

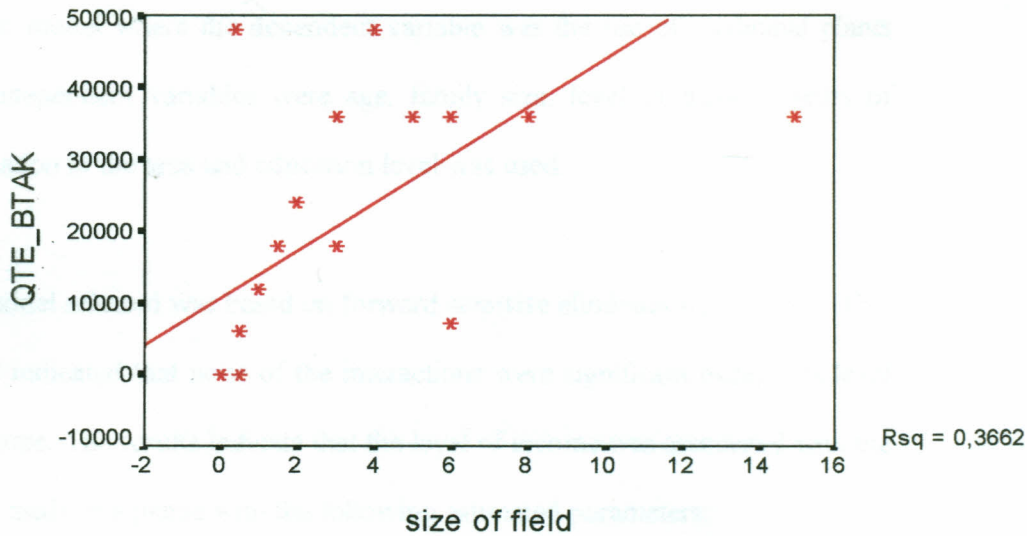
Key : QTE_FIR : Quantity of firewood

5.7.3.2 Influence of size of the farm on quantity of bean stake use

The influence of size of the farm was also investigated and the results found that there was a linear relationship between the size of the farm and the quantity of bean stake use. The relationship was rather weak with R^2= 0. 3662 , accounting only for 36.6 %. This could be partly attributed to the fact that as the size of the farm increases, the farmer cultivates other varieties of crops which don't require stakes. The results can be compared by the results of

Njenga (1998) who found that the influence of size of the farm on number of fruit trees has a weak relationship with only $R^2 = 0.065$, in Nyeri, Kenya. Figure 5.4 shows the scattergram of linear regression between farm size and bean stake use.

Figure 5.4: Influence of farm size on bean stakes use in the study area



BSQ = 10666 + 3328 SZF
N=90
Key
QTE BTAK: Quantity of bean stake use

5.7.4 Factors affecting the use of medicinal plants

Table 5.18 presents the results of logistic regression analysis that examined the association between the use of medicinal plants and the socio-economic characteristics of the survey population. The question was: can it be predicted whether or not a household is likely to use medicinal plants? The binary logistic model where the dependent variable was the use of medicinal plants and independent variables were age, family size, level of income, years of occupation in the area and education level was used.

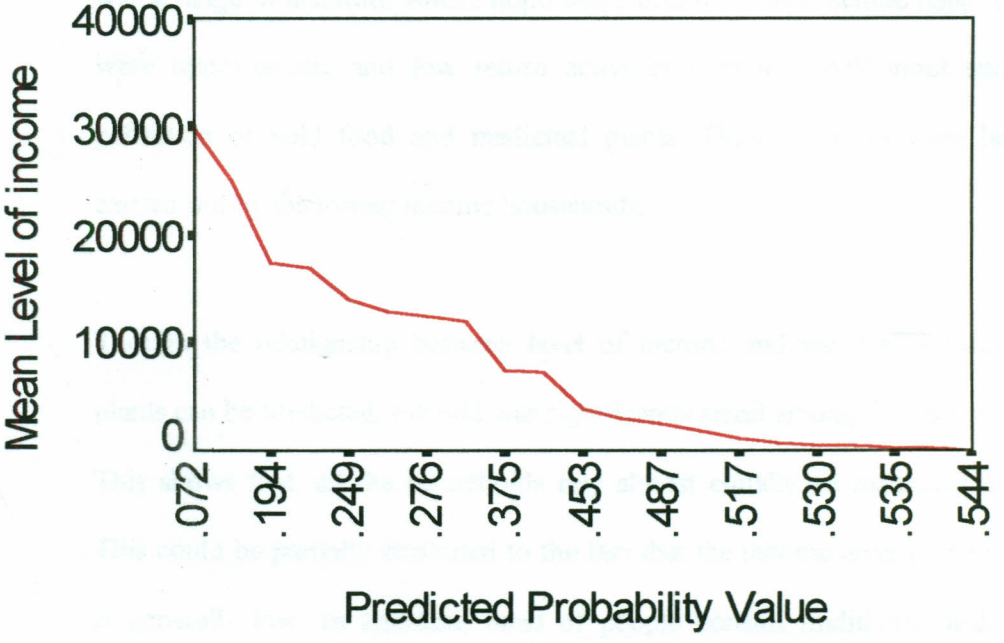
The model selected was based on forward stepwise elimination procedure. This model indicated that none of the interactions were significant except the level of income. The results indicate that the level of income was associated with the use of medicinal plants with the following estimated parameters:

Table 5.22: Parameters of Logistic regression

Variable	Constant	B	S.E	Wald	Sig	R
Level of Income	- .1756	9.13E-05	3.732E-05	5.9851	.0144	.1799

These results show that income was negatively associated with the use of medicinal plants. As the income decreases, the probability of using medicinal plant increases (Figure 5.5).

Figure 5.5: Relationship between Income level and Medicinal Plant Use in the study area



Equation

$$LOG\frac{\prod(x)}{1-\prod(x)} = -1.756 - 0.000.0913 INCOME$$

Hedge *et al.*(1990) reports a similar association in the Soligas community (India) between income level and extraction of NTFPs. This study found that income from other vocations had a negative influence on the extraction of NTFPs whereby with an increase in income from other vocations, the probability of a household to extract NTFPs decreases by 0.76 %. The study further noted that although income derived from the extraction of NTFPs was high, the extraction was not a preferred vocation.

Clarke *et al.* (1998) also observed that the importance of Miombo Woodland resources increase as total income decreases. He however observed that there was a range of activities whose importance declines when income rises. Those were opportunistic and low return activities with low skill input such as collection of wild food and medicinal plants. These activities were largely carried out by the lowest income households.

Though the relationship between level of income and the use of medicinal plants can be predicted, the odd was significantly small among the respondents. This shows that, all the households rely almost equally on medicinal plants. This could be partially attributed to the fact that the income level in the region is generally low. In addition, most of people consult traditional healers to receive medical attention.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This research examined the use of NTFPs and its ecological impact on the conservation of Nyungwe Forest Reserve, the largest afro-mountain forest situated in the South West of Rwanda. The study was carried out in Kirambo, Gatare and Busozo *communes* of Cyangugu *prefecture* bordering the forest. This chapter presents the summary of the findings of this research, conclusions and recommendations.

6.2. Summary of findings

The study found that 87% of respondents were in favour of conservation mainly because of its benefits in improving rainfall (77.7%). However the local community felt the cost of conservation particularly through the lost opportunity to obtain bush meat (33.3 %), followed by the ban on gold extraction (27.7%).

The study recorded 104 plant species with 70% of the plants identified as having medicinal value. The study further noted that the most common NTFPs were crop stakes (98%) followed by firewood (96%) and medicinal plants (44.4%) extracted from two management categories (buffer zone and natural forest) within Nyungwe Forest Reserve.

The study established that most NTFPs collected were used for subsistence needs. The market for selling NTFPs in the study area is not well developed and some respondents were selling forest products from their homes. The study noted that average annual gross value of NTFPs identified from the sellers ranged between 2,000 Frs (5.7 US $) and 40, 540 Frs (115 US $) with traditional medicine and sale of wood products generating the highest income among the NTFPs used. The respondents recognize that NTFPs are important to their lifestyle though not very much. However, the study indicates that the Batwa community, originally hunter-gatherers heavily rely on forest products which they exchange with other communities for food. The average gross value per member per year was estimated at 58, 200 Frs (166.2 US $).

The study established that the harvesting of NTFPs was carried out illegally, impacting negatively on the Nyungwe Forest Reserve. Use of medicinal plants had the least effect on the forest compared with other NTFPs that required the harvesting of wood, since it is the leaves that were mainly used (83.1%). The study established that though firewood and bean stakes were mostly extracted from the buffer zone and outside the forest, their consumption rate was of ecological concern. An estimated 12,000 bean stakes were used per hectare while firewood extracted from the buffer zone was estimated to be 24,943 tonnes per year, an amount which may not be sustained by the buffer zone for a long time.

The study also established that bee-keeping had two major impacts, the use of fire to harvest honey and the removal of slow growing tree species for making bee hives. The target species identified were *Polyscia fulva*, *Ficus thonningi* and *Podocarpus milanjianus*.

From the study, it was also found that there was a significant variation in mean of NTFPs used, both from the natural forest ($P<0.05$) and the buffer zone ($P<0.05$) between Gatare and the other two communes, Busozo and Kirambo. However no difference in uses was observed in the three wealth categories on both the natural forest ($P>0.05$) and the buffer zone ($P>0.05$). The study also established that some factors influence the use of NTFPs in the region. Family size was found to influence firewood consumption with a relationship accounting for 33.35 % of the variation while the size of the farm influences the use of bean stakes with a relationship accounting for 36.62 %. The association between the use of medicinal plants and the socio economic characteristics of the respondents was analysed. The results indicate that the level of income influenced the use of medicinal plants.

6.2 Conclusion

Inspite of the ban on forest use, Nyungwe Forest Reserve supplies many products and services essential to the neighbouring community's well being by providing basic needs to them. Around 104 plant species were used for a variety of purposes by local households. Seven broad categories of uses were identified in the three communes studied. The most predominant are bean stakes, firewood, medicinal plants and beekeeping as well as household artefacts such as mats and baskets among others. Indigenous species from the natural forest were used mainly for medicinal purposes and wood carving while plant species from the buffer zone were used for bean stakes and firewood.

Most of the households were subsistence based hence there is no product harvested exclusively for trade. Occasionally, depending on the availability or need for money, products such as firewood and vegetables were collected for sale to meet the rural population's needs.

The study showed that forest products contribute significantly to the welfare of rural communities, mainly of the Batwa people who depend heavily on the forest for their livelihood. In addition, specialists such as TMPs, beekeepers and wood carvers extract NTFPs from the forest. These are important sources of cash income.

In the course of this study, it became clear that NTFPs played an essential role in the lives of the people. This was the case not only in terms of daily subsistence but also in the wider socio-cultural and economic context. However, many of these activities are not compatible with the ecological integrity of the forest and pose a threat to its conservation. This is exemplified by the cutting down of trees for making beehives and beer boats because it involves selected trees which are also targeted by pit-sawers, hence they are over exploited.

Extraction for subsistence is not sustainable mainly due to the fact that the activities are illegal and no management plan is available neither for the natural forest nor the buffer zone. Furthermore, because of the ban vis a vis the benefits that accrue from the exploitation of Nyungwe Forest Reserve, people illegally sneak in to carry out activities such as wood carving, gold mining and pit-sawing which are more devastating.

6.3. Recommendations

To mitigate the problems mentioned above, the following recommendations to improve the conservation and management of Nyungwe Forest Reserve are advanced:

1. There is enough evidence that many people rely on Nyungwe Forest for both subsistence and economic needs. For this reason, management of the forest should integrate this protected area into the economic and cultural life of the local community. Implementing programmes that

meet important traditional needs with minimum negative ecological impact such as collection of medicinal plants and dead wood can become more attractive to forest users. This will prevent them from clearing the forest for agricultural purpose.

2. The Government alone is incapable of managing and protecting Nyungwe Forest Reserve. Measures should therefore be identified to encourage the local community, to conserve and manage the forest by involving them in the forest's management. People could be organised in such a way that they use more of the NTFPs from the buffer zone. The buffer zone should therefore be the obvious place to concentrate efforts toward understanding and rationalising the use of NTFPs and involvement of people.

3. In Rwanda, forests continue to be degraded in part because of the lack of information. Effective forest conservation education which is cost effective could alert forest communities of the importance of forests. Awareness campaigns should be set to reverse negative attitudes about ORTPN and PCFN, institutions involved in conservation in Nyungwe Forest Reserve.

4. Efforts should be made to alleviate poverty in the local community by improving their income. For example, traditional crafts based on forest resources that have significant potential in terms of generating income

without depleting renewable natural resource base. Production and sale of handicrafts to tourists and for export could be of immense economic importance to the local people.

5. More research on non-timber forest products should be enhanced. The focus should be on their abundance, distribution, reproductive biology, traditional method of propagation as well as cultivation.

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APPENDIX 1 : HOUSEHOLD QUESTIONNAIRE

QUESTIONNAIRES NO: .....

LOCATION INFORMATION

COMMUNE: ..... SECTEUR: .....

CELLULE: .....

HOUSEHOLD NO:

PERSONAL INFORMATION

Head of household

1. Gender (01) Male ☐

(02) Female ☐

2. Date of birth .....(age): .....

3. Level of education attained.

(01) None.....(02) Primary.....

(03) Secondary.....04) Post Secondary.....

4. What is the size of your family?

(01) Children	
(02) Adults	
(03) Total	

5. For how long have you been living in this area? .....

6. Where did you originally come from? .....

7. What is your source of income?

(01) Farmers

(02) Livestock's keeping

(03) salaried employment

(04) Business

(05) Others(Specify)

8. What the approximate size of your farm?

9. What crops do you cultivate?

(01) Beans

(02) Sweet Patatoes

(03) Maize

(04) Others

10. Do you use Crop stake in your farm?

(01) yes ..... (02) No .....

If yes go to 11)

11. For which crops do you require Stake?

(1) Crops (2) Field size .

12. Where do you get the stake from?

(01) Forest

(02) Homestead

(03) Market

(04) Other sources (Specify)

13. What species do you use for staking your crops?

Name	size	How long does it last?

14. What animals do you keep?

Animals	Number

15. How do you feed them?

(01) Zero grazing

(02) Pasture

16. Where do you get the grass from?

(01) Near homestead

(02) From the forest

(03) Others (specify)

17. How do you treat animals when they fall sick?

(01) Modern veterinary medicines

(02) Medicinal plants

(03) Others (specify)

18. If you use medicinal plants, what plants do you use to treat animals?

Local name	Part used	Treatment

19. Where do you get them?

(01) From market

(02) From the forest

(03) Near homestead

(04) Others (specify)

20. What do you use for cooking?

(01) Charcoal (03) Crops residues

(02) Fuelwood (04) Others

21. Where do you get charcoal / fuelwood from?

(01) From the market

(02) From the Forest

(03) Others sources

22. Which tree do you prefer for energy use ?

Name	Origin

23. Note the materil used for roofing

(01) Grass

(02) Iron sheet

(03) Tiles

(04) Others

If (01) Go to 24)

24. Where do you get the thatch grass from?

(01) From the forest

(02) Others sources (specify)

25. Do you keep bees?

(01) Yes

(02) No

(If yes go to 26)

26. Which particular trees do you use for beehives?

Name	Rank according to the preference	Reasons

27. How do you harvest honey?

28. What is the purpose of honey harvested?

(01) For sale (sale)

(02) For consumption

(03) For making alcohol

(04) Others

29. Do you obtain any plant for food from the forest?

(01) Yes (02) No

30. If yes, what plants are used for food?

Plants	Parts used as food

31. How regularly do you rely on these forest?

(01) During the hunger season

(02) Seasonally

(03) Throughout the year

(03) Other time (specify)

32. Where do you get your treatment from?

(01) Traditional practitioner

(02) Medicinal plants

(03) Modern medicine

(04) Others

If (01) and (02) go to 33)

33. Which plants do you use for your treatment?

Name of plant	Part used	Type of sickness treated

34. Beside you, who else is involved in harvesting?

(01) Husband

(02) Children

(03) Others

35. What products do they obtain from the forest?

Name of plant	Purpose

36. Do you harvest any forest products for sale?

(01)Yes (02) NO

If yes list them

37. Are you for the Gazettement of Nyungwe Forest?.

(01) Yes

(02) No

Give reasons:

38 According to you, what are the costs of gazettement of the Nyungwe Forest ?

APPENDIX 2 : INTERVIEW GUIDE FOR SSI :

1. Name and part of plants used
2. Mode of administration
3. Disease treated
4. Time spent in gathering
5. Frequency of harvesting per week
6. Number of people consulted / week
7. Cost of consultation

Appendix 3: Check list of plant species identified in the field

Family	Scientific Name	Vernacular Name	Life Form	Use
-	-	Umudomo	Herb	Med
-	-	Agahisha	Climber	Med
-	-	Umumenamutwe	Herb	Med
-	-	Kamaramahano	Herb	Med
-	-	Ubugomboro	Climber	Med
	Pteridium Aquilinum	Ibishihe	Herb	Hi
Acanthaceae				
	Hygrophila Auriculata (Schumach-) Hein	Buganga Bugari	Shrub	Med
	Thunbergia Alata Bojer ex sims	Nkuriyumwonga	Shrub	Med
	Mimulopsis Solmsii schweinf	Umunayu	Climber	Med
Agavaceae				
	Dracaena Afromontana	Umuhati	Shrub	Bf
Alangiaceae				
	Alangium Chinense (Lour.) Harms	Intogota	Tree	Med, BH STC, HI
Amaranthaceae				
	Amaranthus Sp	Dodo	Herb	Ed
	Sericostachys Scandens (Gilg Et Lopr))	Umukipfu	Climber	Med
	Pycnospora Lutescens (poir .) Schindl	Igifashi	Climber	Med
Amygdalaceae				
	Prunus Africana(Hook.f.)Kalkman	Umwumba	Tree	Med
Annonaceae				
	Morianthotaxis Orophila	Umuhashya	Climber	Med
Apocynaceae				
	Ancylobotris Amoenahua	Umukamira	Climber	Med
"	*Rauvolfia Mannii Stapf"*	Ikinesha	Shrub	Med
	Tabernaemontana Johnstonii Stapf	Umuronzi,Umubari bari	Tree	Med,HI
Asclepiadaceae				
	Ryncostigma Racemosa Bent	Umushebeshebe	Climber	Med
Asteraceae				
	Anisopappus Africanus(Hook.f.) Oliv & Hiern	Umuretezo	Herb	Med
	Bidens Pilosa	Inyabarasanya	Herb	Med
	Carduus Nyussanus(S Moore) R.E.Fr	Mugaboudasumir wa	Climber	Med

	Crassocephalum Sp	Igifuranindi	Herb	Med
	Crassocephalum Picridifolium	Isununu	Herb	Med
	Mikania Cordata(Burn.f.) B.L.Rob.	Umugwantakara	Climber	Med, HI
	Mikania Capensis D.C.	Umunkamba	Climber	Med
	Migloglossa Pyrifolia	Umuhe	Climber	Med
	Mikaniopsis Sp A.	Urugozi	Climber	Med,HI
	Senecio Kazibiensis	Ingurukizi	Herb	Med
	Senecio Nyungwensis	Imbatura	Herb	Med
	Vernonia Conferta Benth	Umwerangabo	Herb	Med
	Volkensia Glomerata	Uruhashi	Herb	Med
Basellaceae				
	Basella Alba L	Indarama	Herb	Med,Ed
Begoniaceae				
	Begonia Meyeri-Johannis (Engl)	Irebe	Climber	Med
	Impatiens Purpureo	Indondori	Herb	Med
Cupparaceae				
	Wahlenbergia	Ikimara	Climber	Med
Celastraceae				
	Maytenus Acuminatus (L.f) Loe	Umunembwe	Tree	Med,STC
	Loeseneriella Apocynoides(Oliv.) J Raynal	Imigega	Climber	Hi,Bm
Chrysobalanaceae				
	Magnistipula Butayei de wild	Umunganza	Tree	Med
	Parinari Excelsa sabine esp . holstii Engl	Umunazi	Tree	Fire, HI,BM, BH
Clusiaceae				
	Harungana Montana(Spirlet)	Umushayishayi	Tree	Fire
	Garcinia Volkensi Engl	Urungutu	Tree	Med
	Pendadesma Reyndersi	Umwasa	Tree	Med
	Symphonia Globulifera (Linn)	Umushishi	Tree	Fire,BM
Clutiaceae				
	Clutia Abyssinica	umutarisonga	Shrub	Med
Cucurbitaceae				
	Momordica Foetida (Schum)	Umwishwa	Herb	Med
	Lagenia Sp	Umutanga	Herb	Med
Cyperaceae				
	Cyperus Sp.	Ubugugu	Grass	Hi
	Cyperus Articulatus L.	Ubusuna	Grass	Hi
	Cyperus Latifolius Poir	Urukangaga	Grass	Hi

Dichapetalaceae				
	Dichapetalum Heudelottii	Umumenamabuye	Shrub	Med
Dioscoraceae				
	Dioscorea Sp. L	Ibikoro	Climber	Ed
Euphorbiaceae				
	Alchornea Hirtella(Benth)	Uruvobo	Climber	Bs,Hi
	Bridelia Micrantha (Hochst)	Umigimbu	Tree	Fire
	Croton Megalopus(Hochst)	Umunege	Tree	Med
	Macaranga Neomildraediana(Lebrun)	Umusekera	Tree	BS, Fire,BM
	Millettia Psilopetala Harms	Umuyogoro	Tree	Stc
Ericaceae				
	Agauria Salicifolia Lam	Umukarakara	Shrub	Fire,Hl
Fabaceae				
	Kotschya Aeschynomenoides (Baker)	Umuhanga	Tree	Fire
	Aeschynomene Schimperi (Hochst. Ex A. Rich)	Imihunga	Tree	Bs
Flacourtiaceae				
	Casearia Runssorica Gilg	Umuhanda	Tree	Stc
Gentianaceae				
	Swertia Calycina N. E.Br	Ubugomboro	Climber	Med
Hippocrateaceae				
	Salacia Sp	Imifuba	Climber	Hi
Lamiaceae				
	Leucas Alluaudii	Akanyamapfundo	Herb	Med
	Plectranthus Luteus Gürke	Uruhahe	Herb	Med
	Pychnosterchys Eminii Gürke	Imitsinduka	Shrub	Fire,BS
Lauraceae				
	Ocotea Usambarensis Engl	Umutake	Tree	Med,Hl,BM
	Ocotea Michelsonii (Robyns And Wilczek)	Umuganza	Tree	Fire Med
Lentinaceae				
	Lentinus Prolifera	Ibihumyo	Fungus	Edi
Lobeliaceae				
	Lobelia Anceps	Ubwungu	Shrub	Med
	Lobelia Giberroa hemgl	Intovu	Shrub	Med
	Lobelia Kiwensis	Ubwungu	Shrub	Med
Melastomataceae				
	Dichaentanthera Corymbosa (Cogn)	Umuhube	Tree	Fire,BH
Meliaceae				
	Carapa Grandiflora (Sprague)	Umushwati	Tree	Med,Fire
	Entandrophragma	Imiyovu	Tree	Fire,Med,B

	Excelsum (dawe & Sprague) Sprague			M
Melianthaceae				
	Bersama Abyssinica (Fresen)	Umukaba	Tree	Fire
Menispermaceae				
	Stephania Abyssinica(Quart.-Dill & A. Rich) Walp	Umutoyi	Shrub	Stc
Mimosaceae				
	Albizia Gummifera (Auct)	Umusebeya	Tree	Fire,BS
	Newtonia Buchananii (Baker)	Imikerero	Tree	Fire
Myrsinaceae				
	Embelia Schimperi(Vatke)	Umukaragata	Climber	Med
	Maesa Lanceolata (Forssk)	Umuhanga	Tree	Fire,Med
	Rapanea Melanophloeos(L.) Mez	Uruneke	Tree	Bm Med
Myrtaceae				
	Syzygium Parvifolium(Engl.)	Umugote	Tree	Bs,Hi
Moraceae				
	Ficus Thonningii (blume)	Umuvumu	Tree	Ed, HI
	Myrianthus Holstii (Engl)	Umwufu	Tree	Ed,HI
Myricaceae				
	Myrica Salicifolia(Hochst. Ex A. Rich)	Imisengeti	Tree	Fire,HI
Oleaceae				
	Olea Hochstetteri (Baker)	Intobo	Tree	Med, Fire
	Strombosia Scheffleri(Engl)	Umushyika	Tree	Med
Plantaginaceae				
	Plantago Palmata(Hook.F)	Mbatama	Herb	Past
Poaceae				
	Exotheca Abyssinica (A.Rich.) Anderson	Inyovu	Grass	Past
	Panicum Calvum(Schumann)	Ikirumbi	Grass	Past
	Hypharrenia Sp	Inkeke	Grass	Hi
	Pennisetum Purpureum (Schum)	Urubingo	Grass	Past,
Podocarpaceae				
	Podocarpus Milanjianus (Rendle)	Umuhulizi	Tree	Hi,Bh
	Podocarpus Usambarensis(Pilg)	Umufu	Tree	Bh
Proteaceae				
	Faurea Saligna(Harv)	Umutiti	Tree	Fire,BH,BM
	Polyscias Fulva(Hiern)	Umwungu	Tree	BH,HI
Ranuncalaceae				

	Clematis Hirsuta	Ubugomboro	Climber	Med
Rhamnaceae				
	Gouania Longispicata(Engl)	Umubimbafuro	Climber	Med,Soap
Rhizophoraceae				
	Cassipourea Gummiflua (Stapf)	Intogota	Tree	Fire
	Cassipourea Ruwenzoriensis (Engl.) Alston	Ingogo	Tree	Fire,STC HI
Rosaceae				
	Rubus Sp L.	Inkeri	Shrub	Ed
Rutaceae				
	Zanthoxylum Gillettii(De Wild.) P.G. waterman	Umuturirwa	Tree	Med
	Fagara Chalybea	Intareyirungu	Tree	Med
Rubiaceae				
	Canthium Oligocarpum (Hiern)	Umushabarara	Shrub	Med
	Ixora Burundensis (Bridson)	Ikinesha	Climber	Med
	Mitragyna Rubrostipulosa	Umuzibira	Tree	Med
	Pentas Decora (S. Moore)	Isagara	Herb	Med
	Rytigynia Sp L.	Umushabarara	Shrub	BS,STC,Med
	Virectaria Major (K. Schum.) Verdc.var.major	Urukiryi	Herb	Med
Sapindaceae				
	Pancovia Golungesis(Hiern) Exell & Mendonça	Intiritiri	Tree	Ed
Sapotaceae				
	Chrysophyllum Gorungosanum Engl	Umushara	Tree	Stc
Smilacaceae				
	Smilax Anceps Willd	Umusuli	Climber	HI,Med
Solanaceae				
	Solanum Nigrum L.	Isogo	Herb	Ed, Med
Sterculiaceae				
	Dombeya Goetzenii (K.Schum)	Umukore	Tree	Hi
Theaceae	*Ficalhoa Laurifolia(Hiern)*	Umuhumbo	Tree	Fire,BM
	Balthasorea Schliebenii	Urushingati	Tree	Bm
Tiliaceae				
	Triumfetta Cordifolia (A.Rich)	Umunaba	Shrub	Hi Ropes,Past
Urticaceae				
	Urera Hipsellodendron	Umuse,Umusande	Climber	Hi

	(A. Rich.) Wedd			
Verbenaceae				
	Clerodendrum Johnstonnii(oliv.)	Igikimbuguru	Climber	Med
	Clerodendrum Myricoides (Hochst.) Vatke	Umukuzananya	Climber	Med
Violaceae				
		Ubunyinya	Fungus	Ed
-	-	Ibigote	Fungus	Ed
-	-	Imegeri	Fungus	Ed
-	-	Ubufu	Fungus	Ed
_	_	Intyabire	Fungus	Ed

Note : HI : Household items

Ed: Edible Med: Medicinal plants

BH : Bee hive Fire: Firewood

STC: Herding stick

BS: Bean stake

APPENDIX 2: INTERVIEW GUIDE FOR SSI :

1. Name and part of plants used
2. Mode of administration
3. Disease treated
4. Time spent in gathering
5. Frequency of harvesting per week
6. Number of people consulted / week
7. Cost of consultation

Appendix 4: Plant Species used to make different household Items

Scientific name	Vernacular name	Products
1. Myrica salicifolia	Imisengese	Traditional bed
2. Agauria salifolia	Imikarakara	
3. Pteriptium aquilinum	Ibishishi	Traditional matresses
4. Myrianthus holstii	Umwufe	Household items (*imbehe, umwoko, umudaho*, traditional chair)
5 Polyscias. fulva	Umwungo	
6. Tabernaemontana johnstonii	Umuronzi	
7. Smitia elliotii	Imibazi	Big baskets (*ibitebo*)
8. Hypharrhenia sp	Inkeke	
9. Triumfetta cordifolia	Umunaba	
10. Cyperus articulas	Ubusuna	
11.Zanthoxylum mildbraeedii	Imwasa	Dryers
12. Carapa grandiflora	Umushwati	
13. Teclea nobilis	Umuzo	
14.Macaranga neomildbreadiana	Imisekera	
15. Alchornea hirtella	Uruvobo	
16. Mikaniopsis sp	Urugozi	
17. Triumfetta cordifolia		
18. Dombeya goetzenii	Imikore	
19. Smilax anceps	Insuri	Traditional plate(*inkoko*)
20. Hibiscus fuscus	Umugusa	
21.Cyperus articulas		
22. Lantana trifolia	Imihengeri	Stores (granaries)

23. Cyperus latifolius	urukangaga	
24.Cyperus latifolius		Sleeping mats (*ikirago*)
25 Cyperus sp	ubugugu	
26.Urera hypselodendron	umuce	
27 Salacia elegans	imigwantakara	Winnowing basket (urutaro)
28.Loeseneriella apocynoides	imigega	Pots covered
29. Smilax anceps		
30. Salacia sp	imifuba	
31. Ocotea michelsonii	umutake	Beer boats (imivure) Mortors (isekuru)
32. Ficus thonningii	imivumu	

Appendix 5 : Market survey in the study area

	Kirambo				Busozo		Gatare	
Products	Market 1		Market 2*		Market 1		Market 1	
	Oct.	Feb	Oct	Feb	Oct	Feb	Oct	Feb
Firewood	_	1 selle			1 seller	_	_	_
	_	2.head load			2 head loads	-	_	_
							_	_
Herding stick	_	_	1 seller	1 seller	_	_	_	_
			30 Fr stick	30 Frs stick				
	-	_	5 sticks	6 sticks	_	_	_	_

Appendix 6: Value of traditional medicine in survey area

Category Midwives	Diseases treated	Number of patient / month	Price/ patient	Estimated of Gross monetary value to the respondent/ year
1	Delivery	2 pregnant women	1000 Frs.	12000Frs
	Children illness	3 children	Banana beer at least 3 litres	15120 Frs.
1	Delivery	2 pregnant women	Juice of beer	_
	Children illness	7 Children	Gift of their choice	_
1	Delivery	3 pregnant women	1500Frs	54000 Frs. each
	Children illness	4 children	500Frs	18000Frs each
1	Delivery	4 pregnant women	Banana beer with honey	_
	Children illness	4 children	Juice of beer	_
1	Delivery	2 pregnant women	1000 Frs	24000 each
	Children illness	6 children	gifts	_
Traditional healers				
1	Hepatitis	2 a year	3000 Frs / per	6000 Frws
	Increase potency	1 year	2000 Frs / pers	2000 Frws
	Intestinal disease	5 per / week	200 Frws	48000 Frws
1	Hepatitis	3 per/ year	2000 Frs / per	6000 Frws
	Poisoning	4 per months	1000 Frs / pers	48000 Frws
	Ifumbi *	5 per months	1000 Frs / pers	60.000 Frws
1	Skin disease	4 per months	350 Frws/ pers (HP)	16.800 Frws
1	Intestinal disease	6 per month	200 Frws (HP)	14.400 Frws