SOCIO-ECONOMIC ANALYSIS OF PRODUCTION OPTIONS OF THE BUFFER ZONE (HALF-MILE FOREST STRIP) AROUND MOUNT KILIMANJARO CATCHMENT FOREST RESERVE, TANZANIA.

BY

CELLINA LUCAS MONGO

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF SCIENCE IN FORESTRY, SOKOINE UNIVERSITY OF AGRICULTURE.

MOROGORO, TANZANIA

2007

ABSTRACT

The Half Mile Forest Strip (HMFS) around Mt Kilimanjaro has for a long time been the most important buffer zone to Mt Kilimanjaro ecosystem. The strip was set aside in 1941 with emphasis on production of wood and non wood forest products for local use. Rising demands for these products from the forest called for socio-economic analysis and review of the production options on the strip. The aerial survey done in year 2001 revealed that the strip was not managed effectively to the extent of increasing the level of threats to the forest belt. As the width of the strip cannot be increased, there is a need for maximum utilization of the available land, by employing profitable production options. The overall objective of the study was to analyze economic returns of various production options on the strip. Specifically the study aimed at identifying the current forest land use options; identifying and estimating costs and benefits of current production options and proposed suitable options for production and conservation of the buffer strip. Primary data were obtained through questionnaires conducted in four villages of the three districts. Land use options were obtained through visual interpretation of satellite images and benefits of the options were achieved by calculating Net Present Value (NPV) and Land Expectation Value (LEV). Results from the study indicates that at a real discounting factor of 10.2%, the actual NPV and LEV obtained from managing one hectare of land for beekeeping was US$ 617.3 and 747.4 respectively. Growing and selling christmas trees gave NPV and LEV of US$ 3741.8 and 4878.2 respectively while pine plantations provided NPV and LEV of US$ 141.2 and 154.9 correspondingly. Sensitivity analyses revealed that all the three options were economically efficient under a wide range of alternatives of varying inputs and discount rates. Although the pine alternative had the lowest returns, but its associated "*taungya"* farming (growing trees with agricultural crops) has shown to be very important

component in farmers' additional income and food security, in this essence, this option is profitable to both the district authority and the communities while natural vegetation along rivers conserve the catchment value and used for beekeeping activity which does not involve tree harvesting, thus maximizing production and conservation.

DECLARATION

I, Cellina Lucas Mongo, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work and has not been submitted for a higher degree in any other University.

_____ _____

Cellina Lucas Mongo
(MSc. Candidate) Date

The above declaration confirmed

_____ _____

Professor E.J. Luoga Date
(1st Supervisor)

_____ _____

Professor Y.M.Ngaga Date
(2nd Supervisor)

COPYRIGHT

ACKNOWLEDGEMENTS

First and foremost, I am obliged to register my thanks and appreciation to the Ministry of Natural Resources and Tourism through Forest and Beekeeping Division for granting me financial support to accomplish this task.

Secondly I am profoundly indebted to my supervisors Prof. E.J. Luoga and Prof. Y.M. Ngaga for their patience, guidance and supervision of my dissertation, from the initial phase to the final write up. My special gratitude should also go to Kilimanjaro Catchment Forest Reserve manager, District Catchment Forest Officers for Moshi, Hai and Rombo, District Natural Resources Officers (Moshi, Hai and Rombo), District Forest Officers (Moshi, Hai and Rombo), Village leaders (Lukani, Kidia, Lole Marera, Kikelelwa and Mweka) without forgetting my beloved daughter Theresia and son Lucas for their patience and understanding during my long absence from home.

Last but not least, I wish to place on record my appreciation for the assistance I received directly or indirectly from academic members of staff and my colleagues of Faculty of Forestry and Nature Conservation of Sokoine University of Agriculture and from my personal friends who made my stay in Morogoro pleasant.

DEDICATION

This dissertation is dedicated to my beloved parents Lucas Bernard Mongo and late Theresia Bagonga Mongo, who sacrificed much and laid down the foundation for my education and to my beloved children Theresia and Lucas for whom education is vital to their lives.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

LIST OF ABBREVIATIONS AND SYMBOLS

BCR	Benefit-Cost Ratio
CBA	Cost Benefit Analysis
CCS	Community Conservation Services
CRDB	Cooperative and Rural Development Bank
CV	Contingent Valuation
CVM	Contingent Valuation Method
FTN	Fruits and Trees Nursery
GEF	Global Environment Facility
GPS	Global Positioning System
ha	hectare
HMFS	Half Mile Forest Strip
IGAs	Income Generating Activities
IR	Inflation Rate
IRR	Internal Rate of Return
ITTO	International Tropical Timber Organization
JFM	Joint Forest Management
KCFR	Kilimanjaro Catchment Forest Reserve
KEDA	Kilimanjaro Environmental Development Association
LEV	Land Expectation Value
LGA	Local Government Authorities
m	metres
m.a.s.l	meters above sea level
NDR	Nominal Discount Rate

NFR	National Forest Reserve
NGOs	Non Governmental Organizations
NPV	Net Present Value
NTFPs	Non Timber Forest Products
NWFP	Non Wood Forest Products
PA(s)	Protected Area(s)
PFM	Participatory Forest Management
PRA	Participatory Rural Appraisal
RDR	Real Discount Rate
s.e	Standard error
SIDA	Swedish International Development Agency
SWOT	Strength, Weakness, Opportunity and Threat
TAF	Tanzania Association of Foresters
TAS	Tanzanian shilling
TEACA	Tanzania Environmental Action Association
TECOSO	Tarakea Environmental Conservation Society
TM	Thematic Mapper (in Landsat TM)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
US$	United States Dollar
VNRCs	Village Natural Resources Committees
WTA	Willingness to Accept
WTP	Willingness to Pay

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Kilimanjaro Catchment Forest Reserve (KCFR) was established in 1940 with an area of about 107 828 ha spreading around three districts of Hai, Moshi and Rombo in Kilimanjaro region. Around the reserve, there is a narrow belt of forest known as the Half Mile Forest Strip (HMFS); which was demarcated in 1941 under the Chagga council to be managed as a social and a buffer forest, with emphasis on production of wood and non-wood forest products for local use and for sale (Kivumbi and Newmark, 1995).

Later on, a forest plantation was established on the HMFS with the aim of supplying forest products to the local communities and also providing revenue to the Local Government Authorities (LGA) through sales of plantation forest products; so that human impact in catchment forest reserve could be avoided or minimized. In other parts around the mountain, demand for wood is primarily met by forest plantations of North and West Kilimanjaro projects. Also, other patches of the strip were left with natural vegetation due to their water catchment's values so as to protect the most important catchment forest. Mt. Kilimanjaro is well known for its critical water catchment for both Tanzania and neighbouring country of Kenya. High rainfall and extensive forests give Mt. Kilimanjaro its high catchment value. About 96 per cent of the water flowing from Mt. Kilimanjaro originates from the forest belt (Katigula, 1992; Newmark, 1995; Kivumbi and Newmark, 1995).

Mountain ecosystems are generally fragile and are exposed to infringement by inappropriate land-use, forest degradation, destruction of biodiversity and water sources. This is the case now with Mount Kilimanjaro as population pressure has forced more people to seek for livelihood on the limited areas of good land and using the adjacent forest to supply them with forest related products thereby exhausting the forest reserve (Katigula, 1992; Misana, 1995; Kashenge, 1995; Ronald and Kidegesho, 1997).

Prior to 1984, the Forest Division managed the HMFS on sustainable utilization and catchment benefits. Then it was handed over to the Local Government administration. The HMFS has became increasingly affected by rising demands for timber, wood fuel, building materials, animals and other non-timber products such as fodder. At the moment there is little funds to manage the forest, as a result more felling than planting in some of the districts has occurred, which left the land at the mercy of erosion and increased illegal activities in the main catchment forest (Katigula, 1992; Kashenge, 1995). Despite the deterioration of the strip, current management options include plantations of exotic species and natural regeneration where there are beekeeping activities and fodder planting (Akitanda and Mongo, 2003).

1.1.1 Production and management options

Forest production and management options on buffer zones such as the HMFS, have become a matter of concern and increased policy interest. Concern for the loss of natural forest and recognition of the need to promote Participatory Forest Management, led to a reorientation of forest policies away from earlier emphasis on the forest based industry and trade towards wider social and environmental integration. It is generally agreed that good forest management depends on policies that correct policy failures, as well as improved

dialogue to ensure effective shared forest management. The approaches to forest management have changed in recent years to emphasize the importance of effective participation of all relevant stakeholders in decisions relating to the forest. A range of management systems are applied for sustainable management of natural tropical forests. Joint Forest Management (JFM) is one of the systems practiced on HMFS where local communities as stakeholders need to benefit from the strip (Kihiyo, 1998; URT, 1998).

Policy failure has resulted in undervaluation of forestry land and products in comparison with alternative land uses. Early cost-benefit analysis, in which generally only marketed benefits were considered, did not take into account the opportunity costs of other land uses including the environmental and other non-market benefits of forests, leading to policy and project decisions which favoured other land uses (Davies and Richard, 1999). Davies and Richard (1999) went further to explain that this situation led to the International Tropical Timber Organisation (ITTO) to comment on inability of tropical foresters to suggest ways of valuing the goods and services from the forest, which has been a major factor in the continuing loss of these forests.

1.1.2 Socio-economic analysis and planning

Socio-economic analysis is important to forest planners and managers when making or recommending alternative production options to ensure that scarce resources are used to the best advantage for the local communities and other stakeholders (FAO, 1998a). Such socio-economic analysis is performed by considering multiple-use maximization. Nevertheless, there is still a debate on appropriate methods of economic analysis which takes into consideration values of non-timber goods and services from forests (Mogaka *et al.*, 2001).

Economic values may include non-market values, either use values derived from use of the resource or non-use values that go beyond the values derived from use of the resource. Evaluation of non-market (environmental) goods/services is a requirement in rational multiple-use forest management planning. When maximizing the forest multiple-production function, information on costs and benefits of timber as well as non-market values is necessary. Information on non-market values is limited, requiring the forest manager to implicitly define the optimal or most satisfactory solution (Strange *et al*., 1999)

The contingent valuation method (CVM) is used to estimate economic values for all kinds of ecosystem and environmental services. It can be used to estimate both use and non use values, and it is the most widely used method for estimating non-use values (van Gardingen *et al*., 2003).

1.1.3 Problem statement and justification

An aerial survey conducted in 2001 by UNEP/UNDP GEF programmes, to Mount Kilimanjaro forests, revealed that the HMFS, although meant for timber production to reduce the pressure on the natural forest, was not managed effectively (Lambrechts *et al.*, 2002). The buffer zone was disturbed by illegal harvesting which had increased the level of threats to the forest belt of the mountain. On production options on the strip, some patches in Rombo, Moshi and Hai districts were planted with exotic tree species, while other areas had indigenous tree species and fodder. Others were degraded and had bushes which were regarded as valueless as regards to timber species.

Ngoile *et al.* (1999) observed that despite various efforts made at individual, community and national levels to manage Mount Kilimanjaro resources and the HMFS in particular,

there is continued degradation caused by illegal harvesting which has led to changes in the hydrological patterns on the mountain, such that some of the perennial rivers are now intermittent.

In order to address these problems various researchers have recommended on sustainable management of the HMFS (Katigula, 1992; Newmark, 1995; Lambrechts *et al.*, 2002). The width of the HMFS cannot be increased towards the forest or towards the communities farms; this calls for maximum utilization of the available land. However, there is no socio-economic analysis of the production options practiced at HMFS as a basis for identification of the best profitable production options. Buffer forest management, in the broadest sense, integrates all the biological, social and economic factors that affect management decisions of the buffer forest. It encompasses all those decisions needed to operate a forest on a continuous basis including social interaction (Davis and Johnson, 1987).

Katigula (1992), stressed the need to revisit the priorities of managing the strip so that they can fit with the current social forces and that a detailed study should be done on the production and supply of the most critical people's needs as the function of the buffer strip.

This study is an attempt to fill this knowledge gap through socio-economic analysis of the production options and eventually come up with economically suitable options for wood and non-wood forest products that can improve the current management of the forest resources on Mount Kilimanjaro as well as benefits to the community.

1.2 Objectives of the study

1.2.1 Overall objective

The overall objective is to analyze social and economic returns of various production options of the Half Mile Forestry Strip (HMFS) buffer zone around Mount Kilimanjaro Catchments Forest Reserve.

1.2.2 Specific objectives

(i) To identify and quantify the current forestland use options of the HMFS buffer zone.

(ii) To identify and estimate costs and benefits of current production options hence propose suitable management options for production and conservation of the HMFS buffer zone.

1.2.3 Hypothesis tested

The functioning hypothesis of this study (H_i) is that:

Different production options on the HMFS have significant contribution to economic returns for communities and the Local Government Authorities around KCFR.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview of buffer forest utilization

Buffer zones in conservation can be defined as areas peripheral or adjacent to protected areas (PA) such as a national park or a managed resource protected area, on which land use is partially or totally restricted to give an added layer of protection to the PA itself; while providing valued benefits to neighbouring rural communities, and where sustainable utilization of resources is permitted in order to reduce pressure and enhance the conservation value of the reserve (FAO, 1998b). In forestry, these areas are meant to provide forest related products at a minimum price and near the communities' habitats, with the main aim of enhancing the positive and reducing the negative impacts of conservation on neighbouring communities and also neighbouring communities on conservation.

Buffer zones can either be internal or external, the main difference being who has the jurisdiction. An internal buffer zone may have the pragmatic advantage of common jurisdiction (with the PA), but have the disadvantage of losing the opportunity to involve other segments of society in conservation with potential magnification effects. Common forest buffers found are those forest patches adjoining the forest or forest strips around forest reserves set aside for the said purpose (Hylander *et al.*, 1997).

Buffers are considered to serve one of these two functions:

(i) can be an extension buffering which is an extending area of habitats protected in the PA into the buffer zone, allowing larger breeding populations of plant and animal species or

(ii) socio-buffering aimed primarily at providing products of use or cash value to local people as long as this does not conflict with the objective of the PA itself. Such buffer management needs to focus on multiple products and improving existing forest resources especially those of local importance (FAO, 1989).

According to Schelhas and Greenberg (1996), efforts to conserve forest biological diversity have usually concentrated on setting aside large tracts of forests in national parks, catchments forests and other protected areas. These large, relatively undisturbed areas are essential for effective conservation of complex forest ecosystems and many forest species. It is becoming increasingly clear that a conservation strategy focusing only on larger protected areas will leave the conservation needs of some inhabitants unmet, and that conservation efforts must include areas that lie outside the reserve. There is also recognition on the increasing importance of the need for partnership between the community and nature outside protected areas (Luoga *et al*., 2005).

Buffer zones are thus the real interface between human and conservation activities which, given the usual incompatibility of these, has at times been reflected in a zone of increasing conflict across the protected area boundary (Hall and Rodgers, 1992). Hall and Rodgers (1992), went further to explain that buffer zones are thus an integral part of the protected area concept, contributing to ability to conserve the biological and resource values within the PA: if there was not a PA there would not be a buffer zone.

The overall goal of furthering the conservation of a resource is accomplished in two ways. Firstly, suitable habitat is provided around a relatively small PA core to allow species to extend their ranges over an area large enough for a viable population to be supported and

secondly, a sustainable supply of natural resources is made available to residents or adjacent people, reducing their dependence on PA core resources which is the `socio-economic' function. The challenge for the manager of a PA is to combine these functions in an effective way, matching the most sensitive aspects of the extension function with the lowest-intensity socio-economic impact and vice-versa. Conservation of the core PA should go in hand with allowing harvesting of the forest products and traditional gathering of renewable products from a buffer zone where it is accepted that this will not appreciably change the ecosystem.

Leighton *et al.* (1997) suggested that a long-term solution for conserving the magnificent rainforest of Mt. Palung, Gunung Palung National Park in Indonesia, was to start a buffer forest, which would serve as a pilot project for community-based forestry activities. The greatest threats to this park came from villagers in search of high value timber which could be marketed, albeit illegally, to nearby sawmills.

(Hall and Rodgers, 1992), observed a potential role that forest buffer plays in reducing pressure on areas where the natural forest is reserved for timber production. However, they suggested that the size of the buffer zone should be adequate to accommodate the community’s demands while the rotation for tree crops should allow cultivators to re-farm the buffer zone alone. Another typical example is provision for the local Iban people to farm, hunt and gather products in the buffer zone of the Lanjak-Entimau Wildlife Sanctuary, Sarawak (Sayer, 1991). Surprisingly, noting the growing worldwide interest, there has been little critical analysis of the total concept or evaluation of past successes and failures on buffer zones (Hall and Rodgers, 1992).

FAO (1998a), suggested that buffer zones should have similar biological diversity to that in a protected area, but should be developed within the context of specific forest management plans. The problem is that there are few examples of buffer zones that function effectively to provide clear, positive guidance to practitioners (Murniati *et al*., 2001).

Benefits from Buffer Zones

Buffer zones may provide a variety of benefits, depending on the type of buffer zone, natural conditions, investments made and other factors. These benefits can be categorized as biological, social, economic, institutional or policy-related benefits (Hall and Rodgers, 1992; Abramovit, 1998; Ebregt and Greve, 2000):

(i) Biological benefits

- Providing a filter or barrier against human access and undesirable use of the core zone or conservation area;
- Protecting the core zone or conservation area from invasion by exotic plant and animal species;
- Providing extra protection against storm damage, erosion and other forms of damage;
- Extending the habitat and thus increasing the population of large, wide-ranging species in the protected areas;
- Enhancing environmental services provided by the reserve, e.g. watershed protection;

(ii) Social benefits

- Providing a flexible mechanism for resolving conflicts between the interests of conservation and those of the inhabitants of adjacent lands;
- Improving the earning potential and quality of the environment of local people;

- Building local and regional support for conservation programmes;
- Safeguarding traditional land rights and cultures of local people;
- Providing a reserve of animal and plant species for human use and for restoring species, populations and ecological processes in degraded areas;

9(iii) Economic benefits

- Compensation to people for loss of access to the strictly protected core zone or conservation area;
- Increased benefits from protected area for direct users such as;
  - income from tourism,
  - research permit fees from scientists,
  - income of local people employed in the area,
- Increased value of protected area from indirect use like;
  - watershed effects,
  - protective role of buffer;
- Increased value of protected area for non-users;
  - existence value of wild life,
  - existence value of protected vegetation,
- Direct benefits - income generated in buffer zone;
  - new employment opportunities during planting, tending and harvesting or guiding in case of tourism,
  - change in productivity,
  - benefits of newly introduced crops or technologies,
  - income generation from transit movements to and from PA (roadside

stalls, resting places, food and drink establishments, hotels etc.),

13• Indirect benefits from buffer zone;

- new and improved infrastructure,
- new and improved market opportunities,
- improved access to public services;

14• Other benefits:

- increased visitor flows (and income generation) at regional and national Level
- the value from biodiversity and the conservation of habitat (i.e. future direct and indirect uses) and intra-household re-allocation of resource rights and returns;

1(iv) Institutional and policy-related benefits

15• Introduction of participatory planning methodologies;

16• Direct and indirect users' awareness of value of natural areas and consequent willingness to contribute to their establishment;

17• Establishment of local level monitoring mechanisms involving local population;

18• Involvement of local population in management of conservation and buffer

19 zones;

20• Increased responsibility with local government for regional planning and

21 implementation that includes nature conservation components;

22• Economic benefits involving compensation to people for loss of access to the

23 strictly protected core zone or conservation area;

24

2.2 Production and management options in forest buffer zones

Forest buffer zone production and management options may be viewed in a more general way as defined by the physical production possibilities of the forest. Reforestation practices affect density and species and hence forest production possibilities (Leuschner, 1984).

In managing forests buffers, production and management options are the objectives which are the desired end point that the forest organization wishes to reach. Usually there are multiple objectives in options of buffer zone management and changes with each user group (Leuschner, 1984; Bonnicksen, 1999).

In different production management options, the buffer zones should ensure that the ecological boundaries of protected areas are less abrupt (Hall and Rodgers, 1992). In this way they help in conserving biodiversity at lower social and economic costs than expanding the PA. All definitions of buffer zones express dual goals, with respect to both conservation and development. However, in recent years the balance has shifted somewhat towards the second goal that is of providing products of use or cash value to the local community. As gradients between more or less intensively used land and protected areas with defined conservation objectives, buffer zones should deliver a series of biological, social, economic, institutional and policy-related benefits in their management.

FAO (1998b), noted that rural communities and forest users who depend on the forest resources for their survival and for economic development are the primary beneficiaries of the buffer forests. The choice of production option should consider the impacts it might

have on the sustainable production of Non Wood Forest Products (NWFP); it should not change the ecological structure to the extent that significant NWFP species are endangered or lost. So it is essential that choice be based on achieving a balance between the long-term wood productions, short term NWFP production, social and environmental management objectives.

In forest management, different categories of protected area recognized for modern day conservation provide for differing levels of resource protection in a core: in turn, these lead to different levels in the peripheral buffer zones. A totally protected core zone of importance for scientific monitoring of extreme richness of biodiversity permits no disturbance (not even non-exploitative tourism) but justifies at its periphery a rigidly protected area where regulated tourism or equally benign usage is permitted. Beyond this lies a zone where harvests of traditional products may be gathered by local communities at sustainable intensity and zones of progressively more manipulative management ultimately phasing via, for example, plantations of exotics into settled and intensively cultivated areas. Hence, it is constructive to envisage the gradient as one of increasing management intensity away from the core (Hall and Rodgers, 1992; FAO, 1998a). Different options on the HMFS currently include natural regeneration of indigenous species, beekeeping, planting of exotic species for timber coupled with “taungya” farming, fuel, and fodder are obtained from these practices as part of the communities needs.

2.3 Economic analysis

Economic analysis is an aid in making a better choice between alternative courses of action (FAO, 1979; Gregory, 1987). Economic analysis of public projects is concerned with profitability from the society’s point of view, which is related to the return to the society as

a whole that can be obtained with a given use of its limited resources, and is termed as economic profitability, adjusted prices are used instead of market prices (Kanshahu, 1996; Davies and Richard, 1999).

Economic analysis is seen as an analytical tool for decision-making intended to compare the advantages and disadvantages of certain scenarios. In other words, economic analysis is a tool that can provide decision-makers with useful information for deciding between alternatives or on preferred combinations of possible interventions. The value of natural resources depends not only on the market prices of its direct uses but is also based on other indirect uses of these resources that cannot be traded on some kind of market (Davies and Richard, 1999).

FAO (1979), clarified that forest resources have values to the communities, at the same time there are a number of competing uses for the resources. The purpose of economic analysis is to strive to determine the optimum allocation of the scarce resources for economical efficient use (Gregory, 1987; Davis and Johnson, 1987). Therefore there is a need to develop some economic measures of choosing between alternative uses for the same limited resources. An economic analysis is used to identify maximum contribution in the attempt to ensure that scarce resources are used to the best advantage of the community.

Economic analysis is concerned not only with resource use decision making but also how it can help contribute to the institutional arrangements necessary for managing shared access to the resource in a way that leads to equitable and sustainable management. If economic analysis can generate information on the trade-offs of different management options for the

Forestry Department, it can help the latter regulate the multiple stakeholder interests in forestry management (Davies and Richard, 1999).

The essence of an economic analysis is to compare all of the benefits of the proposed action to all of the costs, and a project is said to pass a benefit-cost test if the sum of all the benefits is greater than the sum of all the costs. Such an analysis is deficient without monetary values for the environmental amenities and services (hereafter "goods") affected by a proposed action. Non timber forest products (NTFPs) are harder to value than timber, since they are often confined to small and imperfect local markets, or are intermediate inputs into farming systems (Navrud and Mungatana, 2002).

2.4 Economic viability of production options

Economics provides a powerful body of theory and evidence for explaining and predicting human behaviour (Davies and Richard, 1999). As a basic principle of sustainable forest management, FAO (1993; 1998b), argued that all operations which comprised a balanced programme of activities, needed to be a financially supportive from sales of forest products. The policy of a country should enable a well managed forest to be commercially as well as ecologically sustainable and should permit sound business arrangement to be implemented that, in turn, will enable long term forest management programmes to be achieved. It should however be noted that sustainable forest management which follows ecologically sound environmental standards can be expected to be more expensive than is unregulated exploitation. The concept may be interpreted as sustaining economic benefits rather than physical outputs.

The measure of project worth in economic analysis can be established through economic criteria namely: Net Present Value, Benefit Cost Ratio and Internal Rate of Return.

(i) Net Present Value (NPV) which is the algebraic sum of the present value of a series of individual cash flows. It is derived by subtracting the sum of the present value of cash flow of costs from the sum of the present value of cash flow of benefits. It is represented by the following formula:

$$NPV = \sum_{t=0}^{n}\left[B_t/(1+r)^t\right] - \sum_{t=0}^{n}\left[C_t/(1+r)^t\right] \quad \text{……Equation 1}$$

Where NPV = Net Present Value

B_t = total value of benefits for period t

C_t = total value of costs for period t

r = discount rate in percentage

n = years of project duration

(ii) Internal Rate of Return (IRR) which is the discount rate, at which the sum of discounted benefits expected from a project, equals the sum of discounted costs required by an investment, or the rate which makes the NPV of a project equal to zero.

$$IRR = \sum_{t=0}^{n}\left[B_t - C_t/(1+r)^t\right] = 0 \quad \text{……Equation 2}$$

(iii) Benefit-Cost ratio (BCR), this is used to evaluate an investment in terms of all relevant costs and benefits associated with it, including social benefits, taken as a ratio of the sum of benefits to costs thus:

$$BCR = \sum_{t=0}^{n}\left[B_t/(1+r)^t\right] / \sum_{t=0}^{n}\left[C_t/(1+r)^t\right] \quad \text{……..Equation}$$

If B/C is greater than one, an investment is economically worthwhile but if B/C is less than one the investment should be abandoned.

(iv) Land expectation Value (LEV) is used to calculate project worth of a forest for an infinite number of equal periods that is land production in perpetuity. In economic analysis the prices are adjusted to shadow prices representing the real opportunity cost of resources in the society (FAO, 1979, 1998; Kanshahu, 1996).

$$LEV = NPV\left[\frac{(1+i)^w}{(1+i)^w - 1}\right] \quad \text{.....Equation 4}$$

Where LEV = Land Expectation Value

i = guiding discounting rate

w = length of multiple period group in perpetual series

NPV = Net Present Value as defined in equation 1.

It is desirable to test the sensitivity of a project outcome to a combination of changes in assumptions. A Sensitivity analysis identifies the physical and financial elements, which have the greatest effects on the results (FAO, 1998a).

Non-market environmental values also influence the sustainable management of buffer zone forests. Valuation of non-market goods is estimated by employing the Contingent Valuation Method (CVM) or other techniques. Contingent valuation (CV) is a survey-based method frequently used for placing monetary values on environmental goods and services not bought and sold in the market place (FAO, 2000). CV is usually the only feasible method for including passive-use considerations in an economic analysis, a practice that has created considerable debate. The issue of what a CV study tries to value is first addressed from the perspective of a policy-maker, and then the controversy over the inclusion of passive-use is taken up in more detail. The major issues and positions taken in

the technical debate over the use of CV are summarized from a user's perspective (Shultz *et al*., 1998; FAO, 2000).

Generally, CVM is a method of estimating the value that a person places on a good. The approach involves asking people to directly report their willingness to pay (WTP) to obtain a specified good, or willingness to accept (WTA) to give up a good. The goal is to measure the compensating or equivalent variation for the good in question. The method is applicable to public goods such as improvement in water or air quality or amenities like national parks (FAO, 2000; Carson, 2000). In some cases, people are asked for the amount of compensation they would be willing to accept to give up specific environmental services. It is called "contingent" valuation, because people are asked to state their willingness to pay, contingent on a specific hypothetical scenario and description of the environmental service. The contingent valuation method is referred to as a "stated preference" method, because it involves asking people to directly state their values, rather than inferring values from actual choices, as the "revealed preference" methods do. Willingness-to-pay (and willingness-to-accept) are based on the premise that we are faced with a choice between two different states of the world, one of which (presumably) we prefer to the other and one of which costs us nothing. The logic of this type of valuation is based on making incremental choices among alternatives. Random assignment of cost numbers to respondents allows the researcher to trace out the distribution of willingness to pay (WTP) for the good (Shultz *et al*., 1998; FAO, 2000; Carson, 2000).

Warner (1986), analyzed two village forestry models in Swedish International Development Agency (SIDA) funded afforestation projects in selected villages of Northern Tanzania, which grow multipurpose tree species in rotation of 8 years for period of 24 years. With the assumptions made, positive IRR was obtained when protection costs were

not included, but when protection costs were included, the economic rate of return for the model turned to be negative.

A study by Okting'ati (1992), on cypress (*Cupresus lusitanica*) per hectare grown in the North Kilimanjaro forest project had indicated that with any nominal discount rate of less than 17% the NPV was found to be positive for rotation periods of 22 and 25 years. For higher discount rate the NPV turned to be negative. A study by Luoga (1994), on production alternatives and interaction between local people and a privately owned forest project in Njombe district (TANWAT), observed that LEV analysis revealed profitability in smallholder grown tea, which ranked second after wattle.

Howard and Valerio (1996), reported that, under certain conditions, management of natural forest as an option is economically more attractive than beef cattle ranching or cultivation of maize or beans in Costa Rica. But Nieuwenhuyse *et al.* (2000) found that looking at clear felling and getting benefits at a single cut was more profitable than harvesting at sustainable basis or cultivating maize and beans on the same piece of land. Navrud and Mungatana (2002), conducted WTP and WTA on recreation value of viewing wildlife and concluded that the annual recreational value of wildlife viewing in Lake Nakuru National Park in Kenya was found to be 7.5–15 million US$. The flamingos accounted for more than one third of the value. On the other hand, Shultz *et al.* (1998), managed to convince decision makers in Costa Rica to reduce national park entrance fees after presentation of their report on communities' WTP. They observed that raising the entrance fee could raise revenues but decrease visitation rates.

These studies show that, in many cases, the indirect economic benefits of PA ecosystems can be demonstrated to be far higher than values yielded by consumptive uses as PAs not

only generate local economic benefits, they also typically yield considerable off-site benefits.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

3.1.1 Location

The study was conducted in four villages adjacent to the HMFS buffer zone, around Mt Kilimanjaro in Rombo, Moshi rural and Hai districts. The buffer zone forests where various production options were being practiced within the three districts were also visited (Figure 1). The HMFS is accessible from Moshi municipality through a network of all weather earth roads linking Hai, Moshi Rural and Rombo districts with the Arusha-Tanga highway, Hai district is 20 km from Moshi municipality and Rombo is 60 km (90 km up to Tarakea) from Moshi municipality.

Mount Kilimanjaro is located at 2º52˝ - 3º18˝S and 37º03˝ - 37º34˝E in the North – eastern slopes corner of Tanzania and reaches a peak of 5895 metres above sea level (m.a.s.l) making it the world highest free standing mountain (Katigula, 1992; TANAPA, 1993; Kashenge, 1995). Located on the slopes of this massive peak is the KCFR that includes the entire forest belt around the mountain, between 1800 m.a.s.l and 2700 m.a.s.l (Kashenge, 1995). The forest was gazetted in 1940 with an area of about 107 828 ha for water and timber values it had. The Half-Mile Forest Strip (HMFS) is a strip demarcated around the lower slopes of Mount Kilimanjaro between altitude 1500 and 1800 m.a.s.l. to act as a buffer zone between the villagers and the National Forest Reserve (NFR) having an area of about 8769 ha (Figure 1). The area was demarcated along the Southern and Eastern edge of

the forest since 1941 to buffer the catchment forest reserve and provide local communities with fuel wood, animal fodder, building poles, wood and other non wood products. This strip starts from Kikelelwa River in North Kilimanjaro (Rombo district) along eastern slopes of the noble mountain to Sanya Juu River in Sanya Juu (Hai district). The HMFS in Hai district has an area of about 1065 ha, whereas Moshi has 5120 ha and Rombo has a total of 2584 ha (Figure 1).

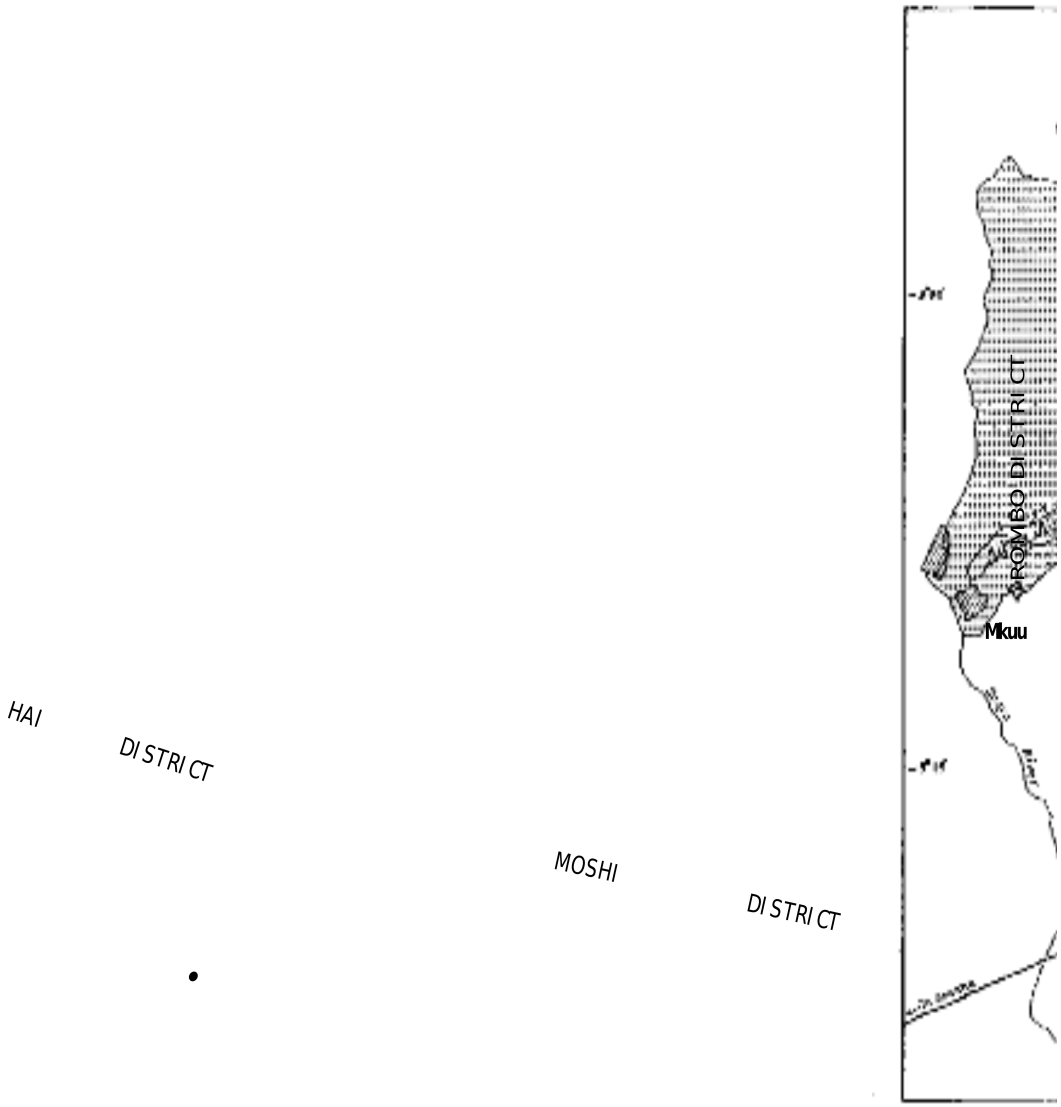

Figure 1: Map of Kilimanjaro Catchment Forest Reserve showing the Half-Mile Forest Strip Buffer zone and the study areas. Source: Modified from William (2003).

3.1.2 Institutional set up

The management of the HMFS is under Hai, Moshi rural and Rombo district councils (local government authorities). The KCFR manager is the coordinator through the directives of the Forestry and Beekeeping Division. Managers for the strip in the respective districts are obliged to send reports on the strip management to the coordinator who in turn summarizes the reports and sends them to the Director of Forestry and Beekeeping.

In 1998 the KCFR office introduced a new concept of joining hands with the local people in conservation efforts called Joint Forest Management (JFM). In JFM approach, the local communities living adjacent to the forest reserves are involved in the management of CFRs whereby there is formation of Village Environmental Committees (VNRCs), preparation and operationalization of Village Forest by-laws, Village based Forest Management Plans and preparation and signing of Management agreements between the government and the respective village and above all there is zonation of CFRs into village management areas. At present there is a move to re-categorize KCFR and the surrounding HMFS to national park status under management of Kilimanjaro National Park (KINAPA).

3.1.3 Geology

Kilimanjaro Mountain is one of the many rift valley associated volcanoes which poured lava and cinders, which characterize the current volcanic soils that are rampant within the HMFS and the land surrounding it. Close investigation into the complexity of the mountain, indicates that it is built around three volcanic centers to which there are many associated number of parasitic cones. There is Shira to the west, Mawenzi in the east and the largest- Kibo, being at the center. Parasitic cones of upper Rombo zone and Himo-

Kilema ridge are situated in the south-east and their lava and tufts extend to the plains at Chala and Taveta (Katigula, 1992; Lovett and Poćs, 1993).

3.1.4 Soils

The soils in the study area are of volcanic origin, andosols rich in nutrients developed on porphyry and basalt lava. At lower elevation deep ferralitic latosols have also developed, while on the rocky ridges of higher elevation acidic lithosols occur. Soils within the HMFS are derived from rocks of tertiary volcanic origin, are acidic with pH ranging from 4 to 4.6, under such edaphic conditions, leaching is common (Lovett and Poćs, 1993).

3.1.5 Climate

The climate of the HMFS buffer zone like the adjacent forest reserve varies with respect to aspect and elevation. There are two rainy seasons, from March to June, and during November and December. The eastern and southern slopes are wetter than the western and northern slopes, rainfall ranges from 1250 mm to 2000 mm per year. There is a short dry season in September on the southeastern slopes, with a long dry season from May to October on the northern slopes. Within the stretch of the HMFS, the temperatures are normally cool throughout the year. The temperature varies from a mean of 16ºC at 1500 m to 7ºC at 3000 m (Lovett and Poćs, 1993; Blot, 1995).

3.1.6 Topography

General topography of the HMFS is continuous hilly, but more often mountainous. The general gradient is normally very steep; interspaced with infrequent conspicuous fissures in the landmass forming canyons and ravines across the landscape (Lovett and Poćs, 1993).

3.1.7 Vegetation

The vegetation on the mountain varies with rainfall and altitude. Lower elevation dry montane forest occurs on the southern and northern slopes below 1800 m with submontane riverine forest in stream valleys from 1400 –1600 m dominated by *Albizia schimperiana* and *Newtonia buchananii.* Montane forests occur from 1600 to 2700 – 2800 m elevations. The forests were rich in *Ocotea usambarensis* but now are dominated by *Albizia gummifera, Macaranga kilimandscharica* and *Polyscias fulva*. KCFR is rich in biodiversity having a number of endemic plants including *Senecio johnstonii* sub species *Kilimanjaro, S. cottonii, Lobelia deckenii*, *Impatiens kilimanjaro* and *llota tanganyikae*. Valuable timber species found include *Ocotea usambarensis, Juniperus procera, Podocarpus* species and *Fagaropsis angolensis* (Katigula, 1992; Lovett and Poćs, 1993; Blot, 1995; Malimbwi *et al*., 2001; Lambrechts *et al.*, 2002; Luoga *et al*., 2005*).*

The HMFS has exotic tree species beside the natural forest. Exotic tree species within the HMFS were geared towards meeting the ever growing demand for wood and wood products. Most important tree species grown where the natural vegetation was cleared include black wattle (*Acacia mearnsii*), Japanese camphor (*Criptomeria japonica*), Pines including *Pinus patula*, *Pinus radiata*, *Pinus kesiya*, Christmas trees (*Widdringtonia whyteii*), Cypress especially *Cupressus lusitanica, Populus alba* and a variety of Eucalypts such as *Eucalyptus saligna*, *Eucalyptus maidenii, Eucalyptus robusta, Eucalyptus citriodora*, and *Eucalyptus camaldulensis* (Lovett and Poćs, 1993; Luoga *et al*., 2005*).* Indigenous tree species have also been planted to supplement the exotics species and especially on water sources, these include *Pygium africana* and *Rapanea rhodondroides* (Katigula, 1992; Lovett and Poćs, 1993).

3.1.8 Wildlife

Wildlife in the study area is associated with the adjoining forest reserve, where they stray away from. The reserve supports a large stock of wild game, commonest observed being African buffalo, elands, bush-bucks, black and white colobus monkeys, sykes monkeys, baboons, hyrax, honey badgers, bush-babies, antelopes, elephants and a multitude of birds like spur fowls, quails, olive pigeons, green pigeons, marabou stalks, hornbills, and francolins. Most of the browsers rove far down to the HMFS in search of their natural feed. Incidences of poaching for commercial purposes and for shear search for wild meat are common (Katigula, 1992; Kashenge, 1995).

3.1.9 Hydrology

The forest has a very high water catchment value and water from the reserve supplies traditional furrow irrigation systems on the Southern and Eastern slopes for coffee and other crops. Many permanent rivers fed by several rivulets and streams flow from the slopes of the mountain to the lowlands where the water supports agricultural production through irrigation. Water is also supplied to the sugarcane plantations of Arusha chini and large-scale rice project South East of Moshi and contributes to the Pangani river system for hydroelectric power production at Nyumba ya Mungu and Hale dams (Katigula, 1992; Kashenge, 1995; Kivumbi and Newmark, 1995; Misana, 1995).

3.1.10 People

The dominant ethnic group is the Chagga who inhabit the slopes of Mount Kilimanjaro in their tradition villages, they are believed to settle around the mountain from their ancestral home land in Taita and Ukamba (Mbonile, 1995; Luoga *et al*., 2005), although the current pressure upon the natural resources of mount Kilimanjaro is a result of the dramatic

increase of human population on its slopes from other parts as well, this is a result of population mobility and migration (Mbonile, 1995).

3.1.11 Farming systems

The agriculture production in this area largely depends on smallholder farmers. A typical farmer in the highland zone has some plots (*kihamba*) for coffee and banana in form of multi-storey home gardens and some additional plots (*porini*) in the lowland zone on which to grow maize, beans, or other crops (Kivumbi and Newmark, 1995; Misana, 1995). Potatoes and vegetables are mostly grown in forest plantations in the form of *taungya* system as practiced by communities near the forest projects and the HMFS (Box 1). Due to inadequacy of land in the highlands, zero grazing is practiced; local people obtain grass from the forest or from the lowland for those with vehicles (Mbonile, 1995).

Box 1: Description of "Taungya" system.

Taungya system involves planting of cash or food crops between newly planted forest seedlings in a reforestation project. The system originated in Burma where it was used mainly as a means of regenerating both the soil and the forest by employing and improving upon shifting cultivation (FAO, 2000). The practice has been reserved to forest estates as a cheap means of plantation establishment as well as an improvement to crop yield. Farmers raise crops while the forest trees are still young. After 2-3 years, depending on the tree spacing and tree species, the canopy closes, and light-demanding annual crops can no longer be planted. The culminating vegetation is a pure tree plantation. Farmers then transfer to other clearfelled areas to repeat the process. Thus farmers help in early tending operations like weeding and early pruning. This can be applied by using different reforestation species.

3.2 Methods

3.2.1 Sampling procedure and sample size

There are about eighty nine villages around the forest reserve whereby seventy villages falls adjacent to the HMFS buffer zone, out of these, thirty one villages are in Moshi,

sixteen in Hai and twenty three in Rombo districts. Multi-stage sampling procedure was used to cover district, villages, hamlets and households (Alreck and Settle, 1985). Villages selected were those falling closer to the HMFS buffer zone forest reserves since those farther did not interact much with the forest. In this case four villages out of 70 were taken as 5% of the total villages. One village was selected from each district i.e Hai and Rombo where the production option is mainly forest plantations and additional beekeeping activity on the area left with natural vegetation; and two villages were selected from Moshi where there are various production options, one being christmas trees plantations and a mixture of exotic and indigenous tree species intercropped with fodder.

Villages selected were Lukani (Hai), Kikelelwa (Rombo), Kidia and Lole-Marera (Moshi Rural). The sampling unit was a household composed of a husband, wife, children and family dependants living in the family and others comprised of widows and widowers. Hamlets and households were randomly selected from the village register. The sample size was 5% of total households present in the four villages; the total sample size was one hundred and fifty five respondents from the three districts.

3.2.2 Sources of information and methods of data collection

Both primary and secondary data were collected for the study. Primary data included land use cover patterns, socio-economic characteristics, production options of HMFS, and associated cost and benefit for each option. Secondary data comprised of management history of the HMFS, establishment costs and review of other work done in the HMFS.

3.2.3 Primary data

Primary data were collected using:

(i) Satellite imageries,

(ii) Participatory Rural Appraisal,

(iii) Structured and unstructured questionnaires,

(iv) Checklist and

(v) Physical visits to the HMFS.

3.2.3.1 Satellite imagery Data

Two Landsat TM satellite images were acquired. The land use/cover on the HMFS buffer zone was studied through the visual interpretation of the two colour composite mosaic of Landsat Thematic Mapper (Landsat TM) satellite imageries taken in year 2002; both imageries were mapped in February which is a dry season in Kilimanjaro. The satellite imageries were classified and interpreted, in general the interpretation of various land use/cover type on the satellite imagery were based on an evaluation of image characteristics such as tone, texture, size, pattern, location and association. The land covered by woody vegetation for example, forests was easily recognized. The geographic references were derived from topographic maps of scale 1:100000 and 1:50 000, covering the mountain and the three districts. The imageries were then transformed into map showing the land use cover to appraise the available use cover.

3.2.3.2 Participatory Rural Appraisal (PRA)

As part of preliminary survey, PRA was done to discuss with villagers on existing relationship and institutional arrangement of relevant stakeholders in the HMFS buffer zone. Tools employed included resource mapping, activity calendar, forest resource trend

analysis, use value analysis according to species and participatory walks in the forest where physical checkup of the current forest land use options and the available resources was done.

3.2.3.3 Structured questionnaires

To check the validity and reliability of the questionnaires, they were pre-tested in Moshi district (Mweka village) and necessary modifications were made to suit the local circumstances. The questionnaires were translated into Kiswahili (Appendix 1) to make it easily understandable by enumerators. The survey was conducted from September to November 2005.

Interviews using structured questionnaires were conducted for the randomly sampled households with representation from both sexes. Both open-ended and close-ended questions were designed to solicit information from respondents, the questions were asked to the head of the house hold and the spouse was encouraged to participate in the interview to supplement the information.

3.2.3.4 Checklist

A checklist was prepared to guide the interviews with village government, district and central government staff and other stakeholders such as non-government organizations. Key informants included village leaders, conservation organizations, district natural resource officers and district forest officers. Information collected included management options, main products and benefits from the HMFS and costs incurred in the operations (Appendices 2 and 3).

3.2.3.5 Participant observations

Participant observation involved direct observation of communities and household activities, behavior, relationship, networks, processes and their perception towards the resource use and related economic returns.

3.2.4 Secondary Data

Secondary data was obtained through a review of literature on various topics and other works done in related studies from Sokoine National Agriculture Library (SNAL), Institute of Resource Assessment library, University of Dar es salaam library and electronic libraries. Topics of interest were the history and function of the HMFS buffer zone, management of buffer zones in other areas, economic analysis of forest undertakings. Other sources of secondary information included consultation with District Natural Resources authorities of the three districts, KCFR office as the caretaker of the HMFS buffer zone, other NGOs that plant trees on the HMFS buffer zone. Relevant progress reports, management plans, policy and legislative documents were also reviewed.

3.2.5 Choice of production alternatives

3.2.5.1 Beekeeping

Beekeeping was observed to be one of the production options on the HMFS where Hai district was identified as among the potential honey area which is unexploited (Ngaga *et al*., 2005). The option was also ranked high by local communities during PRA exercise (pairwise ranking). Due to this, there arose a need for economic analysis on beekeeping as one of the options on the HMFS. Apiculture is one of the traditional occupations of the people of Kilimanjaro; honey has been used as a sweetener and carried a wide range of medicinal application.

3.2.5.2 Christmas trees

In Moshi rural district, the buffer zone was left unattended by the local authorities for a long time, the few christmas trees present are a result of previous planting done by KCFR office. The christmas tree option was observed to be practiced in Moshi district alone and has been a revenue earner to the district council for a long time; this made it subjected to economic analysis.

3.2.5.3 Exotic softwood plantations (pines)

In Rombo district, the option of raising exotic species on the HMFS has been prioritized as one of the high revenue earner for the district council and a substantial part of the strip was planted with exotic softwood species. Pines were observed to occupy a bigger part of the plantation as some of the cypress were affected by the *Cinara cupresii* aphid. Apart from sales of forest products from the compartments, renting the plots for agriculture in the HMFS was observed to be a source of revenue to the council as well as providing food and income to the communities around. Pine plantation activity was therefore chosen for LEV calculations, as it has been one of the major sources of revenue to Rombo district council.

3.3 Data analysis

3.3.1 Participatory Rural Appraisal

Data from PRA were analyzed in the field with the help of the communities in the study area to get immediate feedback. In PRA collected data, pair wise ranking was used to identify preferences on management options; historical trend analysis was done to understand land use and cover over time.

3.3.2 Structured Questionnaires

Quantitative data analysis was done using the Statistical Package for Social Sciences (SPSS) computer software package. The questions were coded first to facilitate data entry in the computer. Descriptive statistical analysis was used in the analysis of quantitative data to explain the socio-economic characteristics, in which the results were presented into frequencies, percentage, pie charts and cross tabulation. In Contingent valuation (CV), respondents were asked directly to state their willingness to pay (WTP) for a specified service which existed on the HMFS. Descriptive analysis was used to present the result.

3.3.3 Economic Analysis

Economic analysis was done using Microsoft excel computer program, where NPV and LEV were calculated. The decision for profitability of the production options was obtained by employing calculations on Land Expectation Value (LEV). LEV was calculated from the revenues and costs from three production options, being beekeeping, Christmas trees plantations and Pine plantations. The following formulae were used:

$$LEV = NPV\left[\frac{(1+i)^w}{(1+i)^w - 1}\right]$$

Where LEV = Land Expectation Value

i = guiding interest rate

w = length of multiple period group in perpetual series.

$$NPV = \sum_{t=0}^{n}\left[B_t/(1+r)^t\right] - \sum_{t=0}^{n}\left[C_t/(1+r)^t\right]$$

Where NPV = Net Present Value,

B_t = Total Revenue accrued at time t, (t = 1, 2, 3…15, 18, 25 years)

C_t = Cost in year t,

n = number of years in the planning period.

r = guiding discounting rate in percentage

In this study, the guiding discount rate used was the real discount rate. The nominal discount rate from the bank was 18% (CRDB personal communication). The Real Discount Rate (RDR) was derived from Nominal Discount Rate (NDR) and the Inflation Rate (IR) i.e.

$RDR = (NDR - IR)/(NDR + 1)$ …… Equation 5

Whereby the current inflation rate is 6% (CRDB, personal communication).

Therefore RDR = (0.18 – 0.06)/ (0.18 + 1) = 0.1016 = 10.2%

Sensitivity analysis was carried out after identification of sensitive variables which were likely to have significant impact on the profitability of the management options.

3.3.3.1 Beekeeping

Costs considered in NPV and LEV calculations for the beekeeping production option included preparation of equipments including making hives, purchasing protective gears, gloves, smokers, small honey press & jack, containers, processing equipments, queen rearing (brood preparation) and constant labour for inspection. Revenues were directly output after selling honey and bees wax (Appendix 10). Period ***w*** for beekeeping was 18 years which was the life span of a top bar hive and 25 years for log hive.

3.3.3.2 Christmas trees

In chistmas tree production option costs were those paid directly during establishment and tending of the compartments. These included purchase and transportation of seedlings,

ground preparation, pitting, planting, weeding, beating up, singling of coppice shoots, harvesting costs and transportation of full christmas trees to the market. Revenues were obtained seasonally from sales of christmas trees for decoration. The period ***w*** for this option was 15 years taken as the limit for a stump to produce healthy coppice shoots after which a stump is removed to replant a new crop (Appendix 11).

3.3.3.3 Exotic softwood plantations (pines)

In this production option the costs considered were; establishment costs which included nursery activities. Planting, weeding and early pruning was done by *taungya* farmers. Other costs were patrols, marking for thinning and supervision. Land for cultivation on the strip was hired whereby land preparation was done by *taungya* farmers who cultivate the land for two years and tree planting was done on the third year, there after cultivation continued until the shade was unbearable for the agricultural crops (see Box 1). Weeding and first pruning was done by the plot owners, although over pruning was common to allow light for the agricultural crops. Thinnings and clearfelling was done by the customers at their own expenses. The main outputs from the option were plot renting, poles from thinning, sawlogs from final harvesting and agricultural crops from the plots. The period ***w*** was 25 years as rotation age for pines (Appendix 12).

3.3.4 Satellite images

A field operation was carried out which involved assembling data source materials namely, topographic maps, vegetation maps and satellite images. Data generation was through visual interpretation of Landsat TM satellite images and extraction of complementary information features used for image geo-referencing from topographic maps.

Land use/cover was mapped on the basis of two Landsat TM (with path and row numbers 168-62 and 167-62) captured in 2002. Both images were enhanced using contrast enhancement by Gausion function. Then images were displayed in Archview GIS Software (ESRI, 1996). This was later followed by on screen visual interpretation of major land use covers. Interpretation of land use covers were done based on interpretation key, the interpretation results were handled as polygon shape file and output map was compiled in ArcView as a layout.

The image interpretation was only done in the HMFS (Eastern and Southern) of KCFR. The zone was digitized by using ArcInfo (ESRI, 1996), and then overlaid on images in ArcView. Topographic maps of scale 1:50 000 and vegetation cover map of scale 1:100 000 of Kilimanjaro Catchment Forest Reserve were used for geo-referencing Landsat TM images. Selected ground control points identifiable both on the satellite images and topographic maps, such as road junction, river junctions, roads, rivers and railway line intersection were used for geo-referencing. Coordinates transformation was done by using polynomial function of second order, image coordinate were then transformed to UTM map coordinates, zone 37 south. Rectification process was done by using Erdas Images (Smith *et al*., 1991).

The resultant land use map was taken into the field for ground truthing (field checks). Ground truthing which basically confirmed the land use and management options in the three districts was done with the aid of a GPS. The map provided an understanding of the current land use/ cover in the study area.

3.3.5 Qualitative data

Qualitative data analysis was done by content and structural-functional analysis technique. According to Kajembe (1994), the method is used to analyze in detail the component of verbal discussion captured from different respondents. Recorded conversations with respondents were broken into smallest meaningful units of information or values and attitudes of respondents. Structural analysis seeks to explain social facts, which are related to each other within the social system and by manner in which social system are related in physical surrounding.

3.4 Limitations of the study

Some difficulties were encountered during the study, these include:

- Poor record keeping (Costs and Revenues) from respondents.
- Few respondents were not willing to reveal some of the issues especially utilization of KCFR and sometimes the HMFS as it was regarded as illegal to obtain forest products without permission.
- With exception of Rombo and Moshi districts, Hai district forest office did not have records of the strip, so data from KCFR office were used because most of the work on the strip was done by the office.
- Due to limited time, non use values from the natural forests were not established.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents results and discussion on the categories of land use options on the HMFS, socio-economic benefit of the strip and the economic analysis of three management options on the strip.

4.1 Land cover and land use options on the HMFS buffer strip

The spatial distribution of the various land use options on the buffer strip revealed that there were seven identified major categories of land use options in the HMFS (Table 1; Figure 2), of which nearly 52% was covered with natural forest followed by plantations of exotic species (25%). Most of the natural forest (3413 ha) was found in Moshi district and the bigger part of the plantations (1334.5 ha) were found in Rombo district where cultivated land on the strip was also taking a bigger coverage than the other districts (419.7 ha). Hai district has been observed to have the least area in plantations as there was no developmental activity on the strip before the start of JFM; the few hectares are a result of JFM whereby the communities were encouraged to plant exotic species in selected villages.

Misana (1995) and Kivumbi and Newmark (1995), observed that when the management of HMFS was handed back to the district council in 1984; planting of exotics continued in Rombo district where utilization was permitted while Hai district council did not allow harvesting of trees. Previously, when harvesting was allowed in Moshi rural district, uncontrolled harvesting took place resulting in soil erosion which led to harvesting ban in 1994. Shrubs (347 ha), have been observed only in Moshi rural district due to over logged

areas hence the communities took the advantage of the open area to graze their animals as it was observed by Lambrechts *et al.* (2002) and William (2003). Natural vegetation along the rivers in all the three districts has been observed to be left intact to conserve the catchment value of the rivers. Figure 2 shows the spatial distribution of the land use option on HMFS as observed from satellite images.

Table 1: Distribution of land uses along the HMFS buffer zone of Kilimanjaro mountain, Tanzania

Land category	Area coverage (ha)			Total	Percentage
	Hai district	Moshi district	Rombo district		
Natural Forest	746.6	3413.3	416.4	4576.3	52.2
Plantations (trees)	34.0	807.3	1334.5	2175.8	24.8
Riverine vegetation	200.4	398.8	284.6	883.8	10.1
Cultivation	82.3	55.4	419.7	557.4	6.4
Shrubs	0.0	347.0	0.0	347.0	3.9
Grassland	0.0	98.2	119.0	217.2	2.5
Bare land	1.7	0.0	9.8	11.5	0.1
Total	**1065.0**	**5120.0**	**2584.0**	**8769.0**	**100.0**

4.1.1 Half mile forest strip in Hai district

The HMFS in Hai district consisted an area of 1065 ha, which was managed by Hai district authority, it stretched from Sanya Juu river to Nsere river bordering Moshi district. From the satellite imagery it was observed that on this stretch, 746.6 ha were occupied by natural forests whereas along the rivers, the riverine vegetation covered an area of about 200.4 ha (Table 1; Figure 2). Main exotic species which covered 34 ha of the area included *Acrocarpus fraxinifolius*, *Grevillea robusta*, *Cordia abbyssinica*, and *Pinus patula*. From classified species use preference it was observed that *Acrocarpus fraxinifolius* and *Grevillea robusta* were most referred in the farms, by the communities in the sampled village as they served the purpose of providing firewood, bees forage and later on timber.

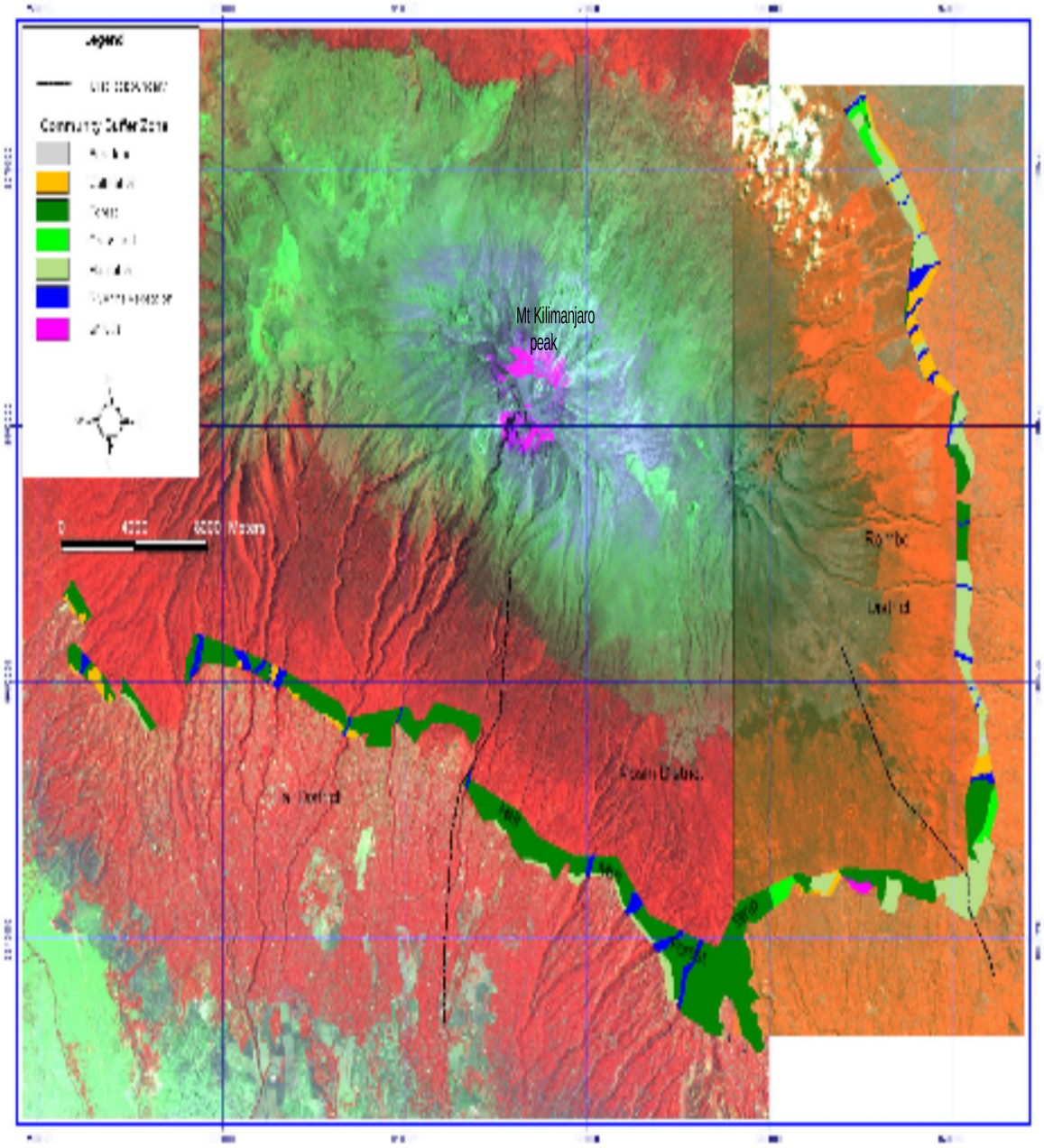

Figure 2: Land use options on the HMFS buffer zone of Kilimanjaro Mountain, Tanzania.

Trend analysis of forest resources with the communities in the sampled village revealed that fuel wood, timber and fodder were dwindling gradually while human population was escalating. This result tallies well with the findings by Luoga *et al.* (2005), which revealed that the forest condition has deteriorated in recent years. The HMFS though meant to supply forest products to the villagers, was faced by destructive activities such as illegal timber harvesting, overgrazing and encroachment for agriculture. In 1998 when Joint Forest Management (JFM) was introduced, local communities were encouraged to hang hives on suitable areas in the strip and inside the reserve as one of the income generating activities (IGAs), also they were allowed to cut fodder for the animals and stall litter on which animals lay and most important was fuel wood for cooking and warmth. In a research done at Nkweshoo village (Hai district), Luoga *et al.* (2005) found that the strip and adjoining forest provided all of the residents needs for water, 30% for housing timber, 15% for fodder and 15% for fuel wood.

4.1.2 Half mile forest strip in Moshi district

In Moshi rural district, the HMFS stretched from Nsere river up to beacon number 39 where it adjoined Rombo district, occupying an area of 5120 ha (Table 1). Out of these, 3413.3 ha were natural forests of which 398.8 ha were found along the rivers. Plantations of exotic tree species occupied 807.3 ha and main exotic species were *Eucalyptus* spp, Cypress, Pines, *Acacia melanoxylon*, *Acacia mearnsii* (black wattle) and *Widringtonia whyteii* (christmas tree). Eucalypts were sold for transmission poles, fuelwood and for construction poles. Cypress and pines were used for industrial wood for construction and light furniture. Black wattle was used for production of wattle bark for tannin and fuelwood. The HMFS in Moshi district was also characterized by shrubs which were a result of continuous tethering of animals and removal of trees on the strip bordering the

villages. The area occupied by these shrubs was 347.0 ha. Nyaki and Mshana (1999) reported that, from the five year management plan (1985/86-1989/90), the area which was cleared to be planted with exotic was 1050.6 ha though just 900.1 ha were planted. The plan further revealed that, 4069.4 ha which is 80% of the total area formed a stretch of natural forest (when the HMFS was demarcated) which is very important for catchment purpose. This explains the reason for the HMFS area in Moshi rural to be comprised of a large area with natural forest.

The stand characteristics of the exotic species in Moshi district were not good except that of *Widringtonia whyteii* (christmas trees) planted by Tanzania Association of Foresters (TAF). The poor quality in most compartments had been attributed to lack of timely silvicultural treatments. For example Pines and Cypress stands had never been pruned and thinnings were not done in time.

Forest resource trend analysis in the two sampled villages showed that, before 1980s the forest adjacent communities could rely on forest products from their farms and topped up very little from the HMFS. But with time it has been difficult for them to suffice forest related products needs from their farms, due to increased population and reduced farm productivity influenced by land fragmentation; which has led into uncontrolled harvesting of forest resources from the HMFS and KCFR as well; this was also noted by Ronald and Kidegesho (1997).

Species use analysis revealed that the two sampled villages in Moshi district prefered planting *Grevillea robusta* in their farms, followed by Cypress in the HMFS, *Croton*

megalocarpus, *C. macrostachis*, *Markhamia lutea* and *Ficus thorningii* were planted on water sources. Other species included Pines, *Macaranga* and *Syzigium*.

4.1.3 Half mile forest strip in Rombo district

HMFS in Rombo district occupied an area of 2584.0 ha which stretched from beacon number 39 to Kikelelwa river. Among them 1334.4 ha were covered with plantations of exotic species of Pines, Cypress, Eucalypts and black wattle. Natural forest (including the riverine forests) covered an area of 701.0 ha, cultivated land covered 419.7 ha which was the result of harvesting (clearfelling) on the strip where *taungya* was being practiced and partly due to longtime encroachment near beacon number 39. The grassland covered 119.0 ha and 11.5 ha was bare land which was a result of landslide. William (2003) noted that encroachment on the strip had increased due the communities' loss of sense of ownership after the transfer of the HMFS management to the district authority.

Forest plantation operations in Rombo district continued since the HMFS was handed back to the three districts' authority. Plot allocation for "*taungya*" farming has sometimes been a source of local communities' resentment of the HMFS (Wiliam, 2003). The communities complained of having to go further into KCFR to collect free fodder and firewood or buy from other sources because the nearby HMFS area was occupied by agricultural crops which did not belong to them as the most adjacent occupants. It was the communities' wish that they should be first considered in plot allocation, hence benefit directly from the HMFS.

On species preference, the communities' preferred planting in their farms *Grevillea robusta*, *Cupressus lusitanica*, *Casuarina* spp and *Pinus patula* for timber and firewood;

they also liked *Acrocarpus fraxinifolius*, *Ficus* spp and *Acacia* spp for soil and water conservation.

4.2 Socio-economic benefits of the half mile forest strip

4.2.1 Livelihood dependency

Nearly 93% of the respondents mentioned that they depended on the HMFS for the provision of alternative economic activities. The findings further showed that about 96%, 92% and 78% of the respondents in Moshi rural, Hai and Rombo districts respectively felt that the HMFS was very important for their livelihood (Table 2). The mean willingness to pay (WTP) of US$ 147.8 ± standard error (s.e) per household per year for HMFS existence was another reason that indicated a high livelihood dependency. However, WTP varied considerably across the districts as respondents from Moshi rural were willing to pay as much as US$ 2487.6 per household per year as the highest offer though in Hai district 60% of the respondents indicated very low WTP of US$ 0.4 per household per year. These results tally well with those of William (2003) who observed the dependence on the strip to be 90%. The HMFS had for many years been a supplementary of forest products to the communities adjacent to it. First, they saw the strip as part of their lives but the change in institutional arrangement caused some not to value the strip much; hence the low WTP for some of the respondents and secondly most of the rural people are poor and therefore likely to indicate low WTP as observed by Ngaga *et al.* (2005).

Among respondents from Rombo district, 20% did not see the importance of the HMFS, the reason put forward was that they were denied some of the benefits like fodder from the strip and plots for *taungya*. Another reason given by those who could not see the importance of HMFS existence was the fact that they were not allowed to use the strip as

freely as they wanted. These accounted for 7.5% and 4% from Hai and Moshi rural districts respectively.

Among the enlightened benefits from the respondents, which made the HMFS worth included; climate amelioration, land for *taungya* practice (agriculture), fodder, poles, honey and beekeeping, water, timber and firewood (Figure 3). The forest was criss-crossed by foot-paths linking one ridge and the other; and in some parts the open land was used for cattle, sheep and goats grazing as observed also by Lambrechts *et al.* (2002) and William (2003). Such disturbances were indicators of high level of utilization of the HMFS. Catchment value of the forest has for long been realized, this has been envisaged by leaving natural vegetation around most of the water sources and along the rivers.

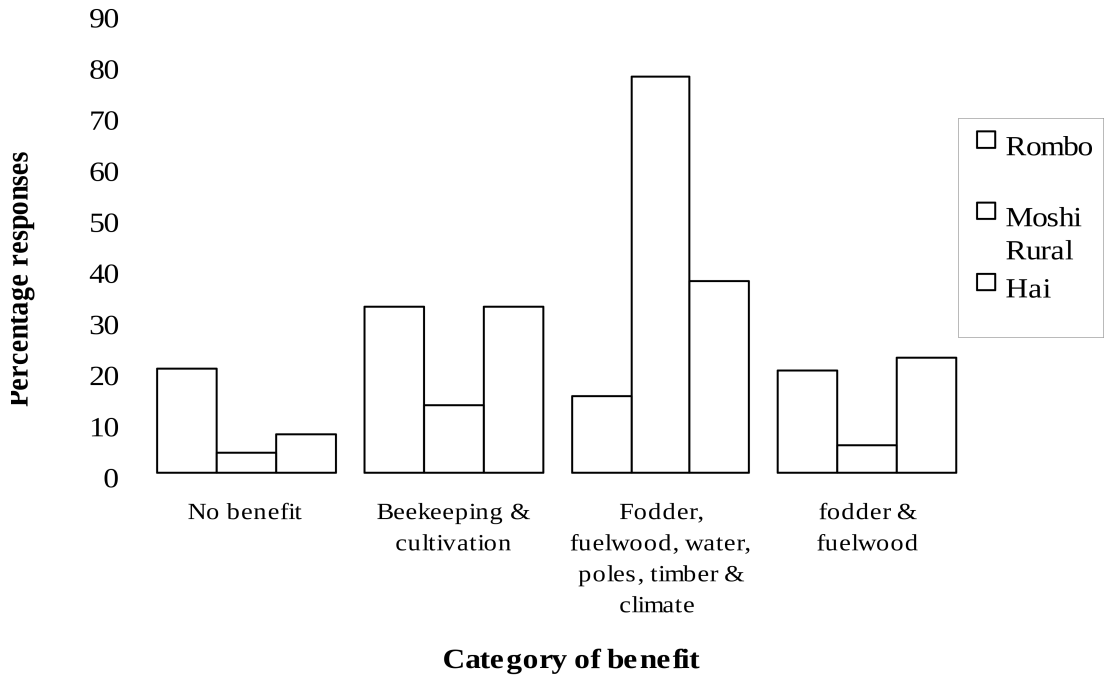

Figure 3: Benefits from the HMFS buffer zone of Kilimanjaro Mountain, Tanzania

Table 2: Socio economic characteristics of communities around HMFS buffer, Kilimanjaro Mountain, Tanzania

Socio-economic attribute		Responses			
		Rombo	Moshi rural	Hai	Total
Economic activities	Farming/ agriculture	40 (100)	75 (100)	35 (87.5)	150 (96.8)
	Business/mechanics/plumber	0 (0)	0 (0)	1(2.5) ea	1 (0.6)
	Driver	0 (0)	0 (0)	2 (5)	2 (1.3)
Landsize and ownership Land inherited	0	7 (17.5)	42 (56)	6 (15)	55 (35.5)
	0.05-0.7ha (0.1-1.5acres)	28 (70)	20(26.7)	13 (32.5)	61 (39.4)
	0.9-1.8ha (2-4 acres)	5 (12.5)	13(17.3)	17 (42.5)	35 (22.6)
	2.3-3.6ha (5-8 acres)	0 (0)	0 (0)	4 (10)	4 (2.6)
Land bought	0	33 (82.5)	72 (96)	36 (90)	141(91)
	0.05-0.7ha (0.1-1.5acres)	6 (15)	2 (2.7)	2 (5)	10 (6.5)
	0.9-1.8ha (2-4 acres)	1 (2.5)	1 (1.3)	2 (5)	4 (2.6)
Land under taungya	0	20 (50)	67(89.3)	16 (40)	103(66.5)
	0.05-0.7ha (0.1-1.5acres)	15 (37.5)	8 (10.7)	24 (60)	47 (30)
	0.9-1.8ha (2-4 acres)	5 (12.5)	0 (0)	0 (0)	5 (3.2)
Types of livestock kept	Cattle	0 (0)	7 (9.5)	1 (2.5)	8 (5.2)
	Poultry	2 (5)	4 (5.4)	0 (0)	6 (3.9)
	Cattle, goat, sheep, poultry & pig	38(95)	63(85.1)	39(97.5)	140(90.9)
Firewood collection	Own farmland	6 (20.4)	3 (6.7)	23(32.5)	32(25.8)
	HMFS	11 (42.5)	56(82.7)	13(57.5)	80(64.5)
	Timber factory & forest plantation	5 (12.5)	0 (0)	0 (0)	5 (4)
	Own farm & forest reserve	6 (15)	1 (10.7)	1 (10.7)	7 (5.6)
source of domestic water	Tap water	32 (82.1)	50(66.7)	37(92.5)	119(77.3)
	River water	0 (0)	5 (6.7)	0 (0)	5 (3.2)
	Spring water	4 (10.3)	6 (8)	1 (2.5)	11(7.1)
	Tap water & spring water	1 (2.6)	11 (14.7)	2 (5)	14(9.1)
	Springs + river + furrow	2 (5.1)	3 (3.9)	0 (0)	5 (3.1)
Past 5yrs tree planting	Yes	25 (67.6)	64(87.7)	35(97.2)	124(84.9)
Reasons for not planting trees	Not necessary/has enough trees	1 (9.1)	3 (37.5)	0 (0)	4 (20)
	Lack of seedlings	4 (36.4)	0 (0)	0 (0)	4 (20)
	Land shortage	3 (27.3)	5 (62.5)	1 (100)	9 (45)
	Shortage of rains	1 (9.1)	0 (0)	0 (0)	1 (5)
Seedlings availability	Wildlings (W)	8 (30.8)	13(20.3)	20(62.5)	41(33.6)
	Buying (B)	7 (26.9)	4 (6.3)	5 (15.6)	16(13.1)
	Environmental committee (E)	0 (0)	21(32.8)	0 (0)	21(17.2)
	Forest office/school nursery(F)	4 (15.4)	9 (10.7)	0 (0)	13 (10.6)
	Combining W,B,E and F	7 (26.9)	17 (26.6)	7 (21.9)	31(25.4)
HMFS Beekeeping	Yes	2 (5)	41(54.7)	18(45.)	61(39.3)
Involvement in b/keeping activities in the family	Men	2 (100)	3 (60)	8 (88.9)	13(81.3)
	Women	0 (0)	0 (0)	1 (11.1)	1 (6.3)
	Men & women	0 (0)	2 (40)	0 (0)	2 (12.5)
Reasons for HMFS' worthiness	Climate amelioration	2 (7.7)	2 (2.7)	1 (2.5)	5 (3.5)
	Agriculture	1 (3.8)	0 (0)	1 (2.5)	2 (1.4)
	Fodder	1 (3.8)	0 (0)	0 (0)	1 (0.7)
	Poles, honey & water	0 (0)	2 (2.7)	0 (0)	2 (1.4)
	Timber, firewood, agriculture, climate	22 (84.6)	71(94.7)	38(95)	131(92.9)
WTP for HMFS existence	US$ 0.4-8.3	9 (36)	14(32.6)	17(60.7)	40(41.7)
	US$ 8.4-66.3	13 (52)	5 (11.6)	7 (25)	25 (26)
	US$ 66.4-248.8	3 (12)	13(30.2)	4 (14.3)	20(20.8)
	US$ 248.9-2487.6	0 (0)	11(25.6)	0 (0)	11 (11.5)
Reasons for not seeing the HMFS' worthiness	No plots for agriculture	3 (7.5)	-	-	3 (1.9.)
	Plots are sold at high price	3 (7.5)	-	-	3 (1.9)
	Local communities are less considered	7 (17.5)	3 (4)	3 (7.5)	7 (8.4)

Figures in parentheses are percentages and those out of parentheses are frequencies

4.2.2 Main economic activities

4.2.2.1 Land size and ownership

It was observed among respondents that 40% from the three districts owned inherited land between 0.1-0.5 ha (Figure 4). In this study, it was found that 15% of respondents from Rombo managed to buy 0.05-0.7 ha of land. Land for farming was supplemented from renting on lowlands and *taungya* practice on the HMFS where it has been observed that most people have been able to rent 0.05-0.7 ha. About 20% of respondents have been able to rent land in Hai district (Table 2).

Figure 4: Land size occupied by respondents around the HMFS buffer zone of Kilimanjaro Mountain, Tanzania.

The findings of the study conformed to the findings of Mbonile (2003), who observed that 43% of the farmers around Mt Kilimanjaro owned less than one acre (0.5 ha) of land which was considered small size and 42% owned between 0.5-0.9 ha (1-2 acres). A study by William (2003) found that 84% of the respondents owned land between 0.1 ha - 0.8 ha in

Moshi rural which was expressed as too small to sustain a living. It was noticed that inherited land is continually lessening for example in Moshi rural district 56% of sampled households did not inherit land from their families (Table 2).

On the other hand Mwaikambo (2001), who interviewed farmers from Moshi rural alone found that 94% owned land ranging from 0.1-2.0 ha on the average, in that study it was also observed that 88% inherited their pieces of land. Selling of land to another person or family was a very rare phenomenon which was also observed by Mwaikambo (2001), and if it happened to take place a piece of land say of 0.2 ha (half an acre) costed more than US$ 332 (TAS 400 000).

Land ownership in the study area was on the basis of clan-lineage and family land ownership which is patrilineal (Nyaki and Mshana, 1999). With the expansion of families, land fragmentation was a common feature which result into small land holding of less than 0.5 ha (one acre) of land.

4.2.2.2 Farming

Farming has been observed to be the main occupation as 97% of the respondents were farmers who also practice dairy cattle keeping around their homesteads (Table 2). Crops grown include maize, beans, potatoes, banana, coffee and various vegetables. Urio (2002) and Campbell *et al.* (2004) observed that agriculture was the main industry of Kilimanjaro region and farming has been a long time occupation in the area since when communities settled on the slopes. Farmers cultivated both cash and food crops in a unique multi-storied agroforestry farming system, growing a variety of food crops and hardwood trees on the same plot of land. The system combined low canopy plants, such as coffee, which requires

shade and wind protection, with banana and high canopy trees that protects the coffee and reduce vulnerability from crop failure by offering alternate food and livelihood sources. This was also influenced by the fertility of the slopes of the mountain that is rich in volcanic soil and abundant rainfall. Since colonial times, a cleverly constructed irrigation furrow system has served to deliver water to the smallholders who live on the mountain (ABCP, 2000). Mbonile (2003); William (2003) and Campbell *et al.* (2004) noted the multi-storied farming system which has not changed and which is also influenced by reliable rainfall and fertile soil.

Taungya was mostly practiced in Rombo district (80%) where they grew softwood trees, while Moshi rural and Hai utilized 10% and 15% of the HMFS area respectively for *taungya*. About 38% of respondents in Rombo had 0.05-0.7 ha of plots for taungya while in Hai 60% of the sampled people had plots of 0.05-0.7 ha. Hai district practiced *taungya* in three pilot villages and it was seen that there was a perceived fair distribution of the plots to members of the villages. In Rombo district, unfair distribution of *taungya* plots has sometimes been reported to be one of communities' resentments on the existence of the HMFS where villagers are less considered. This has also been a source of encroachment into the catchment forest (William, 2003).

4.2.2.3 Livestock keeping

The study findings shows that common livestocks found in the districts were cattle, sheep, goats and pigs. The study has revealed that 9.5% of the respondents kept cattle alone in Moshi rural. The study further observed that about 98% and 95% of respondents in Hai and Rombo districts kept a combination of livestock (Table 2). In this study it was observed that about 98% of the animals are stall fed (indoor feeding). This has been compelled by

lack of enough grazing land. The HMFS has for a long time been a supplementary source of fodder for the local community. Livestock raising was found to be an integral part of most household production systems in Tanzania. In Kilimanjaro region livestock raising is traditional and is generally considered to be a source of security for future and unexpected needs, though animals are occasionally slaughtered for home consumption (Urio, 2002; FAO, 1998a).

Figure 5 shows that local communities have various sources of fodder for their animals. However, the major source (61%) for the households is a combination of own plot (pastures), HMFS and purchase from other areas especially from the lowlands and transport to the mountain homesteads.

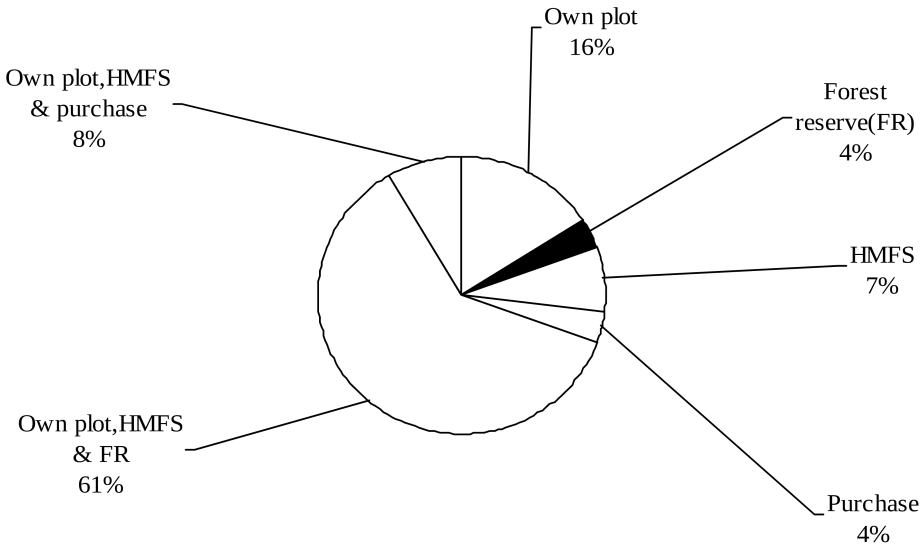

Figure 5: Percentage distribution of sources of fodder around the HMFS buffer zone of Kilimanjaro Mountain, Tanzania.

4.2.2.4 Tree planting activities

Findings from this study has shown that 97%, 88% and 68%, of the households in Hai, Moshi and Rombo respectively have planted trees in the past five years (Table 2). Tree planting by individuals in Rombo was low due to the relative small areas they owned as 70% had land less than 1.25 ha. Land shortage was mentioned by respondents as one of the reasons for not planting trees (100% in Hai), whereas 38% of respondents in Moshi declared to have enough trees in their farms. Preferred tree species were *Grevillea robusta* mainly used for firewood, timber and environmental conservation, *Pinus patula* used for timber, poles, firewood and *Percea americana* (avocado) used for timber, firewood, fodder, fruits and environmental conservation. The cutting down of fruit trees for timber and charcoal is not a common phenomenon but is being practiced because of economic reasons and has been reported elsewhere in Tanzania (Luoga *et al.*, 2000; Kajembe *et al.*, 2004). Seedlings were available freely from the forest office, school nursery, environmental committee, buying from private nurseries and some planted wildlings from older trees. Trees outside forests are of particular concern in the developing countries. They are one way of meeting the needs of a growing population both rural and urban and a means of slowing down encroachment of the forest (FAO, 2002). The communities around the strip are well known for their culture in tree planting as trees provide shade for coffee and banana plants in their home gardens (Mbonile, 2003; William, 2003; Campbell *et al.*, 2004).

Tree planting on the HMFS in Moshi rural was done by NGOs which included TEACA who have planted 53 ha, TAF (25 ha), Maua seminary (24.5 ha), Kibosho East ward group (12 ha) and FTN mazingira group (6 ha). In Rombo there was TECOSO (7 ha) and KEDA (4.4 ha). The NGOs have got nurseries, which provided seedlings for their tree planting

activities. It was however noted that Hai district did not have any tree planting NGO on the HMFS, probably there was no encouragement for them to participate in such activity on the strip and since there was no any activity in the development of the strip by the district council. Local NGOs and the private sector have played a significant role in the promotion of tree planting aimed at reducing pressure on the forest reserve (Ngoile *et al.*, 1999).

4.2.2.5 Beekeeping activities

In beekeeping activities it was observed that about 55% and 45% of respondents in Moshi rural and Hai districts respectively were involved in the activity on the strip as opposed to only 5% in Rombo district. The main reason being that beekeeping as one of the IGAs has not been introduced in the Rombo sampled village. All the beekeeper respondents were also farmers meaning that beekeeping was taken as a side activity; this was also noted elsewhere in Tanzania by Ngaga *et al.* (2005) and Moustafa (2000). Beekeepers used both the traditional log hive (86%) and the modern top bar hives (14%). Traditional hives were made of hard durable species such as *Rauvolfia caffra, Acacia albida*, and *Ocotea usambarensis.* They were usually hung onrelatively small trees that were easy to climb.

Acrocarpus fraxinifolius was mentioned as a tree that bees prefer for nectar. Farmers also noted that the following species were highly preferred by bees for gathering nectar: *Rauvolfia caffra, Cordia abbyssinica, Albizia* spp, *Grevillea robusta*. *Syzygium guineense,* and *Ficus* spp. However, FAO (1998a) recounted that traditional beekeeping utilizes cheap and plentiful local materials for hive construction, some of which would otherwise be wasted. Lambrechts *et al.* (2002) observed that beekeeping was important on Mount Kilimanjaro; two main bee species were found to be kept in the forest; there was the bigger, stinging honey-bee *Apis mellifera monticola* and a small sting less bee of the genus

Meliponula. The more thermophilic *Meliponula* bee was kept in the lower altitudes, mostly in the plantation belt and sometimes around homesteads, while the hives of *Apis mellifera monticola* were found up to upper forest border at about 2800 m.a.s.l.

Honey is a uniquely exploited product in that it does not compete with other land uses, or cause land degradation, although the use of fire has been mentioned as an adverse effect of traditional beekeeping practices (ABCP, 2000; Stein, 2003). The respondents further explained that 94% of the honey produced was sold in the villages as the harvest was still little. FAO (1998a) noted that honey and wax appear to be under-exploited and the demand for both is said to be higher than the supply. New beekeeping groups in the villages under the village natural resources committees (VNRCs) have been formed in year 2001-2003.

In beekeeping activities, it was observed that women participated in the beekeeping groups (13%) and not as individuals (6%) (Table 2); low participation of women in beekeeping activity has also been observed in a survey done in Chunya, Songea and Nachingwea districts where it was noted that 80% of the beekeepers were males (Ngaga *et al.*, 2005).

In a village market, honey could fetch up to US$ 1.24 (TAS 1500) per litre and in towns US$ 2.1 (TAS 2500) which is a bit higher compared to what Ngaga *et al* (2005) observed in Chunya, Songea and Nachingwea where the average gate price for honey was US$ 0.9 (TAS1100) . Some villagers on the slopes of Mt. Kilimanjaro have reported that some of the bees have disappeared due to coffee pests' eradication particularly the use of pesticides. Stein (2003) acknowledged the Kilimanjaro honey to be unique due to good taste though there are complaints that some of the bee keepers use a lot of smokers and mix brooder cells and wax which lowers honey quality.

4.2.3 Household energy source

The main source of household energy observed from respondents in the three districts was firewood (92%) (Figure 6). Kerosene was also used as a supplementary energy to firewood whereby it accounted to 13.3% in Moshi rural. The main source of firewood collection are HMFS (64%), own farmlands (26%), timber factories wastes (4%); national forest plantation and a combination of own farmland and forest reserve (6%) (Table 2). Respondents from Rombo explained that firewood from the HMFS was in the form of pruning and off cuts after clear felling of softwood compartments; whereas timber factories wastes provided about 13% of the collection. The study further found that the communities sometimes go farther to forest reserve to get firewood to supplement firewood obtained from the farms where, they collect dry firewood from the reserve though it is considered as an illegal activity.

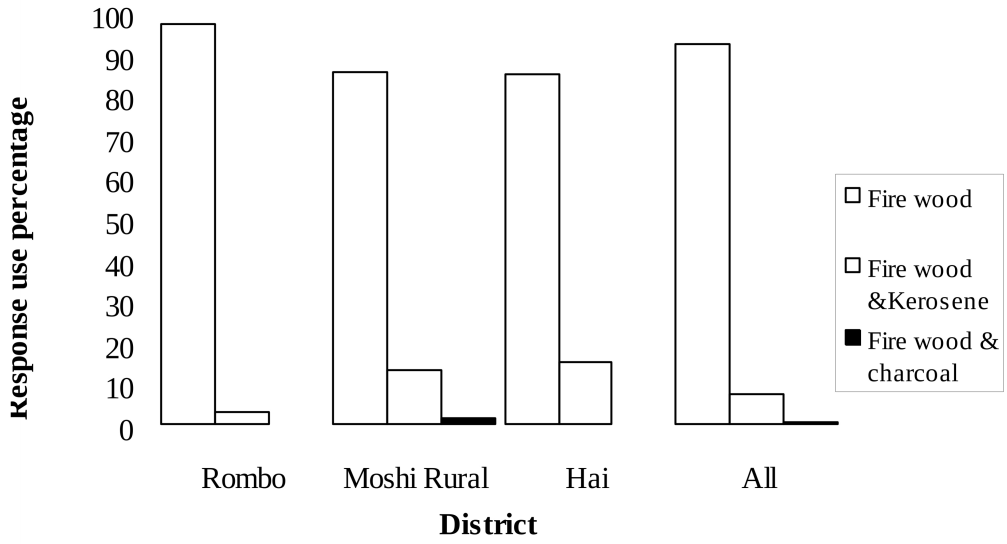

Figure 6: Source of household energy around the HMFS buffer zone of Kilimanjaro Mountain, Tanzania.

It was also observed that the traditional open three stone stoves were widely used throughout the study area and the improved stoves were used by only 3% of the respondents in Rombo and 13.3% of respondents in Moshi rural. This may be due to the weather condition of the areas as the improved stove does not provide sufficient dispersed heat to warm the house. However ABCP (2000) hinted that firewood on Kilimanjaro was increasingly becoming difficult to procure due to the human population increase that was putting added pressure on available natural resources. Energy derived from biomass resources is largely used close to its sources of production to meet local needs. In Tanzania firewood is the main source of energy for rural households, and is an important source for cooking. Monela (1989) observed that all sampled households around Meru softwood plantation used firewood. In rural areas many people rely solely on firewood for cooking although other households use more than one type of fuel (FAO, 1998b; ABCP, 2000).

4.2.4 Rainfall and water use

The study showed that water was not a problem in the study villages as 92%, 80% and 67% of respondents in Hai, Rombo and Moshi rural respectively used tap water for their domestic purpose. The study further revealed that apart from tap water, domestic water was being supplemented by rivers, springs and furrows used for irrigation. The FR and HMFS were a source of many rivers and sources of irrigation water and the main rivers being Sanya Juu, Kikafu, Weruweru, Rau, Ona, Tarakea and Kikelelwa (Figure 2). The study also observed that domestic water from taps, in the districts was paid by the users being 95%, 90%, and 49% of the respondents in Hai, Rombo and Moshi rural respectively. Less people paid for domestic water in Moshi district because of the old water networks in the villages which were freely supplied to consumers; Hai used water from furrows therefore when Uroki Bomang'ombe water supply (UBWS) and Losaa-KIA water supply (LKWS)

projects started, most of the people opted to use tap water for domestic consumption. Water from the forest and adjoining HMFS also supply water to the Amboseli ecosystem in Kenya (Lambrechts *et al.*, 2002)

4.3 Economic efficiency analysis

4.3.1 Beekeeping

Beekeeping groups formed during the initiation of JFM were provided with modern hives made from timber planks as part of income generating activity (Plate 1).

Plate 1: A top bar hive in the HMFS in Lukani village, Hai district, Kilimajaro, Tanzania

The Net present value (NPV) and Land expectation value (LEV) for beekeeping using top bar hives was US$ 617.3 and 747.4 respectively (Table 3). These results were obtained based on the current practice of keeping about 28 hives per ha. When the maximum capacity of 80 hives per ha is assumed, the NPV and LEV increased to US$ 9605 and 11630 respectively (Table 3).

Ngaga *et al.* (2005) observed in Chunya district that production from beekeeping was equivalent to US$ 100.5 per ha (TAS 121 200/ha), this was obtained by using traditional log hives with life span of up to 50 years.

Table 3: Net Present Values (NPV) and Land Expectation Values (LEV) of three production options of the HMFS buffer zone of Mt Kilimanjaro, Tanzania

Number	District	Option	Project life cycle (years)	Net Present Value (NPV)		Land Expectation Value (LEV)	
				Actual (US$)	Max-capacity (US$)	Actual (US$)	Max-capacity (US$)
1	Hai	Beekeeping (Top bar hive)	18	617.3	9605.5	747.4	11630
2	Moshi	Christmas trees	15	3741.8	8894.1	4878.2	11595.4
3	Rombo	Pines	25	141.2	64.5	154.9	70.8*

* Pine plantation values did not include values from agriculture.

Hive stocking was left to take place by chance once hives were hanged in the forest. Honey was extracted and sold locally as a crude product hence low price. When comparing log and top bar hives as practiced on HMFS in Hai district, it was observed that there was a slight difference on NPV (US$ 675.2 and US$ 617.3 at present practice of 28 hives per ha) (Table 4). The cause of the difference was based on the initial cost of the hives which was lower for log hive and also the log hive had a longer life span. This has been reported elsewhere by Ngaga *et al.* (2005) that traditional beekeepers made their own hives at a cost of US$ 0.26 (TAS 315) or bought at US$ 0.41 (TAS 500). However in this study, LEV was calculated based on sales of honey and bees wax only, other values like medicinal value, pollination, environmental conservation and biodiversity were not valued.

Table 4: Comparison between Top bar hive and Log hive in Hai district, Kilimanjaro, Tanzania

Type of hive	Initial cost (TAS)	Average production per hive		Average life span (years)	NPV	LEV
		Honey (kg)	Wax (kg)			
Log	10 000	15	0.7	25	675.2	817.5
Top bar	25 000	20	1	18	617.3	747.2

The discount rate used (i) was 10.2%.

In this study, it was observed that the first three years of the beekeeping option showed negative discounted net revenue in actual revenue scenario (Figure 7) whereas; in the ideal scenario it is only the first year that experienced negative net revenue. The first years are years of investment hence negative discounted net revenue.

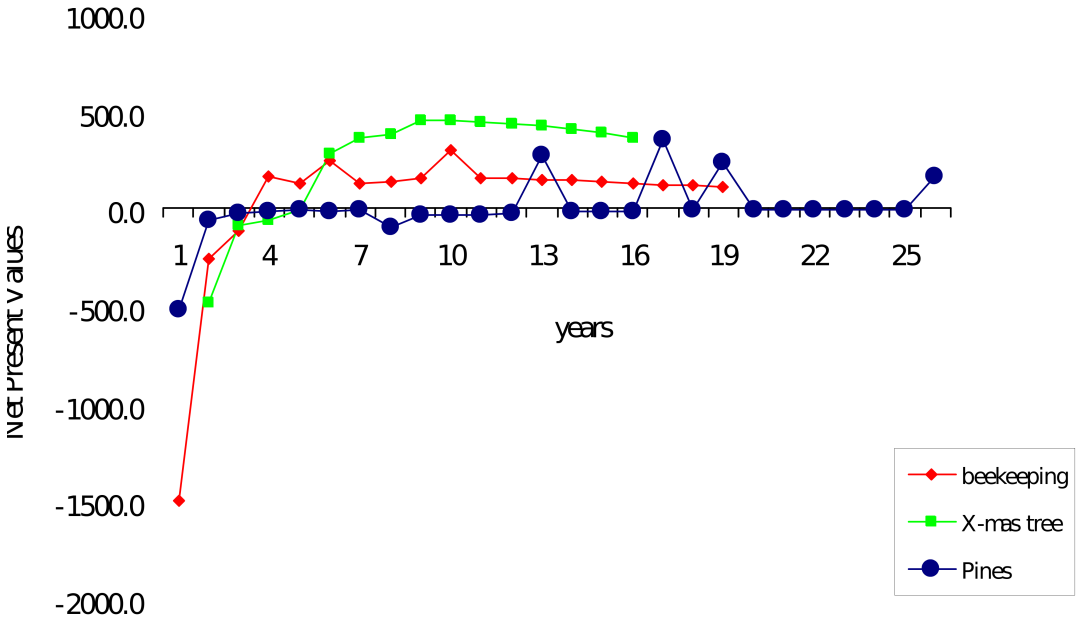

Figure 7: Net Present Values (NPV) for the three production options on the HMFS buffer zone of Kilimanjaro Mountain, Tanzania.

4.3.2 Christmas trees

The christmas tree option gave a Net Present Value (NPV) of US$ 3741.8 under the current practice. When the maximum utilization capacity was considered the NPV was raised to US$ 8894.1. The LEV values followed a similar trend (Table 3). The first four years of the crop experienced negative discounted net revenue followed by an ascending profit up to year ten where it reached a maximum NPV of US$ 447.5 (Fig. 7). It was observed that the first three years were years of investment, the crop was harvested on the fourth year but the revenue was less than the costs incurred. In another study, Johnson *et al.* (1997), experienced a positive NPV of US$ 2515.5 per ha (US$ 1132 per acre), for white pine christmas trees at an 8% discount rate. The analysis was based upon the sale of trees at US$ 10.50 each.

Widringtonia whyteii (Plate 2) is used during Christmas for decoration and is harvested during that period only as an important seasonal commodity. *Widringtonia whyteii* has been preferred due to its characteristics of conical form, blue-green needle colour and have a pleasant fragrance; the needles are soft and can be retained for a long time after they are cut. FAO (2002) described the United States as the major producer of christmas trees in the world with an annual harvest of about 35 million trees during 1993-96. Most trees are harvested for domestic use.

4.3.3 Exotic softwood plantations (pines)

In the option of raising pines plantations, Rombo district council got an NPV of US$ 141.20 from one hectare, which was observed to be low compared to the other two options, but revenue (gross margin) from agricultural crops was not considered in the calculations, as the communities gain more in *taungya* practice than the final harvestable product.

Plate 2: Two years old *Widringtonia whyteii* (Christmass tree) in HMFS in Moshi district, Tanzania.

The low NPV was also attributed by low loyalty for the logs which the district council had set, thus reducing the profit value for the logs. In this study it was observed that when considering agricultural crops gain, there was an addition of US$ 293.3 per ha per year when maize was grown or US$ 266.7 per ha per year when the plot was grown with potatoes (Plate 3). In the actual scenario LEV obtained was US$ 154.9 while in the maximum utilization of the area LEV obtained was US$ 70.8 (Table 3). In the actual scenario revenue gained was high, the reason being that activities like planting, weeding and pruning were not paid for as were done through *taungya* farming, so production cost were much reduced resulting into a high LEV per hectare.

FAO (1989) observed that *taungya* system was a way to reduce the costs of forest plantations establishment, and at the same time contributed to solving social problems. In Campeche, Mexico, where *Cedrela mexicana*, *Swietenia macrophylla* and *Cordia ciricote* were the main species planted, the costs per hectare for planting and tending during five

years, with two weedings per year, were reduced to as much as 27% (to US$ 58.4) of the normal costs through *taungya*.

Plate 3: Young *Pinus patula* trees intercropped with potatoes (taungya practice) in HMFS of Rombo district, Tanzania

In his study, Monela (1989) obtained NPV of aggregate consumption benefit of TAS 3 529 341 (US$ 2941.1) at 1977 constant prices when doing economic analysis on the performance of Meru softwood plantation. The study also showed a spill over effect of contributing agricultural cropland after clearfelling where 50% of sampled households had plots of 0.5 ha on the plantation area. Luoga (1994) obtained positive SEV when comparing production of wattle, pines and tea under smallholder farming and Tanganyika Wattle Company in Njombe though SEV was lower in the pine plantation option than that of wattle and tea. Yet, Sannoh (1998) experienced a positive NPV of TAS 51 416 (US$ 42.6) per ha at a discounting rate of 9% over a 30 year rotation, when appraising management of Magamba softwood plantation project.

4.4 Sensitivity analysis

4.4.1 Beekeeping

To avoid problems associated with future uncertainty, in the beekeeping option, assumptions for maximum revenue gain by utilizing one hectare of land for beekeeping were considered to be optimal weather conditions with readily available forage and water and constant wind. Another assumption was that queen rearing or colony preparation was manipulated by the owner; there was no waiting for bees to enter the hives by their own will or by chance and labour for inspection was constant and minor repairs were done as required.

The above factors were considered in uncertainty for honey and beekeeping production. When the weather was not favourable i.e. forage and water were not readily available production could be halved and LEV obtained was US$ 945.7. Availability of bees in the hives also affects production, so if colonization was not manipulated production could be lowered to ¾ or even ½, some of the hives would be empty (Table 5).

In the first place, when half of the hives are not colonized, production would be lowered to half capacity of one ha, a negative LEV of US$ 4266.1 was obtained. When ¾ of the hives have colonies, but weather was unfavourable then a negative LEV of US$ 1447.8 was obtained. Another scenario considered was when the price fall, say there was bumper crop where honey and wax were sold at a low price of US$ 1.2 (Tsh 1500) and US$ 0.8 (Tsh 1000) respectively, still there was a positive LEV of US$ 5635.1 as long as all the hives had colonies and there was full production per hive. Increase in discounting rate to 12% and 14% did not affect much the LEV obtained, still there was a positive LEV (Table 5).

Looking at the option of utilizing the land for beekeeping, it was observed that although beekeeping was being practiced all over the mountain, it had not been commercialized as most of the products were sold as crude and production of honey and wax was still low, this resulted into low income to beekeepers. The villagers still used crude processing techniques and inappropriate storage facilities and packing materials which made it difficult to control water content, particles of pollen and broods hence low quality bees' products. This was also noted by Ngaga *et al.* (2005) that poor processing technology and storage lowered the quality of bees' products.

At the time of the study, the main activity done was inspection for bee pests but nothing else was done to intervene on productivity; a hive could remain for more than two years without a colony. This alternative had moderate income, but had the strength of benefiting the communities as it is easily adopted, above all there is no competition between keeping bees and tree harvesting (Table 6).

4.4.2 Christmas trees

Risk factors associated with christmas tree production are numerous and they are present for a long period of time, unlike those for annual crops. Owners must constantly watch for potential problems such as fire or pests. In addition, an important market risk exists that cannot be ignored as some people switch to synthetic trees (Table 6). In some marketing areas over-supply can drive that price down substantially, thus resulting in lower values for NVP and LEV. Establishment costs and change in discounting factor were also considered as sensitive factors (Table 5). Sensitivity analysis test for christmas trees project was done considering the above factors.

Table 5: Sensitivity analysis for three management options around the HMFS buffer zone of Kilimanjaro Mountain, Tanzania.

No	Assumptions		% change in assumption	OPTION					
				Beekeeping (US$)		X-mas trees (US$)		Pines (US$)	
	Original	New		NPV	LEV	NPV	LEV	NPV	LEV
1	Favourable weather, full production	Weather not favourable ½ production.	-50	782.69	947.65	na	na	na	na
2	Queen rearing done by owner	No queen rearing ½ of the hives do not have colonies..	-50	-3523.50	-4266.12	na	na	na	na
3	-same-	No queen rearing ½ of the hives have colonies, bad weather	-25	-1195.75	-1447.77	na	na	na	na
4	-same-	No queen rearing ½ of the hives do not have bees & full production		1152.62	1395.55	na	na	na	na
5	Price	bumper harvest & price lowered to 1500 honey and 1000 for wax	-25	4654.18	5635.10	na	na	na	na
6	Real disc rate 0.102	i=0.12	+18	8086.86	9791.25	7793.02	10159.8	-122.91	-134.80
7	0.102	i=0.14	+37	6666.40	8071.42	6764.95	8819.5	na	na
8	0.102	i=0.08	-22	na	na	na	na	397.57	436.03
9	US$ 468.12	Increased establish. cost US$ 564.04	+20	na	na	8808.23	11483.4	na	na
10	US$ 21.43	increase in labour charges US$ 35.71	+25	na	na	8773.56	11438.2	na	na
11	US$ 228.57	Increased transport cost US$ 274.29	+20	na	na	8545.82	11141.3	na	na
12	US$ 1.7	25% increase in price US$ 2.1	+25	na	na	11619.18	15252.3	na	na
13	US$ 1.7	25% decrease in price US$ 1.2	-25	na	na	6089.08	7938.39	na	na
14	1600 trees	Lowered production 1200 trees	-25	na	na	5744.72	7489.44	na	na
15	950 stems	Fire incidence ½ prod from thinning 475 stems	-50	na	na	na	na	-385.79	-423.10
16	US$ 516.08	Increase in establishment costs US$ 612.56	+20	na	na	na	na	-121.68	-133.45
17	US$ 2985.07	increase in price US$ 3283.58	+10	na	na	na	na	170.76	187.28

na=not applicable.

Table 6: Strength, Weakness, Opportunity and Threat (SWOT) analysis of production options in HMFS buffer zone of Kilimanjaro Mountain

Production option	Strength	Weakness	Opportunity	Threat
Beekeeping	1.Moderate NPV/LEV	1.Highly dependent on weather	1.Can easily be adopted by farmers	1.Use of pesticides drive away the bees
	2. Product which does not involve tree harvesting.	2. Low production of honey and wax	2.Local market is readily available	2.Sometimes cause bush fire
	3.Conserve water sources	3.Destructive tree harvesting disturbs bees	3.Colonies can be Manipulated	3.Bumper harvest lowers gate price
Christmas trees	1.Highest NPV/LEV	1.Not easily adopted by farmers	1.Local market is readily available	1.Introduction of synthetic trees
	2.Profuse coppicing	2. Labour intensive	2.*Taungya* can be used in establishment	2.Sensitive to bush fires.
	3.Continuos harvesting	3.Communities do not benefit directly	3.Fodder can be planted in between trees	3.Illegal harvesting or destruction
Pine plantation	1.Low establishment costs	1.Not easily adopted by farmers	1.Provides labour to adjacent communities	1.Availability of labour (*taungya* farmers within forest vicinity)
	2.Intermediate crops(thinning)	2.Low loyalty reduces NPV/LEV	2.Local market is readily available	2.Use of alternative species
	3.Dual income (to farmers and the council)	3.Tending operations determines final crop	3.Land is used for cultivation during early stages.	3.Uprooting of young seedlings to maintain the plots
	4.Appreciating value due to its long term nature	4.Sensitive to discount rate as the increase lowers NPV/LEV	4.Can be sold as standing value	4.High risks of fire & pests.

When establishment costs increased by 20% the LEV obtained was US$ 11483.4 which does not differ very much from the maximum scenario, when labour charges were increased by 25%, LEV changed to US$ 11438.2. Twenty percent increase in transportation charges lowered the LEV to US$ 11141.3. When discount rate was at 12% and 14%, LEV obtained was US$ 10159.8 and 8819.5 respectively.

High LEV per ha was experienced in the ideal or maximum utilization and although in the actual scenario the LEV obtained was almost half that of maximum utilization but still the option gave high LEV per hectare. The option looked like it was the most profitable endeavor the reason being that after the first harvest, the crop could be continuously harvested without a lot of management costs which made it very much profitable (Appendix 7).

Johnson *et al*. (1997) observed that growing white pine christmas trees in Virginia was an enterprise that had wide appeal as a land management alternative with a moderately long-term investment that was time-consuming and labour intensive. In that study it was also observed that growing christmas trees was fairly risky, with unpredictable potential for damage from insects, disease, weather, animals, weeds, and man caused accidents.

4.4.3 Exotic softwood plantations (pines)

In order to see how the NPV and LEV were changing with variations in assumptions, the following sensitivity analyses were performed; change in discount rates in relation to change in NPV and LEV, establishment costs, and fire as a natural factor since the period between investment and harvest is long and anything might happen (Table 5).

Discount rate was varied from 10% to 8% and 12% and the LEV obtained was US$ 436.0 and USD -134.8 respectively, i.e. with low discount rate there was high LEV per hectare, and a discount rate higher than the real discount rate (RDR) gave a negative NPV hence negative LEV. When considering natural incidences like fire, there would be less production in thinning thus a negative LEV of US$ 423.1. If the prices were increased by 10%, LEV obtained was US$187.3. When there was an increase in establishment costs

LEV became US$ -133.45. Sannoh (1998), observed in Magamba softwood plantation that, increasing the discount rate from 9% to 12% shifted the NPV from positive to negative. Softwood plantations were very sensitive to varying discount rates and costs which is one of its big weakness (Table 6). With its long term nature, high discount rate reduces the future benefits significantly.

As far as LEV calculations are concerned, pines options ranked third. This option provided plots for *taungya*, prunings and offcuts are used as household energy, and the option gave double profit to the district authority and the communities as well. Due to land pressure, *taungya* supplements cash and food crops for the communities adjacent to the strip.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results and subsequent discussion, the following conclusions and recommendations have been drawn. The chapter also suggests areas for further research.

5.1 Conclusions

5.1.1 Socio-economic benefit of the Half Mile Forest Strip (HMFS)

The identified current forestland use options on the HMFS are comprised of seven major categories. These include; natural forests, tree plantations, riverine vegetation, cultivated land, shrubs, grassland and bare land. These categories provide environmental services as an integral component of the biosphere. The options also provide employment for those who manage and protect the forest as well as those who depend on the forest to some extent for their livelihoods. Apart from labour in softwood plantations of Christmas trees and pines, the communities benefit directly from beekeeping option and *taungya* practice on the plots of the HMFS which is an important component of income generation and subsequent poverty reduction. *Taungya* has an additional income from agriculture; therefore the provision of plots for cultivation is looked upon as one of the direct benefits enjoyed and acknowledged by adjacent communities. The three district councils therefore benefit directly from the forest products from the HMFS. The benefits are in the form of revenues accrued from sales of the product in a manner that they cannot do without them.

With its direct and indirect benefits to the adjacent communities and the local governments, HMFS as a buffer strip has a considerable dual functions of simultaneously conserving areas of ecological importance and attaining economic development objectives. If buffer

zones cannot be managed successfully, it is not only protected areas that are at risk but also sustainability of rural land use.

5.1.2 Implication of Net Present Value (NPV) and Land Expectation Value (LEV)

The calculations of NPV and LEV and the associated sensitivity analyses have indicated that all the three options (beekeeping, christmas trees and pines) are economically efficient under a wide range of input and output alternatives. The option of managing one ha of christmas trees is the most profitable but the forgoing discussions have led to the logical conclusion that management of pines is profitable to the farmers and the economy of the district authority as a whole. Since farmers can grow food crops locally for self sufficiency, it makes sense to assist farmers to acquire the plots on the strip for *taungya* practice. Principally, the three options can be executed together because they are independent projects which are not mutually exclusive. They are also complementary as they yield different products all of which are important in improving the livelihood.

5.2 Recommendations

On the basis of the results of the social and economic analysis of the three production options, the following measures are recommended in order to increase profitability and hence efficiency.

(i) Market for bee products needs to be strengthened, to ensure additional income to beekeepers. Together with market strengthening, there is a need to train the adjacent communities on best harvesting, packing and storage of bee products to ensure quality products which will fetch higher prices.

(ii) The adjacent communities should be encouraged to be involved in christmas tree project especially on the strip.

(iii) Environmental NGOs in all the three districts should be encouraged to participate in tree planting to conserve the strip for the benefit of the communities.

(iv) The adjacent communities should be given first priority in plot distribution as an incentive in the conservation of the forest.

(v) The district council should look on the possibility of revising the royalty for pines.

5.3 Area for further research

Various participatory models of natural resources management have been introduced around KCFR but have not been evaluated to deliberate on their effectiveness. Due to time limitation and financial constraints, the study could not examine stakeholder analysis and revenue sharing among stakeholders. The study should also compare benefits in villages under Joint Forest Management (JFM) executed by KCFR office, Community Conservation Services (CCS) as practiced by KINAPA and those without intervention.

REFERENCES

Abramovit, J. N. (1998). *Taking a Stand: Cultivating a New Relationship with Worlds' Forest*. World Watch Institute, Danvers, M.A. 84 pp.

ABCP, Afrcan Black wood Conservation Project, (2000) Involvement in Community Based Conservation on Mt. Kilimanjaro. [http://www.blackwoodconservation.org] visited on 8/3/2006.

Akitanda, P.C. and Mongo, C. (2003). Unpublished Annual Report of Kilimanjaro Catchment Forest. 12pp.

Alreck, P.L. and Settle, R.B. (1985). *The Survey Research Handbook*. Irwin Series. Homewood, USA. 136 pp.

Blot, J. (1995). Ecology, Dynamic and Evolution of Vegetation in Kilimanjaro. In: The Conservation of Mount Kilimanjaro. Awareness Drive on Mt Kilimanjaro Forest Reserve. (Edited by Newmark W). The Catchment Forestry Project. Dar es Salaam. Tanzania. pp 82-84.

Bonnicksen, T (1999). Forest Management California Forest Product Commission [http://www.calforest.forest/mngt.htm] visited on 5/11/2004.

Campbell, D.J., Misana, S.B. and Olson, J.M. (2004). Comparing the Kenyan and Tanzanian slope of Mt. Kilimanjaro: Why are the adjacent land uses so distinct? The Land Use Change, Impacts and Dynamics Project. Working paper number 44. Department of Geography UDSM. [www.lucideastafrica.org/publications.htm] visited on 12/08/2006.

Carson, R.T. (2000). Contingent Valuation: A User's Guide. [http://pubs.acs.org/journals/esthag/index.html] Visited on 2/7/2005

Davies, J. and Richard, M. (1999). The Use of Economics to Assess Stakeholder Incentives in Participatory Forest Management: A Review. European Union. Tropical Forestry Paper 5. European Commission Brussels [eutfp_05use of economic analysis.pdf] site visited on 7/3/2006.

Davis, L. S. and Johnson K. N. (1987) *Forest Management*. Mc Graw- Hill Book Company. 790 pp.

Environmental Systems Research Institute (1996). ESRI Arch View GIS. *The Geographic Information System for Everyone*. ESRI, Redlands, USA. 340 pp.

Ebregt, A. & Greve, P. (2000). Buffer Zones and their Management. Policy and Best Practices for Terrestrial Ecosystems in Developing Countries. Theme Studies Series 5. EC-LNV and IAC, Wageningen, The Netherlands. [http://www. snworld.org/ csd/rgSFB] Visited on 19/2/2005.

FAO (1979). *Economic Analysis of Forestry Projects*. No 17 FAO Rome Italy. 193 pp.

FAO (1989). *Forestry and Food Security*. FAO Rome Italy. 127 pp.

FAO (1993). *Assessing Forestry Project Impacts: Issues and Strategies*. FAO Rome Italy. pp 74.

FAO (1998 a). *Indigenous multipurpose trees of Tanzania*: Uses and Economic Benefits for People. [http://www.fao.org/fo] visited 8/3/2006

FAO (1998 b). *Guidelines for the Management of Tropical Forests No 1. The Production of Wood*. Rome Italy. pp 293.

FAO (2000). *Application of The Contingent Valuation Method in Developing Countries- A Survey.* FAO Economic and Social Development Paper 146. FAO Rome Italy. pp 63.

FAO (2002). Trees outside the Forest – Towards a Better Awareness. Conservation Guide paper 35. [http://fao.org/docrep/005/y2328e/ y2328e00.HTM] visited on 10/3/2006.

Gregory, R. G. (1987). *Resource Economics for Foresters*. John Wiley and Sons. New York. 477 pp.

Hall J. B and Rodgers W. A (1992). Buffers at the boundary. *Rural development forestry network*. Paper 13a Social Forestry Network ISSN 0951-1857 [http://www.rcfa_cfan.org/services/buferzone.htm] site visited on 19/2/2005.

Howard, A.F. and Valerio, J. (1996). Financial Returns From Sustainable Forest Management And Selected Agricultural Land Use Options In Costa Rica. *Forest Ecology & Management.* 81: 35-49.

Hylander, K., Johnson, B.G. and Nilson, C. (1997). Evaluating Buffer Strips along Boreal Streams Using Bryophytes as Indicators. [http://.esajournals.org/esaonline/html] site visited on 15/11/2004.

Johnson, J. E.; Leuschner. W. A, and. Burchinal, F. E. (1997) Economics of Producing an Acre of White Pine Christmas Trees. Publication Number: 420-081, Virginia Department of Forestry [http:www.ext.vt.edu/pubs/forestry/420-081] visited on 5/11/2004.

Kajembe, G.C. (1994). Indigenous Management System as a Basis For Community Forestry in Tanzania. A Case Study of Dodoma Urban And Lushoto Districts. Tropical Resource Management Paper No 6. Wageningen Agricultural University. The Netherlands Framework for Intergrating Biodiversity Conservation and Sustainable Management Development. Maryland 194. pp.

Kajembe, G.C., Namubiru, E.L., Shemweta, D.T., Luoga, E.J and Mwaipopo, C (2004). The Impact of Rules in Forest Conservation in Tanzania. A Case of Kwizu Forest, Same District, Kilimanjaro. In: Shemweta, D.T.K., Luoga, E.J., Kajembe G.C. and Madoffe S.S (eds) Proceedings of The Ifri East African Regional Conference pp 92-107.

Kanshahu, A. I. (1996). *Planning and Implementing Sustainable Projects in Developing Countries. Theory, Practice & Economics*. Agbè Publishing Holland. pp196.

Kashenge, S.S. (1995). Catchment Management Plan for Kilimanjaro Forest Reserve. Forest Division, Tanzania. Unpublished. 18pp.

Katigula, M.I.L. (1992). Conservation of the Ecosystem on Mount Kilimnajaro. Reality in Experience Catchment Forests. Tanzania Catchment Forests. Unpublished. 97pp.

Kihiyo V. B.M.S. (1998). Forest Policy Change in Tanzania: Towards Community Participation.SUA.[http://srdis.ciencis.columbia.edu/cases/tanzania-009'html] site visited on 13/10/2004.

Kivumbi C.O. & Newmark W.D. (1995). The History of the Half-Mile Forestry Strip on Mount Kilimanjaro. In: The Conservation of Mount Kilimanjaro. Awareness Drive on Mt Kilimanjaro Forest Reserve. (Edited by Newmark W). The Catchment Forestry Project. Dar es Salaam. Tanzania. pp 81-86.

Lambrechts, C., Bongo W., Hemp, A., Hemp, C. and Nyiti, P. (2002). Aerial Survey of the Threats to Mount Kilimanjaro Forests. UNEP/UNDP GEF Programme. 48 pp.

Leighton, M., Cherry, R., Hikma, L. (1997) Community Logging in The Buffer Zone of Gunung Palung National Park in West Kalimantan. [http://www.worldwildlife. org/bsp/bcn/projects.htm] site visited on 19/2/2005.

Leuschner, W.A. (1984). *Introduction to Forest Resource Management.* John Wiley & Sons USA. 298 pp.

Lovett, J.C And Poćs, T. (1993). Assessment of the Conditions of the Catchment Forest Reserves. Catchment Forest Project – FBD. Dar Es Salaam. Unpublished consultancy report. 105pp.

Luoga, E.J. (1994). An Economic Analysis of Forest Production Alternatives in Njombe District, Tanzania. Case Study of Tanganyika Wattle Company (TANWAT) and Surrounding Villages. Unpublished MSc Thesis, Agrculture University of Norway. 126pp.

Luoga, E. J., Witkowisk, E. T. F. and Balkwill, K. (2000). Economics of Charcoal Production in Miombo Woodlands of Eastern Tanzania: some hidden costs associated with commercialization of the resource. *Ecological Economics* 35: 243-257.

Luoga, E.J., Kajembe, G.C., Shemweta, D.T.K., Zahabu, E. and Mwaipopo, C. (2005). Assessment of Tree Stocking and Diversity for Joint Forest Management (JFM) in Nkweshoo Village Forest Management Area, Kilimanjaro, Tanzania. *Forests Trees and Livelihoods.* 15:259-273.

Malimbwi, R.E., E. Luoga and R. Mwamakimbullah (2001). Inventory Report of Kilimanjaro Catchment Forest Reserve (Unpublished). 96pp.

Misana S.B. (1995). Importance of Mount Kilimajaro and the Need for its Integrated Management and Conservation. In: The Conservation of Mount Kilimanjaro. Awareness Drive on Mt Kilimanjaro Forest Reserve. (Edited by Newmark W). The Catchment Forestry Project. Dar es Salaam. Tanzania. pp 103-110.

Mbonile, M.J. (1995). Population Mobility and Migration in Mount Kilimanjaro. In: The Conservation of Mount Kilimanjaro. Awareness Drive on Mt Kilimanjaro Forest Reserve. (Edited by Newmark W). The Catchment Forestry Project. Dar es Salaam. Tanzania. pp 24-33.

Mbonile, M.J. (2003). Absentee Farmers and Change of Land Management on Mount Kilimanjaro, Tanzania. The Land Use Change, Impacts and Dynamics Project.

Working paper number 24. Department of Geography UDSM. [www.lucideastafrica.org/publications.htm] site visited on 12/08/2006.

Mogaka, H., Gacheke, S., Turpie, J., Emerton, L. and Karanja, F. (2001). *Economic Aspects of Community Involvement in Sustainable Forest Management in Eastern and Southern Africa*. Laba Graphic Services. Nairobi Kenya. 151 pp.

Monela, G. C. (1989). A Socio-Economic Analysis of Forest Plantation: A Case of Meru Forest Project, Arusha – Tanzania. MSc Thesis, SUA Morogoro. 170 pp.

Moustafa, H. (2000). Beekeeping in Africa. *Apimondia. Apiacta.* 3:32-48. [http://www.fao.org/docrep/t0104e] site visited on 28/08/2006

Murniati, Garrity, D. and Gintings, A. Ng. (2001). The Contribution of Agroforestry Systems to Reducing Farmers' Dependency on the Resources of Adjacent National Parks: A Case Study from Sumatra, Indonesia. *Agroforestry Systems* 52:171-184.,

Mwaikambo, N. W. (2001). Farmers Co-Operatives, Crop Enterprises and Gender in Kilimanjaro Region: A Socio-Economic Analysis. MSc Thesis, SUA Morogoro. 113pp.

Navrud S. and Mungatana E.D. (2002). Environmental Valuation in Developing Countries: The Recreational Value of Wildlife Viewing. *Ecological Economics 11 (2) 135-151. Elsevier Science*. [www.sciencedirect.com] site visited on 2/7/2005.

Newmark, D. (1995). Priorities for The Conservation of Mount Kilimanjaro. In: The Conservation of Mount Kilimanjaro. Awareness Drive on Mt Kilimanjaro Forest Reserve. (Edited by Newmark W). The Catchment Forestry Project. Dar es Salaam. Tanzania. pp 111-113.

Ngaga, Y., Otsyina, R., Senkondo E. and Mpuya P. (2005). Economic Survey on the Role of Beekeeping in Poverty Reduction and Environmental Conservation in Chunya,

Songea and Nachingwea Districts of Tanzania. Ministry Of Natural Resources and Tourism Forestry and Beekeeping Division. Consultancy report. 157pp.

Ngoile M., Kohi Y. and Rodgers W.A. (Eds) (2001). Planning for the Long Term Conservation of The Mount Kilimanjaro Ecosystem.Workshop Proceedings Held at Moshi. NEMC, COSTECH, IUCN and UNESCO. 89pp.

Nieuwenhuyse, A., Hengsdijk, H., Bouman, B.A.M., Schipper, R.A. and Jansen, H. (2000). Can Forest be a Competitive Land Use Option? Model Simulation from Humid Tropical Costa Rica. *Forest Ecology and Mangement* 137: 23-40. *Elsevier Science*.

Nyaki, J and Mshana M. (1999). Half Mile Forest Strip Development (Uendlezaji wa Msitu wa Nusu Maili). Report to Moshi District Administrative Offier (Unpublished). 4pp.

Okting'ati, A. (1992). Financial Returns from Tree Crops. Paper Presented in Seminar in Investment Opportunities in Forestry in Tanzania 10 Nov 1992. Forestry Action Plan, Dar es Salaam. 28 pp.

Ronald, W.T. and Kidegesho, R. (1997). Protecting the Catchment of Kifura Forest Reserve .SIT Wildlife Ecology and Conservation (Unpublished Research Report). 54pp.

Sannoh, A. (1998). An Economic Analysis of Magamba Forest Project. MSc Thesis, SUA Morogoro. 84 pp.

Sayer, J. (1991). *Rainforest Buffer Zones: Guidelines for Protected Area Management*. IUCN-The World Conservation Union Gland. 127 pp.

Schelhas, J. and Greenberg, R. (1996). *Forest Patches in Tropical Landscapes*. Island Press. Washington DC. 426 pp.

Shultz S., Pinazzo J. and Cifuentes M. (1998). Opportunities and Limitations of Contingent Valuation Surveys to Determine National Park Entrance Fees: Evidence from Costa Rica. [www.ingentaconnect.com] site visited on 2/7/2005.

Smith. C., Pyden, N and Cole, P (1991) (Editors) Erdas Field Guide. Erdas Inc. Atlanta, Georgia. 116pp.

Stein, E. (2003) Bee keepers in Norway and Tanzanian. Fredskorpset Dep, N-0031 Oslo, Norway. [http://.fredskorpset.no/templates_107.aspx] site visited on 22/3/2006.

Strange N., Tarp P., Finn Helles F. and John Douglas Brodie, J.D. (1999). A four-stage approach to evaluate management alternatives in multiple-use forestry. *Forest Ecology and Management* 124:79-91. *Elsevier Science*. [http://www. aginternetwork net] site visited on 13/8/2006.

TANAPA (1993). Kilimanjaro National Park General Management Plan. (Unpublished). 123pp.

URT (United Republic of Tanzania) (1998). *National Forest Policy.* Government Printers, Dar Es Salaam. 59 pp.

Urio N. A. (2002) Feed resources for dairy farmers in Kilimanjaro, Tanzania Animal Science and Production Department, Faculty of Agriculture Sokoine University of Agriculture, Morogoro, Tanzania [http://www.ilri.cgiar/ Inforserv/Webpub] site visited on 8/3/2006.

Warner, M.R.W. (1986). *Decision Making in Forest Management*. Galliard Printers Ltd. Great Printers Lts. Great Britain. 133 pp.

William, C. M. (2003). The Implications of Changes in Land Use on Forests and Biodiversity: A Case of Half Mile Strip on Mount Kilimanjaro, Tanzania. Working paper number 30. Department of Geography UDSM. [www.lucideastafrica.org/ publications.htm] site visited on 12/08/2006.

van Gardingen P. R., McLeish M. J., Phillips P. D., Fadilah D., Tyrie G. and Yasman I. (2003) Financial and Ecological Analysis of Management Options for Logged-over Dipterocarp Forests in Indonesian Borneo. [https:www.aginternetwork.net/http:/www.sciencedirect.com] site visited on 19/2/2005

APPENDICES

Appendix 1: Questionnaire for household data (English Version)

(This is to be completed by the head of the household)

BASIC INFORMATION

1. Date …… 2. Household ID ……..
3. Name of household head/respondent……..…….1.Male 2. Female
4. Age …… 5. Ethnicity/tribe …….
6. Village …….. sub village/hamlet……
7. Ward …… 8. Division ……..
9. District ……

Section A. Family Structure

1. Household composition

1.1 Who live with you here at present?

No	Relationship to household head	Sex M/F	Age	Main occupation	Education level
1.					
2.					
3.					
4.					
5.					
6.					
7.					

- Relationship to household head: husband /wife, son/daughter, father, mother, others (specify)
- Education levels Primary P 1-7 e.g. std 3 P3, secondary F1 – 6, Others specify

SECTION B: SOCIO ECONOMIC STATUS

2. Area of the land you cultivate and tenure system

2.1 Farming: what is the size of the land under cultivation..……(acres)

2.2 Tenure system of the above-mentioned plot:

1. Inherited……..……..(acres).
3. Bought…….(acres)
4. Rented (paid)……...(acres)
5. On the HMFS (*Taungya*)…….(acres)

3. Crop production in2004/2005 season.

		Land under *taungya* system			Other land		
S/No	Crop	Costs incurred Tsh	Yield Volume kg	Sold value Tsh	Costs incurred Tsh	Yield Volume kg	Sold value Tsh
1.	Maize						
2.	Beans						
3.	Banana						
4.	Coffee						
5.	Potatoes						
6.	Carrots						
7.	Cabbage						
8.	Tomatoes						
9.	Onions						
10.	Other crops						

4. Livestock keeping and poultry

4.1 Type of livestock kept and number □1 Cattle……. □2.Goat...…….
□3.Sheep…….□4.Chicken…… □5.Others…….

4.2 Type of grazing
□1. Free grazing in village land □2. In the forest reserve □3. In door (zero) grazing
□4.In the halfmile forest

4.3 If zero grazing where do you get your fodder
□1. From my plot □2. From the forest reserve □3. From the halfmile forest
□4. I buy

4.4 If bought at what price per load…….(estimation of a load)

4.5 How far does the person go to collect fodder……(estimate distance)

4.6 How long does it take to reach where you collect fodder……..(hrs/day)

SECTION C. FOREST PRODUCT UTILIZATION & MANAGEMENT ISSUES

5. Uses of HMFS

5.1 What do you benefit from the HMFS?…. □1. Timber □2. Water □3 Grazing □4.Fodder □5.Beekeeping □6. Scenic beauty □7. Poles □8. Rituals □9. Firewood □10.Cultivation……□11.Others……

5.2 How do you get these benefits? □1.Free □3. We buy □4.Other methods (mention) …….

5.3 If bought, how much do pay for □1.timber…….Tsh/m^3 □2.Fodder……Tsh/head load
□3.Poles…….Tsh/m^3 □4.License for grazing…..Tsh/year
□5.Eco-tourism……Tsh/day
□6.Hanging hives…..Tsh/hive □7. Cultivation……Tsh/acre □8.Others…….

5.4 How much would you like to pay for □1.timber…….Tsh/m^3 □2.Fodder……Tsh/head load □3. Poles…….Tsh/m^3□4.License for grazing…..Tsh/year
□5.Eco-tourism……Tsh/day
□6.Hanging hives …..Tsh/hive □7.Cultivaion……Tsh/acre □8.Others…….

6. Do you collect any food materials from the HMFS? □1.Yes □2.No

6.1 If yes, what do you collect? ……..
6.2 If it was sold how much do you think you could pay for it?……..Tsh/unit

7. Cooking facility

7.1 What kind of cooking facility do you use
□1.Open three stone, □2.Improved stove □3.Charcoal stove,
□4.Kerosene stove□5.Others…..

8. What kind of fuel do you usually use for cooking?

□1. Fire wood, □2. Charcoal □3. Electricity □4. Gas □5. Kerosene □6. Others……

9. Firewood

9.1 How much firewood do you use per week …….. head loads
9.2 How do you get firewood? □1.Collect □2.Buy,
9.3 If bought how much does it cost per load?…….(estimate head load)
9.4 How much do you think is fair to pay for the head load? ……Tsh.
9.5 Where is the firewood collected? □1.Homestead, □2.Own farmland, □3.Neighbours, □4.Forest reserve, □5.Half-mile forest □6.Others (specify……..
9.6 Do you pay for the firewood collection? □1.Yes □2. No.
9.7 If yes how much do you pay?……Tsh.
9.8 How much would you like to pay for the head load……Tsh.
9.9 How far does the person go to collect fire wood……(estimate distance)
9.10 How long does it take to reach where you collect firewood……..(hrs/min)

10. Water

10.1 What kind of water source do you use?
□1.Tap water, □2.River water, □3.Spring water, □4.Tube well, □5.Others
10.2 Do you pay for the water? □1.Yes □2.No
10.3 If yes how much do you pay for a 20lt bucket?…….
10.4 How much would you like to pay for a 20lt bucket?……
10.5 How far is the source from your house ……..km
10.6 How long does it take to go to the water source ……(estimate hrs/day)

11. Tree planting

11.1 In the past 5 yrs have you or other family members ever planted trees on your private land. □1.Yes □2.No
11.2 If No, why □1.Lack of necessity □2. Lack of seedlings,□3. Labour shortage,□4. Lack of knowledge □5. .Others reason……
11.3 If yes which species, how many, when planted and for what uses.

Species	Number	When planted	Uses

11.4 To whom does the planted trees belong?□1.The family □2.Person who planted □3.Village
11.5 Where did you get the seedling □1.schools nursery, □2.Forest office, □3.Environmental committee, □4.Buy □5.Others sources……..
11.6 What is the cost of seedlings if bought……..
11.7 What are the costs incurred in tending operations?…….
11.8 Other costs incurred in tree planting activity…….
11.9 What are the mandays used in tree planting activities? Planting…….mds. Weeding…….mds. Beating up……mds. Others……mds

12. Beekeeping activities

12.1 Do you practice beekeeping in the HMFS. Yes….. No….

12.2 If Yes give the number of hives…… stocked……..empty…… per year

12.3 Amount produced per hive per year 1.Honey…….lts 2. Wax…… kgs3.Others

12.4 Do you sell the products? 1.Yes 2.No.

12.5 How much do you sell per unit? 1.Honey…..Tsh/lt. 2.Wax……Tsh/kg. 3.Others……

12.6 Where do you sell?…….

12.7 How many times do you harvest per year? ……Specify the time of harvest/year

12.8 How many mandays do you use in beekeeping activities……mds/week,month,year.

12.9 In your family who are involved in beekeeping?……..

12.10 What costs do you incur in beekeeping activities?…….

13 Is it worth having the HMFS? 1.Yes 2.No

13.1 Why…….

13.2 How much will you pay for its existence…….Tsh/ha

THANK YOU VERY MUCH FOR YOUR COOPERATION.

KISWAHILI VERSION
Maswali dodoso kwa kaya
(Ijazwe na mkuu wa kaya)
MASWALI YA MSINGI
1. Tarehe ……2. Namba ya kaya ……..
3. Jina la mwulizwaji...…….. 1.Mume 2. Mke
4. Umri…… 5. Mzaliwa/mhamiaji/kabila …….
6. Kijiji …….. Kitongoji….……
7. Kata …… 8. Tarafa ……..
9. Wilaya ……

Sehemu A. Muundo wa familia

6. Muundo wa kaya
1.1 Unaoishi nao kwa sasa ni kina nani?

Na	Uhusiano na mkuu wa kaya	jinsia Mume/ Mke	Umri	Kazi yake	Kiwango cha elimu
1.					
2.					
3.					
4.					
5.					
6.					
7.					

- Uhusiano na mkuu wa kaya: mume/mke wake, binti/mwana, baba, mama, wengineo (taja uhusiano)
- Kiwango cha elimu, E/msingi P 1-7 mf. drs 3 P3, sekondari F1 – 6,Vinginevyo (taja)

SEHEMU B: UCHUMI

7. Eneo unalolima na miliki yake.
2.1 Kilimo:Unalima eneo kiasi gani……..…….(ekari)
2.2 Miliki ya eneo ulilotaja juu:
1. Urithi……..……. (ekari).
2. Umepewa na serikali ya kijiji……(ekari)
8. Umenunua…….(ekari)
9. Umekodishiwa (unalipa)……...(ekari)
10. Umeazimwa (hulipi)……..…(ekari)
11. Nusu maili (*Taungya*)……(ekari)
12. Mnagawana mazao…….…… ..(ekari)

3. Mavuno ya mazao msimu wa 2004/2005.

		Ardhi kwenye *taungya* (nusu maili)			Maeneo mengine		
S/No	Zao	Gharama Tsh	Mavuno kiwango kg	Thamani mauzo Tsh	Gharama Tsh	Mavuno kiwango kg	Thamani Tsh
1.	Mahindi						
2.	Maharage						
3.	Ndizi						
4.	Kahawa						
5.	Viazi mv						
6.	Karoti						
7.	Kabichi						
8.	Nyanya						
9.	Vitunguu						
10.	Mazao mengine						

4. Mifugo (na kuku)

4.4 Aina ya mifugo na idadi 1 Ng'ombe……. 2.Mbuzi...……. 3.Kondoo…….4.Kuku…… 5.Wegineo…….

4.5 Jinsi ya kulisha mifugo

1.Huria ardhi ya kijiji 2.Ndani ya msitu wa hifadhi 3. Ndani ya banda 4.Kwenye msitu wa nusu maili

4.6 Kama bandani, unapata wapi majani?

1. Shambani mwangu 2. Msitu wa hifadhi 3. Msitu wa nusu maili 4. Nanunua

4.4 Kama unanunua mzigo ni shs ngapi?…….(kadiria mzigo kg/siku)

4.5 Je ni umbali gani (msituni) majani yanapopatikana?……(kadiria umbali km)

4.6 Inachukua muda gani kwenda na kurudi kufuata majani?……(kadiria muda/siku)

SEHEMU C. MATUMIZI YA MAZAO YA MISITU & MANAGEMENT ISSUES

5. Matumizi ya msitu wa nusu maili.

5.3 Unapata nini toka HMFS?…. 1. Mbao 2. Maji 3 kulishia mifugo 4.Majani 5.ufugaji nyuki 6. mandhari nzuri 7. Nguzo 8. Matambiko 9. kuni 10.Kilimo……11.Mengineyo……

5.4 Mnayapataje hayo kutoka HMFS? 1.Bure(Hatununui)3. tunanunua 4.Vinginevyo (eleza)…….

5.3 Iwapo mnanunua mnalipa shs ngapi kwa 1.mbao…….Tsh/m^3 2.majani……Tsh/mzigo 3.Nguzo…….Tsh/m^3 4.Leseni kulishia mifugo…..Tsh/mwaka 5.utalii ikolojia……Tsh/day 6.kutundika mizinga…..Tsh/mzinga 7. kilimo……Tsh/acre 8.mengineyo…….

5.4 Ungependa ulipe shs ngapi kwa 1.mbao…….Tsh/m^3 2.Majani……Tsh/mzigo 3.Nguzo…….Tsh/$m^3$4.Leseni ya kulishia mifugo…..Tsh/mwaka 5.utalii ikologia……Tsh/siku 6.kutundika mizinga …..Tsh/mzinga 7.Kilimo……Tsh/ekari 8.mengineyo…..…….

6. Je unakusanya aina yoyote ya chakula toka HMFS? □1.Ndio □2.Hapana

6.1 Kama ndio ni kitu gani ? ……..

6.2 Kama kingeuzwa ungelipia shs ngapi?……..Tsh/unit

7. Matumizi ya kupikia.

7.2 Unapikia jiko la aina gani?

□1.Mafiga matatu, □2.Jiko sanifu □3.La mkaa la kawaida, □4.La mafuta ya taa □5.Mengineyo…..

8. Kawaida unatumia nishati aina gani kupikia?

□1. kuni, □2. mkaa □3. umeme □4. Gesi □5. mafuta ya taa □6. Mengineyo…….

9. Kuni

9.11 Unatumia kuni kiasi gani kwa wiki? …….. ….(mizigo)

9.12 Unapata wapi kuni? □1.Naokota □2.nanunua,

9.13 Ukinunua unalipa shs ngapi kwa mzigo?…….(kadiria mzigo)

9.14 Kihalali unafikiri ungelipa shs ngapi kwa mzigo? ……Tsh.

9.15 Unakusanya kuni kutoka wapi? □1.Viunga vya nyumba, □2.shamba langu, □3.kwa jirani, □4.msitu wa hifadhi, □5.Msitu wa nusu maili □6.Kwingine……..

9.16 Je unalipia ukusanyaji kuni? □1.Ndio □2. Hapana.

9.17 Kama ndio unalipa shs ngapi?……Tsh/mzigo/siku.

9.18 Ungependa ulipe shs ngapi kwa mzigo …….……Tsh.

9.19 Ni umbali gani kufikia eneo mnalopata kuni?……(kadiria umbali)

9.20 Unachukua muda gani kwenda na kurudi?……..(saa/siku)

10. Maji

10.4 Ni vyanzo gani vya maji mnavyotumia?

□1.Maji ya bomba, □2.Maji ya mto, □3.Chemchem, □4.Kisima, □5.Mengineyo

10.5 Je mnalipia huduma ya maji? □1.Ndio □2.Hapana

10.6 Kama ndio,mnalipia shs ngapi kwa ndoo ya lita 20?…….

10.4 ungependa ulipie shs ngapi kwa ndoo ya lita 20?……

10.5 Chanzo cha maji kiko umbali gani toka nyumbani kwako……..km

10.6 Unachukua muda gani kwenda na kurudi ……(Kadiria muda saa/siku)

11. Upandaji miti

11.10 Katika miaka mitano iliyopita ,je wewe au mwanafamilia mmepanda miti katika eneo lenu binafsi. □1.Ndio □2.Hapana

11.11 Kama hapana, kwa nini? □1.Hamna umuhimu □2.Ukosefu wa miche, □3.Upungufu wa nguvukazi, □4.Ukosefu wa ujuzi □5.mengineyo……

11.12 Kama ndio,mmepanda aina gani, idadi,lini na kwa madhumuni gani.

Aina	Idadi	Imapandwa lini (Mwaka)	Matumizi

11.13 Miti hiyo inamilikiwa na nani?□1.Familia? □2.Aliyepanda □3.Kijiji

11.14 Ulipata wapi miche?□1.Bustani ya shule, □2.Ofisi ya misitu, □3.Kamati ya mazingira □4.Nimenunua □5.Vyanzo vingine……..

11.15 Kama umenunua mche mmoja unauzwaje?……..

11.16 Gharama gani unazotumia kutunza miche ?…….

11.17 Gharama za upandaji miti…….

11.18 Unatumia muda gani katika shughuli za upandaji miti? Kupanda…….mds. Kupalilia…….mds. Kurudishia……mds.Mengineyo……mds

12. Ufugaji nyuki

12.1Je unafanya shughuli za ufugaji nyuki msitu wa nusu maili. Ndio.Hapana….
12.2 Kama ndio una mizinga mingapi……Yenye nyuki…….mitupu……kwa mwaka
12.3 Mzinga unazalisha kiasi gani 1.Asali…….lts 2. Nta.…kgs3.Mengineyo.....
12.4 Je unauza unchozalisha? 1.Ndio 2.Hapana.
12.5 Unauza kwa bei gani? 1.Asali…..Tsh/lt. 2.Nta…Tsh/kg.3.Mengineyo……
12.6 Unauzia wapi?.....…….
12.7 Unavuna mara ngapi kwa mwaka? …….....(Niambie vipindi kwa mwaka)
12.8 Unatumia siku ngapi kwa shughuli za nyuki.....……mds/wiki,mwezi,mwaka.
12.9 Katika familia nani wanajishughulisha na ufugaji nyuki……..
12.10 Unatumia gharama gani katika ufugaji nyuki?…….

13 Je msitu wa nusu maili una maana kuwepo1.**Ndio** 2.**Hapana**

13.1Kwanini?…….
13.2Unaweza kulipia shs ngapi ili uwepo…….Tsh/ha

ASANTE SANA KWA USHIRIKIANO ULIOONESHA.

Appendix 2: Checklist Questionnaires for key informants

A: District natural resources officers

1. What are the current production options and respective areas on the HMFS?
2. What is the current cost/benefit sharing mechanism with the community around HMFS?
3. What are the costs incurred in establishing the HMFS? Land preparation, seedlings, pitting, planting and beating up.
4. What are the costs incurred in maintaining the HMFS? Weeding, pruning, thinning, patrols, firebreaks and harvesting costs.
5. What are the harvesting procedures?
6. What is the price of timber? (Tsh/m^3)
7. How much do you charge per head load of fodder?
8. How much do you charge for poles?
9. How much do you charge for license for grazing?
10. How much do you charge for a head load of firewood?
11. How much do you charge for eco-tourism/day?
12. What is the system of land allocation for *taungya* practice?
13. Who is given priority?
14. How much do you charge per ha of land on the HMFS?
15. Volume of timber harvested/ha on the HMFS in the past five years
16. Revenues from HMFS in the past five years (for different options)
17. Management problems
18. Future prospects

B: Village government and environmental committee

1. Who initiated community conservation activities
2. What is the status of village environmental committee in forest management
3. How do you participate in the activities
4. How do the villagers participate in the activities
5. What costs is incurred in this joint venture
6. What are the benefits accrued
7. How do you implement forest protection rules and village forest bylaws

C: Non governmental organization (NGO's)

1. Main objective of the project
2. Activities done and their contribution to the management of KCFR and HMFS
3. What are the uses of the planted trees
4. How does the community benefit from the planted trees
5. What are the costs incurred in the activities.
6. What are the problems experienced and how were they solved.

Appendix 3: Checklist for Non Governmental Organizations

C: Non governmental organization (NGOs)

7. Jina la shirika lenu ....
   .....
8. Mahali lilipo: Kijiji……. Wilaya .....
9. Malengo ya shirika lenu…….
   ……
   ……
   ……
   Shughuli zenu na mchango wake katika hifadhi ya msitu wa nusu maili
   ……
   ……
   ……
   ……
10. Mnapata wapi mafungu ya kuendesha shughuli zenu? .....
    ……
11. Gharama gani mlizotumia katika shughuli hiyo ya upandaji miti

MWAKA	KUANZISHA Tsh		HEKTA	KUTUNZA Tsh		HEKTA
2004	Land prep			Weeding		
	Seedlings			Pruning		
	Pitting			Thinning		
	Planting			Patrols		
	Beating up			Firebreaks		
	Others			Others		
2003	Land prep			Weeding		
	Seedlings			Pruning		
	Pitting			Thinning		
	Planting			Patrols		
	Beating up			Firebreaks		
	Others			Others		
2002	Land prep			Weeding		
	Seedlings			Pruning		
	Pitting			Thinning		
	Planting			Patrols		
	Beating up			Firebreaks		
	Others			Others		
2001	Land prep			Weeding		
	Seedlings			Pruning		
	Pitting			Thinning		
	Planting			Patrols		
	Beating up			Firebreaks		
	Others			Others		

2000	Land prep			Weeding		
	Seedlings			Pruning		
	Pitting			Thinning		
	Planting			Patrols		
	Beating up			Firebreaks		
	Others			Others		

12. Miti iliyopandwa ina matumizi gani

AINA (Species)	Mwaka uliyopandwa	Hekta	MATUMIZI

13. Jamii inafaidika vipi na miti iliyopandwa.

(a) Kwa sasa ……...……
……
……
……

(b) Baadaye .....
……
……
……

Mmepata matatizo gani na mmeyatatua vipi ....
.....
.....
.....

Mna malengo gani ya hapo baadaye ....
.....
.....
.....

Appendix 4: Follow up for compartments (soft wood plantation)

District _____
Compt no _____ Spp _____ Area _____
Rotation_____
Yr planted _____ Year harvested _____ Revenue _____

YEAR	ACTIVITY	TOTAL COST	BENEFIT/ REV	COST PER UNIT	TOTAL IN UNIT
0					
1					

Appendix 5: Beekeeping activities

District _____
Hives per Ha_____
Cost per hive (traditional) _____ (modern) _____
Capacity of one hive (tradition) _____ (modern) _____
Life span of a hive_____
Harvesting per hive (lts honey) _____ (kg wax) _____
Intermediate activities

YEAR	ACTIVITY	TOTAL COST	BENEFIT/ REV	COST PER UNIT	TOTAL IN UNIT
0					
1					

Appendix 6: LEV obtained in utilizing the land for beekeeping activities, Hai district.

Working year	Activity year	Actual gain i=0.102	Maximum capacity i=0.102
		Disc. net rev US$	Disc. net rev US$
0	2000	-1498.00	-5586.50
1	2001	-257.80	795.42
2	2002	-115.62	2082.57
3	2003	162.50	1797.35
4	2004	127.86	1556.33
5	2005	243.22	1187.93
6	2006	129.52	1101.89
7	2007	135.87	904.65
8	2008	154.25	843.58
9	2009	300.70	1395.34
10	2010	158.18	637.44
11	2011	155.03	552.11
12	2012	150.12	478.93
13	2013	146.73	423.95
14	2014	140.56	371.11
15	2015	132.70	322.56
16	2016	120.99	272.47
17	2017	119.51	250.71
18	2018	110.89	217.71
	NPV	**617.28**	**9605.54**
	LEV US$/Ha	**747.38**	**11630.01**

Assumptions for maximum revenue gain by utilizing one hectare of lands for beekeeping

1. Weather is standard that is there is readily available forage
2. There is readily available water
3. wind is constant, there is no strong wind
4. Queen rearing is done by the owner; there is no waiting for bees to enter the hives by their own will.
5. Labour for inspection is constant and minor repairs are done as required.

Appendix 7: LEV obtained in utilizing the land for plantation of Christmas trees. Moshi district

Working year	Activity year	Actual gain i=0.102	Maximum capacity i=0.102
		Disc. net rev US$	Disc. net rev US$
1	2002	-486.03	-389.55
2	2003	-88.90	-31.98
3	2004	-56.58	951.83
4	2005	-10.06	778.06
5	2006	277.25	1015.31
6	2007	361.28	1028.96
7	2008	382.71	891.83
8	2009	451.30	891.11
9	2010	453.07	775.33
10	2011	447.53	675.74
11	2012	436.61	589.87
12	2013	421.85	515.65
13	2014	404.43	455.45
14	2015	385.28	399.19
15	2016	362.07	347.34
	NPV	**3741.82**	**8894.13**
	LEV US$/Ha	**4878.24**	**11595.4**

Assumptions for maximum revenue gain by utilizing one Ha of forest land for Christmas tree plantation

1. Rain is adequate to enable growth of three coppices on each stem after initial cut.
2. One coppice with height of 1.5-2m is removed in each season up to 15 years where there is chopping of the stump to get new crops.
3. Market is readily available and there is no competition for the product.

Appendix 8: LEV obtained in utilizing the land for Pine plantation Rombo district

Working year	Activity year	Actual gain i=0.102	Maximum capacity i=0.102
		Disc. net rev US$	Disc. net rev US$
0	1994	-516.08	-516.08
1	1995	-30.03	-56.56
2	1996	-1.82	-28.01
3	1997	0	-17.97
4	1998	0	-7.49
5	1999	0	-12.40
6	2000	0	-5.58
7	2001	-45.70	-95.96
8	2002	-36.89	-36.89
9	2003	-32.40	-32.41
10	2004	-28.85	-28.85
11	2005	-23.98	-23.98
12	2006	232.66	268.85
13	2007	-18.04	-18.04
14	2008	-15.63	-15.63
15	2009	-13.58	-13.58
16	2010	353.45	353.45
17	2011	-10.30	-10.30
18	2012	201.49	235.20
19	2013	-7.86	-7.86
20	2014	-6.88	-6.88
21	2015	-6.03	-6.03
22	2016	-5.29	-5.29
23	2017	-4.65	-4.65
24	2018	-4.09	-4.09
25	2019	161.69	161.54
	NPV	**141.20**	64.51/357.82
	LEV US$/Ha	154.86	70.76/392.43

Assumptions for actual revenue gain

1. Labour for establishment, weeding, and pruning is from squatters and readily available.
2. Market is readily available

Appendix 9: Definitions

Forest: ecosystem with a minimum of 10 percent crown cover of trees and/or bamboos generally associated with wild flora, fauna and natural soil conditions, and not subject to agricultural practices. The term *forest* is further subdivided, according to its origin, into two categories:

i. *Natural forests:* a subset of forests composed of tree species known to be indigenous to the area.

ii. *Plantation forests:*

- established artificially by afforestation on lands which previously did not carry forest within living memory;
- established artificially by reforestation of land which carried forest before, and involving the replacement of the indigenous species by a new and essentially different species or genetic variety.

iii. *Shrubs*, referring to vegetation types where the dominant woody elements are shrubs with more than 50 cm and less than 5 meters height on maturity. The height limits for trees and shrubs should be interpreted with flexibility, particularly where the minimum tree and maximum shrub heights, which may vary between 5 and 7 meters approximately.

Appendix 10: Investments in Beekeeping

Year	Activity	Item	Quantity	Unit Cost	Total	Life Span	Benefit
2000			/Unit	Tshs	Cost	Yrs	(Revenue)
0	preparation of equipments	hive making	80	25000	2000000	18	
	protective gears	gloves,smokers etc	2	54600	109200	15	
	honey press (small)	press & jack	1	75000	75000	50	
	containers	buckets	10	1000	10000	5	
		drum	1	15000	15000	10	
	processing equipments	strainers	1	20000	20000	2	
	labour	inspection 2*12	24	80000	1920000		
	Queen rearing	brood preparation	80	10000	800000		
1	Harvesting	honey (kg)	10	2000			1600000
		wax (kg)	0.5	2500			100000
1	labour	inpection 2*6	12	80000	960000		
		harvesting 5*3	15	2000	30000		

Appendix 11: Investments in Widdringtonia whiteii (Christmas trees),

Spacing 2.5x2.5 = 1600 trees,
After the first harvest there is coppicing of 3-5 branches whereby one is harvested on the third year then harvesting is done in each year, branches cut have 1.5 - 2m

Year	Activity	Quantity	Unit Cost	Total	Benefit
		Per Unit	Tshs	Cost	(Revenue)
1	purchase of seedlings per ha	1600	100	160,000	
1	ground preparation	1	100000	100,000	
1	pitting	1	20000	20,000	
1	seedlings transportation(lts)	40	1200	48,000	
1	planting	1	100000	100,000	
2	weeding	1	20000	20,000	
2	beating up 20%	1	20000	20,000	
3	harvesting - costs(mds/ha)	15	1500	22,500	
	transportation of trees (20ltsx1200)	10	24000	240,000	
	harvesting - selling	800	2000		1600000

Appendix 12: Investments in Pine Plantation Activities in Rombo

Year	Activity	Item	Quantity	Unit Cost	Total	Benefit
			/Unit	Tshs	COST	(REVENUE)
0	NURSERY ACTIVITIES	seed procurement (kg)	0.05	10000	500	0
0		fare and allowance	2	210	420	0
0		labour(2x2)	1	1000	1000	0
0		water bills (10 months xTsh5000)	10	500	5000	0
0		fungicides (lts)	4	230	920	0
0		nursery ingredients	4	100	400	0
0		fuel (25 lts x 2trips)	50	800	40000	0
0	NURSERY EQUIPMENTS	hose pipes(30 metres)	30	65800	65800	0
0		hoes&shovels	4	3500	14000	0
0		rato	1	15000	15000	0
0		wheelbarrow	2	48000	96000	0
0		knives	5	1000	5000	0
0		machete	2	1500	3000	0
0		sieve(m)	2	4000	8000	0
0		polythene pots(kg)	1	3000	3000	0
1	PLANTING	land renting (1 ha = 4 plots @ 5000/-)	4	5000	0	20000
1		land preparation (mds/ha)	8	0	0	0
1		pitting (mds/ha)	4	0	0	0
1		fuel lts	40	800	32000	0
1		supervision cost/ha	1	6110	6110	0
1		planting (mds/ha)	4	0	0	0
2	BEATING UP	20% cost of planting	1	1342	1342	0
2	TENDING	weeding	8	0	0	0
3		pruning (mda/ha)	8	0	0	0
3-5		weeding	8	0	0	0
5		pruning (mda/ha)	8	0	0	0
6		weeding	8	0	0	0
7		protection (patrols)	1	80000	80000	0
7		pruning (mda/ha)	8	0	0	0
8-12		protection (patrols)	1	80000	80000	0
12		2nd thinning	150	6000		900000
13-15		protection (patrols)	1	80000	80000	0
16	THINNING	stem counting & supervision(mds/ha)	2	3350	6700	0
16		3rd thinning by sawmillers(stems/ha)	400	6000	0	2400000
17		protection (patrols)	1	80000	80000	0
18		stem counting & supervision(mds/ha)	2	3350	6700	0
18		4th thinning by sawmillers(stems/ha)	300	6000	0	1800000
19-24		protection (patrols)	1	80000	80000	0
25	HARVESTING	clearfelling by sawmillers(300m^3/ha)	1	3600000	0	3600000
25		supervision cost/ha	1	3350	3350	0