PROSPECTS OF COMMUNITY-BASED FOREST MANAGEMENT IN SUSTAINING FOREST RESOURCE BASE AND SOCIO-ECONOMIES OF LOCAL COMMUNITIES IN TANZANIA

BY

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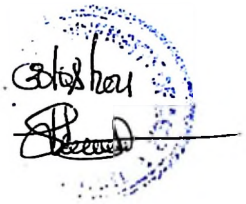

A THESIS SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

ABSTRACT

Worldwide. Community-Based Forest Management (CBFM) has recently been advocated as a good approach for reversing the rapid decline of forest resources and improving socio-economies of local communities adjacent to forest reserves. Despite the assumption that CBFM model improves management of forest resources and maintains the socio-economies of local communities, a wide assessment has not been done in Tanzania. Mgori Forest Reserve (MFR) where CBFM has been implemented was taken as a case study. A cross sectional research design was adopted to generate information on sustainance of forest resource base and socio-economics of local communities. Socio-economic data were collected using questionnaire survey, focus group discussion and key informant interview. Forest resource base data were collected using known forest inventory procedures. Both types of data were analyzed using appropriate data analytical softwares and tools. The findings indicated that the most important institutions were committees, village government, District council, tenure and by-laws. It was observed, further that the effectiveness of existing institutions and dimensions of good governance were ranked satisfactorily. Household socio-economies for communities adjacent to MFR increased after CBFM inception. The contribution of sales of forest products to total income of households was about 18%. Consumption of forest products in households was almost the same during CBFM and before its inception. All selected livelihood's assets showed to have improved after CBFM inception. Significant ($p < 0.1$) positive relationships between wealth status of households and institutions and good governance were observed. Conservation of forest resource base in all the reserves under CBFM has been achieved as indicated by the stand parameters comparable to the other similar protected reserves. Further, the diversity indices (79 tree/shrub species, 2.87 Shannon Weiner diversity index (H'), 0.07 Dominance index C) observed in MFR were equivalent to those observed in

other intact forests of the same category. The study, further, showed that there was 18% reduction of physical damages caused by human activities in the reserves. The study concludes that the CBFM model introduced in Mgori Forest Reserve is effective as the socio-economics of local communities had improved and forest resources were well conserved. The study recommends that more efforts should be put to strengthen and scale up CBFM in Tanzania.

DECLARATION

I, Emanuel Emilian Chingonikaya, do hereby declare to the Senate of Sokoine University of Agriculture that this Thesis is my own original work and has neither been nor concurrently being submitted for a higher degree award in any other Instituion.

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ABBREVIATIONS AND ACRONYMS

AERDD	-	Agricultural Extension and Rural Development Department
ANOVA	-	Analysis of Variance
asl	-	Above Sea level
CAMPFIRE	-	Communal Areas Management Programme For Indigenous Resources
CBFM	-	Community-Based Forest Management
CBNRM	-	Community Based Natural Resources Management
CBOs	-	Community Based Organisations
CFM	-	Community Forest Management
CIFOR	-	Center for Internation Forestry Research
CIMMYT	-	The International Maize and Wheat Improvement Center
cm	-	Centimetre
CPFM	-	Community Participatory Forest Management
DAAD	-	The German Education Exchange Serivce
dbh	-	Diameter at Breast Hight
df	-	Degree of freedom
DFID	-	Department for International Development
eds.	-	Editors
FAO	-	Food and Agriculture Organization of the United Nations
FBD	-	Forestry and Beekeeping Division
Fig.	-	Figure
FRA	-	Forest reserve area
G	-	Basal area ($m^2 ha^{-1}$)
ha	-	Hectare

ha^{-1}	-	Per hectare
ICIMOD	-	International Centre for Integrated Mountain Development
IFPRI	-	International Food Policy Research Institute
IIED	-	Institute for Entrepreneurship and Enterprise Development (IEED)
IUCN	-	The International Union for Conservation of Nature
IUSSP	-	International Union for the Scientific Study of Population
IVI	-	Important Value Index
JFM	-	Joint Forest Management
JMA	-	Joint Management Agreement
kg	-	Kilogram
LGFRs	-	Local Government Forest Reserves
Ltd	-	Limited
m	-	Metre
Max	-	Maximum
MDG	-	Millennium Development Goal
MFCC	-	Mgori Forest Coordinating Committee
MFR	-	Mgori Forest Reserve
Min	-	Minimum
MKUKUTA	-	Mkakati wa Kuondoa Umasikini Tanzania
mm	-	Millimetre
MNRT	-	Ministry of Natural Resources and Tourism
MS	-	Mean Square
N ha^{-1}	-	Number of stems per hectare
NFR	-	Natural Forest Reserve

NSGRP	-	National Strategy for Economic Growth and Reduction of Poverty
NTFP	-	Non Timber Forest Product
NWFP	-	Non Wood Forest Product
°C	-	Degree centigrade
ORGUT	-	A Swedish company providing advisory and project management services in rural and urban development and natural resource management
PEDEP	-	Primary Education Development Plan
PFM	-	Participatory Forest Management
PRSPs	-	Poverty Reduction Strategies Papers
R^2	-	Coefficient of determination
REPOA	-	Research on Poverty Alleviation
RH	-	Relative humidity
SEDEP	-	Secondary Education Development Plan
SI	-	Sampling Intensity
SIDA	-	Swedish International Development Agency
SS	-	Sum of Squares
SSA	-	Sub Saharan Africa
TAS	-	Tanzanian shillings
TASAF	-	Tanzania Social Action Fund
TERI	-	Tata Energy Research Institute
UN	-	United Nations
UNDP	-	United Nations Development Programme
UNEP	-	United Nations Environmental Programme

UNESCAP	-	United Nations Economic and Social Commission for Asia and Pacific
URT	-	United Republic of Tanzania
V ha^{-1}	-	Volume per hectare
VFC	-	Village Forest Committee
VFGC	-	Village Forest Guards Committee
VFMP	-	Village Forest Management Plan
VFR	-	Village Forest Reserve
VFRA	-	Village Forest Reserve Area
VLC	-	Village Land Committee
WBI	-	World Bank Institute
WRI	-	World Resource Institute
ZEF	-	Centre for Development Research
χ^2	-	Chi-square

CHAPTER ONE

1.0 INTRODUCTION

1.1 Dynamics of Governance of Forest Resources

Management of forest resources dates back to pre-colonial, colonial, post colonial and globalization eras. In all periods, a prime objective of the management is conservation of forest resources, although different approaches have been used (Ostrom, 1997; Ghate, 2000; Kowero *et al.*, 2003a, b).

In pre-colonial era, management of forests had been traditionally executed by the surrounding communities. Socially accepted traditional institutions, laws, regulations and structures governed the process of forest management in terms of utilization and conservation (Kowero *et al.*, 2003a, b). During colonial era, governance of forests had vested interests mostly on professionalism, protectionism and gazettement, which involved transferring forest management from the local domain into the state (Rist, 1991 and Kowero *et al.*, 2003a). This resulted to formulation of a centralised administrative structure of forest reserves. Local communities who live close to and depend on the forests were excluded from management and/ or expelled from the forestlands targeted as reserves.

After independence, many countries in Sub Saharan Africa (SSA) adopted a similar structure of forest management (Kojwang, 1996; Akapelwa, 1996; Misana *et al.*, 1996; Kowero *et al.*, 2003b). Exclusion of the local communities from forest management had led to several discontents (Wily, 1996 and Kowero *et al.*, 2003a). Conflicts between forestry departments and local communities, demoralization of local communities in forest management and inadequate budgets at forestry departments were the main problems associated with the centralized administration structure of forest reserves (Western and

Wright, 1994; Kajembe *et al.*, 1999; Murphree, 2000; Agrawal and Clark, 2001). These problems among other factors, have led to deforestation and forest degradation kept on pacing.

Increased deforestation and loss of forestlands, created dynamism in the governance of forests. During the mid 1980s, Brundtland's Commission of Environment and Development put forward a concept of sustainable development in environmental resources utilisation (UN, 1997). The concept was adopted and strengthened in Rio de Janeiro 1992 where it was expanded and transformed into sustainable livelihoods framework, which refers to protection of natural resources, while considering improvements of the economies of local communities. This has been well described in Agenda 21 (UN, 1992). Concerns for sustainable management of natural resources have also been discussed in the Kyoto Protocol of 1997 and Johannesburg Earth Summit in 2002 (UNDP, 2002). An idea behind is to establish appropriate governance that would lead to sustainable management of natural resources including forests. In this, the argument is to have a decentralized management of the resources, under which local governments are responsible.

Recently, worldwide, nations have been establishing suitable governance, which would allow and accept accountability for, transparency to and involvement of stakeholders in development processes (Isham *et al.*, 1997; Kaufmann *et al.*, 2003). Scholarly work indicates that governance of natural resources is about power relationships and accountability, which all of them have influence on the achievement of management objectives (Ostrom, 1997; Borrini-Feyerabend *et al.*, 2004; Luoga *et al.*, 2005a). Experiences have shown that local communities, who live close to the natural resources,

are the most appropriate stakeholders, whose participation in management of the resources would lead to sustainable achievement of the objectives of the resources management and local socio-economies (Kajembe *et al.*, 1999, 2003; Luoga *et al.*, 2000a, b; Menzies, 2004).

Ostrom (1997) points out that proper involvement of user groups, which are close to and totally rely on existing natural resources leads to sustainable conservation of the particular resource. Mogaka *et al.* (2001) showed that power over ownership of the forest resources provides incentives to local communities and other stakeholders towards sustainable management of the resources. Further, Borrini-Feyerabend *et al.* (2004) assert that sharing of relevant responsibilities, rights, costs and benefits, and the generation and sustenance of community, political and financial support for wise and sustainable use is a key to sustainability of the resources management. Likewise, Singhal (2006) sumerises that governance of forest resources should be accounted from eight pillars namely: participatory, accountability, transparency, responsibility, equitability, follow the rule of law, consensus and effectiveness.

However, the concept and practice of governance must adhere to the Human Development Reports of 1999 (UNDP, 1999) and the Millennium Development Goals (MDGs) of 2000 (UNDP, 2000). A trade-off of governance of forest resources and livelihoods of local communities is stipulated in MDG 1 and MDG 7 (UNDP, 2005a).

1.2 Community-Based Forest Management

Community-Based Forest Management (CBFM) is one of the forms of Participatory Forest Management (PFM) that takes place in forests on land, which has been surveyed and

registered under the provisions of the Village Land Act of 1999 and managed by village council. Such forest is regarded, as Village Forest Reserve (Blomley and Ramadhani, 2006).

Participatory Forest Management is an umbrella term for many forms of forests managed under participation of different stakeholders, particularly local communities and forest user groups. Among others Joint Forest Management (JFM), Community Forestry (CF) and Co-Forest Management (CFM) are the forms of PFM (Blomley and Ramadhani, 2006). Hombley (1996) asserts that PFM aimed at securing and improving forest resources and livelihoods of forest-dependent local communities. The author, also points out that involving all key stakeholders in the process of forest management in terms of understanding their needs and situations, decision-making, accountability and transparency is the basis of PFM.

Community-Based Forest Management, world over, started before 1980s, but it was not supported and poorly implemented. Likewise, it was in different forms such as village woodlots, community forestry and social forestry (Ahn, 1978; FAO, 1978; Hoskins, 1979; Skutch, 1983). Since mid 1980s after Brundtland's Commission Report followed by the introduction of Agenda 21 in the Rio de Janeiro 1992 Earth Summit (UN, 1992), Kyoto Protocol of 1997 (UN, 1997) and Johannesburg 2002 Earth Summit (UNDP, 2002), CBFM has become prominent and promising paradigm.

Experiences show that good governance yields high values to forest ecosystems and socio-economies of forest-dependent local communities (Miala *et al.*, 2004; Kajembe *et al.*, 2004a). Evidences are seen in conventional forest management (Kajembe and Mgoo, 1999)

versus CBFM model (Wily, 1996; Shepard and Gill, 1999; Ravindranath and Sudha, 2000; Ghate, 2000; Ghate and Mehra, 2003; Eswaran, 2004; Bahuguna *et al.*, 2004). In most instances, acquisition of high socio-economies by the forest-dependent local communities is an incentive, which influences conservation of forest ecosystems and the reverse is a true case (Olsson, 1991; Swamy, 1997; Arnold, 1998; Mogaka *et al.*, 2001).

In colonial and post colonial periods, management of forests in Tanzania and other countries in Sub Saharan Africa (SSA) was entirely the responsibility of government machinery. The attention to reforming forest management focused on increasing powers and responsibilities on the state and management of forest resources by communities or managing them as common property had rarely been considered (WRM, 2002). In such aspect, local communities around forestlands perceived them as government property and as such, they had no say on their management. This situation has been the root of most misuses of forests on general lands as well as in reserved forests (WRM, 2002; Luoga *et al.*, 2002; Kowero *et al.*, 2003a, b).

To reverse the trend, recently, Tanzania and other countries have been actively adjusting their forest policies to support an adoption of various forms of PFM. In many of these countries, PFM is at early stages, less than two decades, and one of the results of decentralisation and devolution of government structures (Wily, 2002). More specifically, the shift underlined the need for community participation and empowerment in the management of forest resources in order to achieve sustainable development (Muniwasa and Shauri, 2001; Kajembe *et al.*, 2003; 2004a, b, c). This has been due to several reasons among others including the failure of the state agencies to manage protected areas effectively, the potential for cost-effective local management of forests, relevance of local

knowledge of ecological dynamics to proper management, increased motivation for local communities to conserve forests following recognition of their critical role in the management, and eventual increase in socio-economic incentives from the forest and sense of ownership regained over their forest resources (Kajembe and Mgoo, 1999; Kajembe and Kessy, 2000; Kowero *et al.*, 2003b).

In Tanzania, PFM is about two decades since its inception in government forest reserves in a form of JFM in early 1990s and expanded to the level of CBFM. Duru-Haitemba and Mgori Forests are the first forests to be under the CBFM model (Wily, 2001) and are regarded as the model of CBFM in Tanzania. To strengthen the adoption of CBFM in various parts of the country, the new Tanzania National Forest Policy of 1998 followed by the National Forest Programme of 2001 and the Forest Act of 2002 were established (URT, 1998; 2001; 2002). Thereafter, a wide spread of CBFM in most forestlands has been taking place with an assistance of either the Government of Tanzania, bilateral agencies, international and local non-government organizations or communities (Blomley and Ramadhani, 2006).

Before managed a community-based forest in 1996, Mgori Forest Reserve (MFR) had been targeted and gazetted to be one of the central government forest reserves since 1984. Management of the MFR by then was under the state regime with forest officers and guards being responsible in its management. Despite the forest being under government authority, overexploitation was rampant. This led the local communities under the respective village governments had to make claim for managing and owning the reserve. The government in collaboration with Swedish International Development Agency (SIDA) handed the forest to local communities in 1996 (Wily, 1996). Mgori Forest Reserve is

among the good representative model of CBFM in Tanzania. Wily and Dewees (2001) explain the good success as unbelievable story in Tanzanian forest sector.

Many other successful stories exist in various countries (Fisher, 1999; Lawrence *et al.*, 1999; Dahal, 2003). However, in few cases, unsuccessful stories occur (Ghate and Mehra, 2003). The most pointed drivers of unsuccessful stories of CBFM are implicit decentralisation, dominance of elite groups, partial provision of property rights to local communities, exclusion of the most poor households and unclear description of existing heterogeneities such as gender aspects. This contradiction requires immediate solution and monitoring studies that would assess the institutional and governance arrangements in CBFM and their impact on the forest resource base and socio-economies of local communities are worth and important.

1.3 Problem Statement and Study Justification

1.3.1 Problem statement

Tanzania as well as other developing countries in sub-Saharan Africa and the world in general, have recently been adopting various forms of Participatory Forest Management (PFM) model as a way towards sustainable forest management. The management model aims at replacing the government centric model in forest management. This attributed by the fact that the centric model seemed not to be successful as degradation of forest resources kept on pacing. Despite the assumption that PFM model improves management of forest resources and maintains the socio-economies of forest-dependent local communities, there has not been adequate assessment to determine its influence on the forest resource base and socio-economies of the adjacent local communities. There is also no doubt that there is inadequate information on the effectiveness of Community-Based

Forest Management (CBFM) in terms of its governance, institutional arrangements, maintenance of forest resource base, and its contribution to forest dependence socio-economies of surrounding local communities. Therefore, this study sought to generate such information using MFR as the CBFM model.

Understanding socio-economies of local communities and forest resource base under CBFM are likely to be important for sustainable conservation of the forest resources in the world, particularly in developing countries including, Tanzania. Currently, CBFM approach has received great attention in the forestry sector as an appropriate approach to sustainable forest management and improvement of socio-economies of forest-dependent local communities (Wily, 2001; Mongaka *et al.*, 2001; Barrow *et al.*, 2002). Relatively little has been done to assess role of CBFM in improving forest management, socio-economics and governance system in Tanzania (Kajembe and Mgoo, 1999; Kajembe and Kessy, 2000; Kajembe *et al.*, 2003, 2004a; Luoga *et al.*, 2005a, b; Blomley and Ramadhani, 2006). Of significance to note is that CBFM in woodlands such as Mgori Forest, which formerly were not reserved and had been subjected to anthropogenic disturbances. However, this study provides some information on the role of CBFM on sustaining forest resource base and socio-economics at MFR.

1.3.2 Justification of the study

Information on institutions and governance of forest reserves under CBFM and its contribution to forest resource base and socio-economies of local communities is important for sustainable conservation of the forest resources in the world, particularly in developing countries including Tanzania. Of significance to note is the CBFM model in woodlands, which formerly had been subjected to anthropogenic disturbances in which CBFM is

expected to improve the forest conditions. Institutions and governance of forest reserves in Tanzania are well documented (Kajembe and Kessy, 2000; Kajembe *et al.*, 2004a, b, c), but the extent of their performance is less known. It is therefore, important to generate such information. A trade-off between socio-economies of rural poor and forest reserves is well described in Tanzania, yet there are few studies that have established the link between the socio-economies of local communities and the forests that are under CBFM model. It is well known that CBFM improves conservation of forest resources, yet it is not much known the extent of its objective in Tanzania. Earlier on, just after CBFM inception in Tanzania, Wily (1996, 1997, 2001, 2002) reported some successful stories of the model. This also requires some monitoring activities as the process and communities are always dynamic. The study therefore, documents the required information.

The study will: inform the development practitioners, policy makers and other stakeholders on the aspects, and form a basis for future monitoring and development of the approach to achieve its objectives. In line with this, the study adheres to the National Forest Policy of Tanzania (URT, 1998) that demands more researches on the CBFM model to provide information on various aspects such as household's socio-economies, governance and institutional arrangements and forest ecosystems development. Added to, establishment of links between sustainable conservation of natural resources including forests and livelihoods of local communities and poverty reduction is among the strategies articulated in Millennium Development Goals, One and Seven (UNDP, 2005a) and Tanzania National Strategy for Growth and Reduction of Poverty (NSGRP/MKUKUTA) of 2005. Undertaking such a study was worth for provision of such establishment.

1.4 Objectives

1.4.1 Overall objective

The overall objective of this study was to generate information on prospects of Community-Based Forest Management (CBFM) in improving the forest resource base and socio-economies of local communities around Mgori Forest Reserve.

1.4.2 Specific objectives

Specifically, the study:

a) Determined socio-economic factors influencing wellbeing of community members adjacent to Mgori Forest Reserve;

b) Examined the institutional and governance arrangements in the management of Mgori Forest Reserve and their effectiveness in improving forest management;

c) Determined the contribution of Community-Based Forest Management to socio-economies of local communities; and

d) Assessed the contribution of Community-Based Forest Management to improvement of the forest resource base in Mgori Forest Reserve.

1.5 Research Questions

The study was guided by the following research questions:

i. What are the socio-economic factors influencing wellbeing of community members adjancent to Mgori Forest Reserve?

ii. What are the institutional and governance arrangements in the CBFM model in Mgori Forest Reserve?

iii. What is the level of effectiveness of the institutions and governance arrangements under CBFM model in Mgori Forest Reserve?

iv. Does the CBFM model contribute to improvement of the socio-economies of local communities?

v. How has CBFM improved the socio-economies of local communities compared to what used to be before its inception?

vi. How has CBFM model contributed to improve the conditions of the forest resource base?

1.6 Theoretical Framework of CBFM

Serious resource scarcity most often is the root cause of thoughts for appropriate approach in management of the resources. For example in late 1800s. wealthy and politically-connected land owners controlled a majority of land in Mexico. This phenomenon caused problems for the large number of indigenous citizens who were unable to acquire land. They were forced to live off the available open-access land as best they could, which often resulted in over-use of the surrounding resources. Due to this difficulty of acquiring land, one of the main results of the Mexican Revolution in the early 20th century was the creation of community-based resource management within the 1917 Constitution. This property rights system utilizes the concept of tenurial shells, and was adopted in part to halt the unsustainable use of much of Mexico's land. The system designates tenurial rights and responsibilities as defined by local communities within the basic framework of the state. A majority of the decision making is made at the most local level, where decisions can be tailored to a community's needs (Alcorn and Toledo, 1995).

The system of property rights instituted in Mexico allows for local control with higher agencies lending authority to these local decisions. This is a necessary condition for any successful property rights system. The community ownership provided by this system,

coupled with diversified resource use and practices, has provided a sustainable resource base. Instilling a sense of ownership has provided incentives to efficiently manage the land.

Efficient resource management has to address three interrelated problems: (i) the allocation of the correct amount of certain uses or classes of uses; (ii) the assignment of frequencies to certain users or groups of users; and (iii) the adjustment of these allocations and assignments as technologies and markets evolve over time. Inefficiencies can be introduced at any one of these levels. Inappropriate attention to the allocation of resources will distort otherwise efficient assignment methods (Ostrom, 1990). Even if an efficient allocation is established at a particular point in time, it will have to be continually adjusted to reflect technological advances and changing market conditions.

Property rights are complex bundles of rights and obligations. Wide management regimes also define different bundles of property rights. Three principal management regimes are possible: (i) full privatization; (ii) common property; and (iii) open access. These approaches differ in how they define rules for access and use, management of a certain resource, exclusion of others from that resource and alienation that is the right to sell or lease to others. In a private property regime, the owners can execute all these rights. In an open access setting, everybody would have access to the resource, but no user would enjoy any of the other rights. Although these models recently have attracted an increasing number of supporters, they are the exception rather than the rule. The most widespread approach is the treatment of a common property resource.

While spectrum differs in important respects from other forms of common property resources, such as fisheries or forests, important insights can be gained from the vast literature on common resources. Various specifications of property rights are possible within a common property framework (Ostrom, 1990). Schlager and Ostrom (1993) identify four different roles based on the assignment of rights: authorized users, claimants, proprietors and owners. Authorized users only have the limited right of access to and use of the resource. Claimants have management in addition to usage rights. Proprietors also have the right to participate in decisions excluding others from the use of the resource. Owners have all these rights plus the right to sell or lease their use. The only difference to pure private property is that common resources usually restrict ownership rights in the interest of the common good. Thus, the governance options for management within a common property framework span a range that touches on private property at one end, and on open access at the other. A key question for management is how efficient these alternative are and how they influence industry performance.

Based on the theoretical aspect of property rights, the following may be stated as the cause of formation of CBFM:

- Theoretical conception of genesis of CBFM starts from increased rate of deforestation and its consequences (Singhal, 2006);
- Continuous deforestation leading to a decline in forest cover (UN, 1992), which has led to serious thought to the CBFM model (Kumar, 2004);
- People's resistance against the state's colonial oriented forest policies (Balooni, 2002);
- Needs of the hour and backlash of policy failures following colonial oriented forest policies (Joshi, 1998; Mittal *et al.*, 2000; Singhal, 2006);

- Deficit department budgets leading to thinking of potential cost-effective approach (Kajembe and Mgoo, 1999; Kajembe and Kessy, 2000; Kowero *et al.*, 2003b); and
- Incentives from the forests and sense of ownership (Kajembe and Mgoo, 1999; Kajembe and Kessy, 2000; Kowero *et al.*, 2003b).

All of these have led to an emergency of a new institution and rationale for the origin of the CBFM model.

1.7 Conceptual Framework

The study assumed that human socio-economic attributes and productivity of the forest resources depend on institutions and governance arrangements of CBFM model (Fig. 1). The assumption is that good governance and institutions in CBFM model influence sustainable management of forest resources. The study gives a scenario that communities are unlikely to be willing to become involved in forest management, unless the forest tangibly improves their socio-economic welfare.

If the local communities had been gaining from existence of ecosystem functions and governance for their livelihoods, it would be possible for them to maintain the forests and the CBFM model (Fig. 1), which in turn captures the concept of sustainability. The reason behind is that the CBFM model and forests should provide incentives for the local communities to actively participate in forest management. There was also an assumption that effective institutions had influenced socio-economies of local communities and dimensions of good governance as they have the role to play towards improving forest resources. This is attributed by the fact that CBFM model advocates sustainable conservation of forests and improvement of local livelihoods.

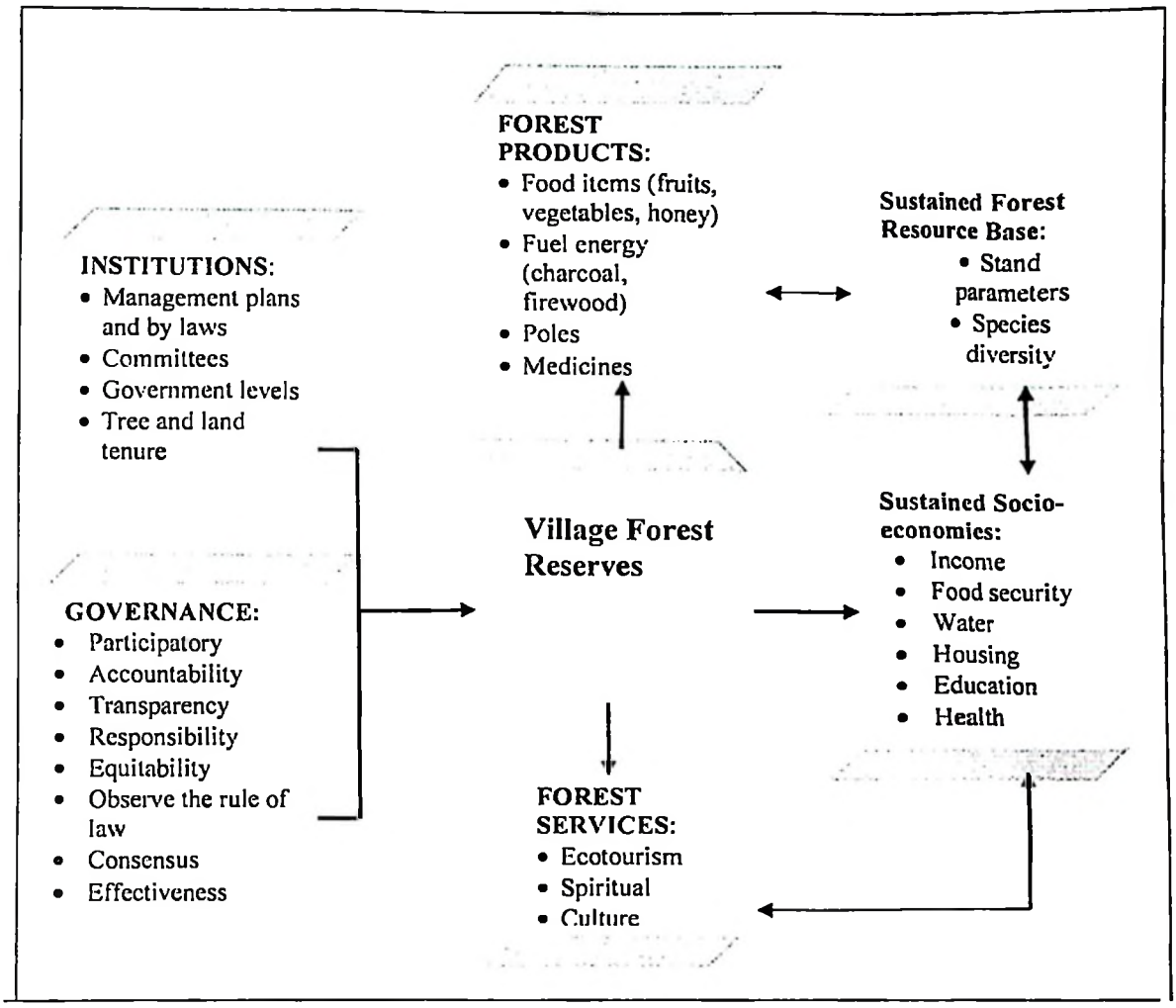


Figure 1: Conceptual framework for the role of institutions and governance on forest resources and socio-economies of local communities

Sustainability of CBFM is accounted for having a scenario that, if the forest resource base and socio-economies of local communities have been improved, the possibility of having sustainable conservation would be very high. This provides an impression that when the local communities realize the benefits of CBFM, the forest resources will be maintained.

Various scholarly definitions of institution exist (Berger and Luckman, 1966; Schotter, 1981; North, 1990; Ostrom *et al.*, 2002; Greif, 2006). "Institutions are structures and

mechanisms of social order and cooperation governing the behavior of a set of individuals. The term, institution, is commonly applied to customs and behavior patterns important to a society, as well as to particular formal organizations of government and public service. Institutions are a central concern for law, the formal regime for political rule-making and enforcement". The study adopted both structures and mechanisms in addressing institutions.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Evolvement of Forest Governance

Governance of forest resources has been evolving and sometimes devolving (Arnold and Campbell, 1986; Arnold, 1998; Dahal, 2003; FAO, 2003a,b; Kowero *et al.*, 2003b). In developing countries, management of forest resources, especially the natural forests can be categorised into four periods as pre-colonial, colonial, post independence, and policy and economic reforms periods (Kowero *et al.*, 2003b). In African, Latin American and Asian context, other authors describe forest management in similar way (Ribot, 1999; Wily, 2002; Menzies, 2004; Lasco and Pulhin, 2006). However, approaches and management goals differ slightly in the three regions.

2.1.1 Pre-colonial period

Kowero *et al.* (2003b) describe governance of forests in some Southern African countries during pre-colonial period based on protection and utilisation of the forest resources. Along with traditional institutions, norms, rules and regulations guided the protection and utilisation of the forest resources. Traditional authorities protected, conserved and regulated harvesting of forests. du Toit *et al.* (1984), cited by Kowero *et al.* (2003b) pointed out that rituals and cultural ceremonies shaped traditional societies to protect particular forests for such purposes. Protection of forests for preserving medicinal plants and dry season fodder has been reported to exist in pastoralist societies. Kamwenda (1999) reported on existence of *ngitiri* as dry seasonal fodder banks in Sukuma land, while Chenje *et al.* (1998), cited by Kowero *et al.* (2003b) pointed out that in mountainous areas of Zimbabwe, societies reserved the forests purposely for medicinal plants. In some

communities, taboos were invoked to maintain control over forest resources. Mukamuri (1995) asserts that taboos brought the notion that forests belonged to the past, present and future generations. Some beliefs such as existence of ancestral spirits and association with bad luck with tree cutting have also been reported to contribute to protection of forests from degradation (Virtanen, 1999). The beliefs also led to religious leaders having influence on conservation of forests following their existing social cultural powers of sanctions.

Wise utilisation of forest resources in different societies existed during the pre-colonial period. Traditionally accepted rules and regulations are reported to bring about sustainable utilisation of the forest resources (Kowero *et al.*, 2003b; Luoga *et al.*, 2005a). Chimedza (1991) reported rules such as regulating spacing between trees to cut, sanctions over cutting of fruit and sacred trees in Zimbabwe. Restrictions in medicinal plants harvesting are also reported by different authors. For example, Matose (1992), cited by Kowero *et al.* (2003b) pointed out that, restrictions such as collection of bark from one side of the tree and not collecting the bark from the tree, which has already been used for similar purpose dominated in different societies. In some communities, local elders were involved in supervising tree cutting and seasonal burning of grassland and bush for agricultural purposes (Virtanen, 1999).

Likewise, the systems of land tenure and ideological control of the land resources use based on kinship helped conserving forests (Misana *et al.*, 1996). Chenje and Johnson (1994), cited by Misana *et al.* (1996) pointed out that, Chiefs had authority over all land resources in systems which were based on clan groupings. In the system, groups or sub groups had authority over the existing resources. In some societies, land was deemed a

social property of the whole ethnic group as Misana *et al.* (1996) asserted that in such land tenure systems, heads of homesteads or households had inheritance rights to clan land.

Despite the fact that during pre-colonial period there was less degradation of forest resources, there is an argument that during the period, there was less pressure on the forest resources. Kowero *et al.* (2003b) spelt out that during the pre-colonial period, there were few demands on forests, human populations were very low, the forest resources were abundant in many communities and communities had many other important priorities like food and security. However, deforestation existed as Misana *et al.* (1996) reported that some communities cleared adjacent forests purposively for creating wide vision against their enemies. The same authors also report that long caravan trade and Ngoni invasions degraded large proportion of forests.

Whatever the form of use, the forest area was under the control of one or a group of households, except in the case of hunting and gathering where the entire community was in control of the whole forest. The households did not have the ownership of the land which was vested with the community or sometimes in a very vague manner with the sovereign. The management however rested within the household/s. In other words, the forest administration was deconcentrated to the household or a group of households or to the community level but the ownership authority was under the community (Luoga *et al.*, 2005a). It has been considered that this devolution is not an introduced or imposed process, but it is a step in naturally developing human society.

Based on the review, governance of forest resources during pre-colonial period was full of traditional institutions, which facilitated communities designing elaborative forest conservation, harvesting and utilisation measures.

2.1.2 Colonial period

During the colonial period, many historic stories of forest management changed differently from the pre-colonial period. Banerjee (1997) describes the change as the equation between households, groups of households and community and the forestland, which changed dramatically with the advent of the colonial powers and consolidation of their hold on the countries concerned. The change was towards concentration, that is, the ownership was usurped by the colonial powers, which took over as the sovereign power.

Kowero *et al.* (2003b) reported that colonial administrations introduced restrictions on local communities' access to forests and land. To support the introduced restrictions, the colonial governments set state or national and formal policies and legislations. Many of these policies concentrated much on protection and production forests, especially those which were rich and wealthy. In such forests, gazettement and imposition of laws, rules, ordinance, acts, decrees and regulations to favour the colonial government interests at the expense of local communities dominated. Local communities were excluded from governance of forests, which existed in different forms namely catchment forests, forest reserves, game reserves, conservation areas and national parks. In some instances, local communities were expelled from such forests (Wily and Dewees, 2001; Kowero *et al.*, 2003b). This undermined the sense of local responsibility for maintaining the forest resources.

Production policies and guiding legislation during the colonial period underlined harvesting of natural forests for commercial purposes, though it was somehow in protected areas only. Development and use of industrial forest plantations and delivery of long-term concessions or short-term licenses were also the case in production policies. Kowero *et al.* (2003b) argued that the production policies marked the beginning of non-sustainable harvesting of forest resources as well as exclusion of ecological and societal concerns.

Governance of forest resources during the colonial period was "top-down" or "centric" (Kajembe *et al.*, 2003 and Kowero *et al.*, 2003a). Professionalism, militarism and state power had been the main features of forest resources management (Kajembe and Mgoo, 1999; Kajembe and Kessy, 2000). Most of the governance arrangements did not divest local communities of their interests and their local framework.

In Tanzania (by then Tanganyika), the Forest Department was established in 1887 during German colonialism and the first Forest Ordinance enacted in 1895. The Ordinance enforced creation of forest reserves as well as allowing Kulturpioner (settlers) to clear forests for plantation agriculture and indiscriminately cutting trees for household purposes and export. British colonial administration restructured the Forest Department in 1921 and introduced the first Forest Policy in 1953 and Forest Ordinance in 1957, with much emphasis on timber production (Raumoli (1990), cited by Kowero *et al.*, 2003b). However, the restructuring of the Forest Department did not mean change of administrative structure to forest resources management.

The colonial government had few resources including labour and professionals to enable proper conservation of gazetted areas or reserves. Despite the fact that colonial forest

policies and legislation were effective, encroachment to forest reserves was high. Coupled with increased population pressure, this situation created conflicts following exclusion or expulsion of local community's management and user rights. Kowero *et al.* (2003b) argue that transformation of traditional to economic mode of lives encompassed increased rate of encroachment and overexploitation of forest resources.

2.1.3 Post independence

After political independence, most of African countries kept on the colonial legacy in forest resources management (Amanor, 2003). In Tanzania, governance of forest resources is explained in three sequential steps namely soon after independence, *Ujamaa* or pre-structural adjustment and structural adjustment periods.

Tanzania continued to operate with some modifications of the Forest Policy of 1953 and the 1957 Forest Ordinance until 1998 when the new Forest Policy was formulated followed by the National Forest Programme of 2001 (URT, 2001) and Forest Act No. 14 of 2002 (URT, 2002). The change was due to the fact that the inherited Forest Ordinance did not encourage significant stakeholder participation in forest management.

During pre-structural adjustment period, the Tanzania economy was centrally planned and controlled. Ownership and control of all means of production and distribution remained under the state. Constraints on market forces in allocating resources and socialist oriented policy characterised the period (Kowelo *et al.*, 2003b). During the same period, particularly after 1982, when the state government introduced local governments, district councils became the owners of some forest reserves, as it was during colonial time, most of which comprised of miombo woodlands (URT, 1982). Under the local authority system,

decision-making was under the councilors. Preservation, conservation and licensing orders were under the District councils. Employment of forest guards and revenue collection through forest resource products crystallized conflict between communities and local governments (Kajembe *et al.*, 2004b). Although district councils are designed to be self-funding agencies, obtaining revenue through a variety of taxation and licensing routes, in practice, consistent lack of funds, manpower and other material supports for supervision and management of local authority forest reserves were the main problems (Wily, 1996), which led to continued encroachment and illegal exploitation of the existing reserves.

However, parallel run of central government and local government forest resources management has been criticized as an existence of administrative fragmentation and duplication (Kajembe *et al.*, 2003, 2004a, b). Regime restrictive, worsening the breakdown of traditional management systems, low capacity of central government to manage forest reserves and woodlands and vulnerability to corruption to forest service are other criticisms.

During the Structural Adjustment Programme period, major changes occurred on the political and economic fronts, which transformed from central to decentralised planned economies (URT, 1982). Democratisation increased with emphasis on people's participation in decision-making and ownership as well as management. This also happened in the forest sector (Kowero *et al.*, 2003b).

Improvements in the institutional contact of village and village governments increasingly opened the way for older mechanisms of natural resources management and local responsibilities. Through Ujamaa in early 1970s, under villagization, almost every village

in Tanzania has been registered and has clear and legal boundaries, and some villages have Title Deeds, meaning that any resource such as wildlife, forests and woodlands found within a respective village boundary is owned as community property. The National Land Policy of 1995, Forest Policy of 1998 and Village Land Act of 1999 give a sense of bringing back community-based forest management (URT, 1998, 1999).

Transformations in the governance of forest resources as well as other resources such as wildlife, fisheries and coral reefs can be explained due to transformation of the governmental political, social and economical structures (Dahal *et al.*, 2001; Amanor, 2003). In some instances, external forces put pressure on changing management structures. The shift of forest governance from "centric governance" to "community governance" is explained in Rio de Janeiro 1992 Earth Summit's, Agenda 21 Chapter 11, followed by other treaties such as the Rio + 5 (Kyoto Summit of 1997) and the Rio + 10 (Earth Summit held in Johannesburg, South Africa), which encouraged decentralised governance arrangements and stakeholder involvement. Low capacity of governments to police large tracts of forested land and recognition of user rights of local communities have also contributed to transformation of management structure of forest resources (Kajembe *et al.*, 2004a). In the forestry sector, participatory forest management approach was adopted as the most probable tool for sustainable management of forest resources and improvement of the wellbeing of stakeholders, particularly the local communities (Hombley, 1996; Blomley and Ramadhani, 2006).

2.2 Concepts of Participatory Forest Management

2.2.1 Definition of Participatory Forest Management

Participatory forest management (PFM) is an umbrella term for many forms of forests managed under participation of different stakeholders, particularly local communities and forest user groups. It includes among others Joint Forest Management (JFM), Community-Based Forest Management (CBFM) and Community Forestry (CF) (Hobley, 1996). Hombley (1996) asserts that PFM aimed at securing and improving forest resources and livelihoods of forest dependent local communities. Involving all key stakeholders in the process of forest management in terms of understanding their needs and situations, decision-making, accountability and transparency is the basis of PFM.

In other words, PFM is a process whereby communities are ensured participation from planning up to decision-making in forest management. In this context, it is like shifting the role of the community and the government whereby the community holds the right to management and the government will have the duty to monitor and give technical and professional backups to the community with defined and agreed roles and responsibilities of the two parties that will be set out under the PFM process.

Blomley and Ramadhani (2006) define JFM as a collaborative management approach, which divides forest management responsibility and returns between government (either central or local) and forest adjacent communities. It takes place, on land reserved for forest management such as National Forest Reserves (NFRs) and Local Government Forest Reserves (LGFRs). Further, the authors pointed out that JFM is formalized through the signing of a Joint Management Agreement (JMA) between village representatives and government (either the District Council or Ministry of Natural Resources and Tourism).

Therefore, JFM is a concept of developing partnerships between fringe forest user groups and the Forest Department (FD) on the basis of mutual trust and jointly defined roles and responsibilities with regard to forest protection and development.

Community-Based Forest Management (CBFM) is used to refer to cases where there is no pre-existing forest reserve, which must be taken into account. Main stakeholders of CBFM are the users of forest resources that live close to the forest. In the context of Tanzania, CBFM takes place in forests on village land (Blomley and Ramadhani, 2006), which has been surveyed and registered under the provisions of the Village Land Act of 1999 (URT, 1999). Under CBFM, villagers take full ownership and management responsibility for an area of forest within their jurisdiction and declared by village and district government as a Village Forest Reserve (VFR). Following this legal transfer of rights and responsibilities from central to village government, villagers gain the right to harvest timber and forest products, collect and retain forest royalties and undertake patrols (Blomely and Ramadhani, 2006). The villagers are also exempted from local government taxes on forest products. The regulations regarding 'reserved tree' species and remission of any part of their royalties to either central or local government are excluded.

Co-forest management is loosely defined as the sharing of power and responsibility for forest management between stakeholders such as the government and local users, government and NGOs, NGOs and local users, companies and local users, among others (Blomley and Ramadhani, 2006). Co-forest management is generally defined as a pluralist approach to managing forest resources, incorporating a variety of partners in a variety of roles, generally to the end goals of forest conservation, sustainable use of forest resources and equitable sharing of forest-related benefits and responsibilities. However, according to

IUCN (2004), Co-management is not a template leading to a clearly defined state, but requires continuous adaptation based on new information and changing social and economic contexts.

2.2.2 Genesis of Participatory Forest Management

Theoretical conception of genesis of PFM starts from increased rate of deforestation and its consequences (Singhal, 2006). Continuous deforestation leading to a decline in forest cover has long been a source of concern for forest managers and policy makers thinking of ways to curb the situation (UN, 1992), which has led to serious thought to the PFM model (Kumar, 2004). People's resistance against the state's colonial oriented forest policies and acts that exclude local communities is pointed out as one of the fuelling factors of PFM formulation (Balooni, 2002). Needs of the hour and backlash of policy failures following colonial oriented forest policies in different states have led to an emergency of a new institution and rationale for the origin of the PFM model (Joshi, 1998; Mittal *et al.*, 2000; Singhal, 2006).

Although, it is clear that defective forest policies, faulty implementation of policies and poverty of forest adjacent communities have been contributing to increased deforestation, world over, many states misdirected forest policies that failed to account for the fact that poor people have historically depended on forests for their needs and have few alternatives (Singhal, 2006). Most of these policies were based on the existing conditions and future projects without considering the well-grounded understanding of the history of environmental use patterns and social, economic and political forces that shape them. With such situations, most forest stakeholders namely village communities, forest users, forest departments or forest owners dealt with forests in isolation and from different perspectives.

Most often implementation of policies focused on overcoming the problem without analyzing the cause and effect relationship. This led to more thought on reversing the trends in forest management. Ultimately, several experiments on forest management were introduced (Joshi, 1998 and Mittal *et al.*, 2000). Among them include Arabori experiments in joint forest management in India (Josh, 1998), CAMPFIRE in Zimbabwe (Bwalya, 2003) and in the hills of Nepal (Dahal, 2003).

A spread of PFM in the world is accounted for the roles being played by NGOs, forest departments or government agencies and international agreements. The NGOs have been pointed out that they provide a link between village communities, forest users and forest departments or government agencies through encouraging involvement of stakeholders in forest management.

However, in the implementation of PFM, Donor influence, change of forest Policies and Acts as well as international fora, which advocate sustainable development framework on the basis of improvement of conservation of natural resources and livelihoods of local communities and favour promotion of PFM engineer the process of the implementation of the PFM (Hombley, 1996; UNDP, 2002).

2.2.3 Institutional arrangements in PFM

Formal and informal institutions in forest resources utilization, conservation and management have been well illustrated (Ostrom, 1990; Gibson *et al.*, 2002; Kajembe *et al.*, 2003, 2004b, c; Shemwetta *et al.*, 2004; Mbeyale *et al.*, 2004). As always the case, there are proponents and opponents of the different types of institutions. Kajembe *et al.* (2004b) assert that local institutions are always effective and should therefore be encouraged.

According to Chopra (2001), existence of conflicts between informal and formal legal and political institutions is likely leading to such situations. Several other studies show conflicting effectiveness of both formal and informal institutions in natural resources, but the fact remains that both institutions could be effective or ineffective depending on their operationalisations (Mukamuri, 1995; Chopra, 2001; Gibson *et al.*, 2002; Kajembe *et al.*, 2004b; Shemwetta *et al.*, 2004).

Institutional arrangements that emerge from a participatory approach to resource management always depend on the existing ground conditions found in a certain country, region or locality (FAO, 2003b and Kayambazinthu *et al.*, 2003). The prevailing land and tree tenure situation, the nature of local institutions, the extent of the government's interest in the resource and the links to local livelihoods has an impact on the type of institutional arrangement that finally emerges (Kayambazinthu *et al.*, 2003). However, whatever the circumstances, a successful institutional arrangement for PFM is one that embodies a consensus on the future management of the resource.

In practice, this usually means that the arrangement includes among others (Ostrom, 1990; FAO, 2003b): (i) security of access to land and tree tenure, (ii) clearly defined forest boundaries, (iii) clearly defined user groups and beneficiaries, (iv) clear management objectives, (v) agreed rules on which products to harvest from where, how much, when, (vi) agreed rules on revenue sharing and benefit distribution, (vii) protection and regeneration programmes, (viii) sanctions, (ix) an executive body with defined roles and responsibilities; and (x) provisions for forest department support.

2.2.4 Governance arrangements in PFM

Governance is a term, which has progressed from obscurity to widespread usage (Plumptre and Graham, 1999) since 1990. Newell (2002) asserts that governance is a term that has become popular in a context of globalization in which governments are thought to be less powerful and autonomous than they once were. Corkery (1999) avows that governance is not a new word, but its appearance in discussions about social organization is a comparatively recent development. Not surprisingly, there are differences and disagreements on what governance means.

Newell (2002) refers to governance as collective attempts that manage and regulate social relations. This means that increasing regulation and management effectively influences government co-operation with, or devolution of government functions to stakeholders. The author also points out that governance has expanded from a preoccupation with law, coercion and formal political structures of government such as bureaucracies and party systems to a broader range of practices and management strategies.

According to Singhal (2006), governance is defined as the manner in which power is exercised in the management of country's economic and social resources. Minogue *et al.* (1998) define governance as the array of ways in which the relationship between the state, society, and the market is ordered. The notion of governance is more than the government, which is one of the actors in the process. Recognizing this Human Development Report of UNDP (1999) suggests that ' governance means framework of rules, institutions and individuals, organizations and firms '. "Governance relates to the management of all such processes that in any society define the environment which permits and enables individuals

to raise their capacity levels, on one hand, and provide opportunities to realize their potential and enlarge the set of available choices.

IUCN (2004) defines governance as the process of formulation, articulation, administration and implementation of policies, legislation, regulations, guidelines and norms relating to the ownership, access, control, rights and responsibility as well as capacity at local and national or international levels.

Governance can be qualified in at least two major ways. One has to do with "type", the other with "quality" (Abrahams *et al.*, 2003 and Borrini-Feyerabend, 2004). "Types" of governance of natural resources can be distinguished on the basis of "who holds management authority and responsibility and is expected to be held accountable according to legal, customary or otherwise legitimate rights. Four broad types of governance have been described (Borrini-Feyerabend, 2004). These are: (i) governance of government, (ii) joint governance by several concerned parties, (iii) governance by private, and (iv) governance by community.

Often the term governance is accompanied by the adjective "good", as we seek "good governance" rather than governance as usual. As "good" can be specified only in terms of benchmarks and criteria, a number of principles of good governance have been advanced at various levels (IUCN, 2004). Good governance has major characteristics or dimensions (IUCN, 2004 and UNESCAP, 2006). These are participatory, consensus oriented, accountability, transparency, responsibility, effectiveness and efficiency, equitability and inclusive and follow the rule of law.

Since, governance is the process of decision-making and the process by which decisions are implemented, an analysis of governance focuses on actors involved in decision-making and implementation through formal and informal structures or institutions. The quality of governance is an issue of increasing concern in both developed and developing countries. Some scholars point out that governance has been associated with larger movement of democratic theory and practice (Ostrom, 1997; Plumptre and Graham, 1999; Newell, 2002). It is to mention that good governance is an ideal, which is difficult to achieve in its totality, therefore, these characteristics are means to achieve good governance.

Forest governance in PFM is about how, and to what ends, forests are managed, how decisions on forest use are taken, who are involved in these decisions and what is done to enforce forest laws and policies on the ground. According to Singhal (2006), in PFM, good forest governance is needed to cope with critical issues like illegal logging and corruption, unclear tenure arrangements and use rights, the protection of global forest values such as biodiversity, carbon sequestration and watershed protection, and the reconciliation of global public good concerns with local livelihood needs and the goal of poverty alleviation.

Therefore, in CBFM, the forest governance is coined to include the notion of democracy and the involvement of non-state actors in decision-making regarding the allocation and use of scarce forest resources. Good governance lies at the heart of sound environmental and natural resource management in general, and forest management, in particular.

2.2.5 Contribution of CBFM to socio-economies of local communities

An attraction of CBFM as an entry point for sustainable livelihood based approach to poverty reduction lies in the fact that assured access to forest resources can provide most of

the forms of capital assets (DFID, 1998 and Amanor, 1999). Participatory forest management can only reduce poverty by widening and enhancing the options of socio-economies of forest-dependent local communities (Pandey, 2005). Shepherd and Gill (1999) urge that for the majority of the rural poor, forests continue to provide only a part of their capital needs, and the importance of this varies between forms of capital as well as by gender, poverty, ethnicity, and location. What is crucial, however, is that the part of the capital base supplied by the forest is often crucial to the proper functioning of other capital assets such as soils, livestock, cash income and housing.

Experiences show that most Forest policies in many countries providing rural communities with an assurance to access to the forest resources have been successfully enabling the communities to use and conserve forest resources for their livelihoods (Green, 1995; Lynch, 1998; Shepherd and Gill, 1999; FAO, 2003b; Dahal, 2003; Kajembe *et al.*, 2003, 2004a; Blomely *et al.*, 2007). However, as caution, high participation of communities in imposing these policies has led to such achievements. These policies, in conjunction with the nature of the forest as a resource base, might provide unparalleled opportunities to make a major positive contribution to the livelihood strategies of the rural poor (Shepherd and Gill, 1999).

Studies elsewhere show that community participation in forest management (CPFM) leads to local communities to acquire their livelihoods through accessing to the different forms of capital (Shepherd and Gill, 1999; Byod *et al.*, 2001; Bwalya, 2002; FAO, 2003b; Pandey, 2005). These forms of capital assets namely natural, physical, financial, human and social capital assets are well described in DFID (1998).

Malla (2000), Kajembe *et al.* (2003) and Pandey (2005) show that CPFM has improved group cohesion and provided a platform for other development activities in villages. Some studies (Wily and Dewees, 2001; Ghate and Mehra, 2003) pointed out that CPFM increased facilitation of empowerment of local communities through devolution of power on management of forest resources. Rights to own resources, participation in decision-making and involvement of community development activities are the important aspects in villages where CBFM and JFM are being practiced.

Ostrom (1997) and Amanor (2003) point out that ownership patterns establish an existence of a strong social capital in any community as the ownership to resources builds a sense of confidence. WRI *et al.* (2003) detail that enhancement of social capital is obtained through committees such as forest committees, village government committees, land committees, patrolmen and coordinating committees. These committees encourage a wide extension of networks among members in communities, thus also enhancing the social capital.

According to Pandey (2005), JFM is expected to increase direct consumption and increase in earnings through sale of forest and agricultural products. It also includes sales of products from employment generating activities with the help of various groups formed in the process of JFM. Meshack *et al.* (2006) revealed that JFM contributed to income of local communities through utilization of forest products such as fuel wood, fodder grasses, thatch grasses, bush meat, medicinal herbs and other non-wood forest products (NWFPs). Many other studies indicated that CBFM improves income and social interactions among communities (Pulhin *et al.*, 2005; Hamza, 2007; Chingonikaya *et al.*, 2008).

Among the objectives of CPFM is to create conditions whereby adjacent communities may benefit from forest resources. In villages where there are CPFM activities, the villagers are encouraged to grow crops, keep livestock and other related agriculture activities for improving the states of their economy, especially food security. Most of the villages where CPFM is being practiced, schools, dispensaries or health centers, village offices and sometimes water points such as wells were reported to be partly constructed in collaboration with the villagers (IRG, 2000; Blomley and Ramadhani, 2006). This is because, PFM encourages participation of various stakeholders ranging from villagers to international organizations. Such activities in PFM facilitate the villagers to obtain their livelihoods.

CBFM reduces long distance in searching for firewood. This would likely lead to save labour for agricultural or any other production activity. Such a case is reported in the Mankòtè mangrove reserves in St. Lucia, Asa Wright Nature Centre in Trinidad, and Bosque Seco and Salto de Limón in the Dominican Republic (Hudson, 1998). Several other studies indicate that CBFM enables local governments or communities to generate revenue through concessions, fines, tourism and contribution of individuals for development activities (Geoghegan, 2002; Mogaka *et al.*, 2001; Amanor, 2003). According to Geoghegan (2002), livelihood security has improved for resource users involved in PFM arrangements in the cases of Mankòtè, Portsmouth Indian River Tour Guide Association, Bosque Seco, and Salto de Limón.

Participatory Forest Management in Shiwalik Hills Haryana Province, India was observed to increase and improve socio-economies of local communities by 25% within five years of the project implementation (TERI, 2007). Similar observations are also made by

Dokharel (2001), when studying CBFM in Hills of Nepal. The reasons for the change are the result of three main factors namely a better managed and thus more sustainable resource base, more skilled and better organized resource users, and rights of exclusive or preferential access.

In JFM, a limited number of local employment opportunities have been generated (Pandey, 2005). For example, through the employment of casual fire fighters in the Western Northern Range in Trinidad and forest wardens in the case of Bosque Seco. Sometimes, due to gained skills through PFM activities, the quality of resources being exploited or appearance of attractions being marketed has improved in some cases, permitting them to be sold at a higher price.

Some of the social benefits that have been noted in CPFM include the following (Geoghegan, 2002; Mogaka *et al.*, 2001; Amanor, 2003; Kajembe *et al.*, 2004b): empowerment of stakeholder groups who have become active partners in PFM arrangements, resulting in improved self-esteem, especially for poor resource users, and in an enhanced capacity to advocate through the development of stakeholder organizations; alienation of resource users, often including the poor and powerless, that have been excluded through new management arrangements; opportunities for learning and information sharing, increasing stakeholders' management skills and capacity; shifts in local power dynamics due to changes in management regimes and use patterns, resulting in new conflicts and negative impacts on some sectors of the community; increased local awareness of forest management issues, needs, and resource potentials. The review shows that PFM has a significant contribution to improved socio-economies or livelihoods of local communities, especially in rural areas, but however, little is known for Tanzanian context.

2.2.6 Participatory Forest Management in Tanzania

Participatory Forest Management (PFM) is a central strategy of Tanzania's Forest Policy of 1998, National Forest Programme of 2001 and Forest Act of 2002 (URT, 1998, 2001, 2002). The National Forest Policy (1998) provides a clear direction and mandate for participatory forest management (PFM) practice in Tanzania (URT, 1998). The National Forest Programme (2001 – 2010). provides a strategic framework and plan for the implementation of the Forest Act and Policy (URT, 2001). The Forest Act (2002) gives further legislative support to these broad policy directions by enabling local communities to declare and ultimately gazette Village, Group or Private Forest Reserves (URT, 2002). Three categories of CBFM are noted in Tanzania: (a) Village Land Forest Reserves (VLFR) - managed by the entire community; (b) Community Forest Reserves (CFR) - managed by a particular designated group in the community; and (c) Private Forests (PF) - managed by individual designated households (Blomley and Ramadhani, 2006).

Until recently, PFM in Tanzania has been facilitated by area-based projects, working with local partners such as Local Government Authorities and NGOs. The National PFM programme, aims to mainstream delivery of services through national and local government institutions. Looking at political, institutional, social and economic dimensions, PFM in Tanzania has two main policy objectives namely sustainable forest management and improved rural livelihoods (URT, 1998).

Of the estimated 33 million hectares of forestland in Tanzania, 57% (around 19 million hectares) is largely unprotected and occurs outside government forest reserves (URT, 2001). The National Forest Policy explicitly recognizes this and provides incentives for forest management at the village level under the local government. In the early 1990s, a

number of pilot CBFM activities started at Duru-Haitemba and Mgori Forest Reserves in Babati and Singida Districts respectively (Wily, 1996, 2002).

These pilot projects became successful through a mechanism for the transfer of forest ownership and management responsibility from central to village government. Following these successful and well-documented pilots, other forest areas were brought under community management or community co-management. Notable examples include the East Usambara forests of Tanga Region, highland forests of Iringa as well as lower miombo woodlands, and more recently coastal forests in Tanga, Mtwara and Lindi Regions (Blomley and Ramadhani, 2006).

These pilot projects, implemented by a range of actors including local and international NGOs, local governments and supported by bilateral donors, collectively demonstrated the viability of PFM under a range of social and ecological conditions. These experiments across the country coincided with a review of the forest policy and legislation in the late 1990s, together with sweeping reforms in Tanzania's economic and political spheres, and directly contributed to a favourable legal environment for PFM. Currently, mainland Tanzania has one of the most advanced community forestry jurisdictions in Africa as reflected in policy, law and practice (Wily, 2001, 2002).

Two main approaches for implementing PFM are being promoted in Tanzania: Joint Forest Management and Community Based Forest Management. According to Blomley and Ramadhani (2006), an estimate of adoption of PFM on mainland Tanzania by 2006 was about 11% as detailed in Table 1.

Table 1: Coverage of Participatory Forest Management in Tanzania

Governance type	Area covered	Number of villages involved	Village that approved plans	District involved
JFM	1 386 000	568	149	7
CBFM	1 641 000	670	570	50
Total	**3 672 854**	**1 821**	**719**	**57**

Source: Blomley and Ramadhani (2006) and FBD (2006)

2.3 Forest Structure and Composition in Tropical Forests

2.3.1 Stand parameters

Stand parameters are some of the indicators used for assessing the wealth of forest reserves (FAO, 2003c). Distributions of tree stems, basal area and volume per hectares and diameter have been used to determine forest status in Duru-Haitemba VFRs (Kajembe *et al.*, 2004a). Malimbwi and Mwansasu (1994) reported diameter distribution in a miombo woodland at Mgori to follow reversed "J" shape an indication of good condition of forest. Different studies adopted diameter class distribution for identification of regeneration rates, especially in forests, which were formerly disturbed before new management (Njana, 1998; Malimbwi *et al.*, 2000; Luoga *et al.*, 2002; Kajembe *et al.*, 2004a, b; Luoga *et al.*, 2005b). Several other studies in Southern Africa have similar observations (Chidumayo, 1987; Frost, 1996; Bauckes *et al.*, 2006; Isango, 2007). The analysis of density distribution among diameter classes of woody species in the forest resulted in different patterns. High densities in small diameter classes indicate a good regeneration capacity, while under representation of these classes indicates little regeneration capacity (Bekele, 1994).

Basal area provides a better measure of the relative importance of the tree species in any forest ecosystem (Bekele, 1994). Trees with the largest contribution in basal area are

considered as the most important woody species in the forest. A forest with a similar basal area distribution to a "J" shape trend, in which the basal area increases with increase in diameter classes is considered as stable, having high regeneration and mature trees (Strang, 1974; Bekele, 1994). Several other studies reported stable forests having basal area followed the J-shape trend (Nduwamungu, 1996; Isango, 2004, 2007). Volume distribution following the J-shaped trend has also been used as a parameter of determining a health and well stable forest (Kielland_Lund, 1990; Malimbwi and Mwansasu, 1994; Kajembe *et al.*, 2004a, b; Nduwamungu, 1996).

2.3.2 Plant species composition and diversity

Plant species composition and diversity are among important ecological varaibles describing the condition status and importance of any forest ecosystem for biodiversity conservation (Kent and Coker, 1992; Smith *et al.*, 1993; Janzen, 1993). The important interest in biodiversity studies is scientific exploration and quantification of biodiversity as learning on how many forms of life inhabit the planet is a legitimate scientific quest (Wilson, 1988). Describing biological diversity in a discrete unit of landscape calls for importance of its conservation (Janzen, 1993). Information on vegetation and biodiversity leads into solutions to ecological problems, monitor management practices or provides the basis for prediction of possible future changes. Within plant communities, the presence or absence of a particular species is of a primary importance (Kent and Coker, 1992), species diversity is a very useful parameter for forest communities, particularly, when one wishes to study the influence of biotic disturbances, the state of succession or stability of a forest community (Luoga *et al.*, 2002; Banda *et al.*, 2006; Munishi *et al.*, 2007; 2008).

According to Huston (1994), diversity is defined as the structural or functional variety of plants or animals at genetic, species, population, community and ecosystem levels. Kent and Coker (1992) describe two major components of diversity as species richness and evenness of the community meaning that species richness refers to actual number of species within a community, while species evenness is the spread of individuals between species within the community. Many ecologists interchangeably use species richness and diversity referring to a community containing a large number of different species. This does not mean that species composition is not important as the community containing the same number of species may have different abundance of the species that influences diversity. High species diversity is desirable property for a community and therefore, a useful parameter for comparison of one community to the other (Misra, 1989). Different scholars (Fisher *et al.*, 1943; Sorensen (1948) and Motyka *et al.* (1950), cited by Perkulis *et al.*, 1997; Krebs, 1989; Kent and Coker, 1992) put forward different measures of species diversity. These measures among others include Shannon-Wiener Index of diversity (*H'*), Index of Dominance (C) and Species Important Value Index (IVI) among others. Descriptions of these indices are clearly shown in Kent and Coker (1992).

Species diversity differs from one forest community to the other. Many reasons have been explained for the differences (Kielland-Lund, 1990; Frost, 1996; Perkulis *et al.*, 1997; Oosterhoorn and Kappelle, 2000; Luoga, 2000; Munishi and Shear, 2004; Munishi *et al.*, 2004a,b; 2007, 2008). High species diversity is observed in tropical rainforests, while dry miombo woodlands are relatively low in species diversity. Otieno (2000) showed such a case for Duru-Haitemba, which by then was only 5 years old since the inception of CBFM.

Abundance of woody species in forests is determined by several measurements namely frequency, density, basal area and importance value index (IVI). Bekele (1994) pointed out that the frequency gives an approximate indication of the homogeneity of a stand. High values in higher frequency classes and low values in lower frequency classes indicate constant or similar species composition, while high values in lower frequency classes and low values in higher frequency classes indicate a high degree of floristic heterogeneity. Bekele (1994) also asserts that high density indicates regular horizontal distribution of wood species in forests, while species with high values of IVI are abundant. It is also noted that species with low values of IVI need monitoring management as they might distinct.

Most of the miombo woodlands, are rich in the genera *Brachystegia*, *Julbernadia* and *Isoberlinia* (Frost, 1996). Miombo woodlands have been divided into two main types namely wet and dry miombo woodlands. Dry miombo woodland occurs in southern Malawi, Mozambique and Zimbabwe in areas receiving less than 1000 mm rainfall annually. According to Frost (1996), the dominant *Brachystegia* species of the dry miombo woodland are either absent or local in occurrence, but *B. spiciformis*, *B. boehmii* and *Julbernardia globiflora* are the dominant deciduous species. The authors also report that wet miombo woodlands occur over much of eastern Angola, northern Zambia, south western Tanzania and central Malawi in areas receiving more than 1000 mm rainfall per year. *Brachystegia floribunda*, *B. glaberrima*, *B. longifolia*, *B. wangermeeana*, *Julbernardia paniculata*, *Isoberlinia angolensis* and *Marquesia macroura* are among the most dominant species found in the wet miombo woodlands, but *Brychystegia* and *Julbernardia* are among the dominant genera in all mimbo woodlands. Similar characteristics in miombo woodlands are reported by different studies (e.g. Frost, 1996; Bauckes *et al.*, 2006; Banda *et al.*, 2006; Isango, 2007).

2.4 Summary of Theoretical Gaps

The review observes that PFM has been a prospective model for management of forest resources compared with other models such as centric administration model adopted after colonial era and during colonial era. The PFM model has been improving conservation of forest resources and livelihoods of local communities. However, the inception of PFM in many countries has been due to efforts of governments, NGOs, donors and local communities.

Although, the PFM model is observed to contribute to improved livelihoods of local communities, it requires monitoring studies in its governance and institutional arrangements, contribution to improvement of the resource base and socio-economies. These aspects have not been covered in most of the southern African countries. Important indicators for monitoring livelihoods or socio-economies of local communities in any PFM programme are not available in Tanzania. Further, quantification of the way in which PFM improves the condition of respective forests is not well documented.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of Study Area

3.1.1 Geographical location

The Forest Reserve is in Mgori Division in Singida District, Singida Region, Tanzania (Fig. 2). The reserve lies between 35° 05' and 35° 22' East, and 4° 45' and 4° 58' South. The forest has an area of about 45 000 ha. It is situated approximately 50 km east of Singida Town. Mgori Division borders Kondoa and Hanang Districts to the eastern and northern parts respectively.

Mgori Forest Reserve (MFR) covers three wards namely: Ngimu, Mgori and Nduamughanga. Five villages namely Unyampanda, Pohama, Mughuunga, Nduwamughanga and Ngimu surround Mgori Forest Reserve. The reserve is divided into five village forest reserves (VFRs). The VFRs are named after the respective villages. These are Ngimu VFR (1966 ha), Unyampanda VFR (7250 ha), Mughuunga (7270 ha), Pohama VFR (10 856 ha) and Nduamughanga (16 709 ha). Pohama and Nduamughanga villages cover more than three–quarters of the total area. Naming of the VFRs has been done purposely to enable management of the forest to be done by respective villages.

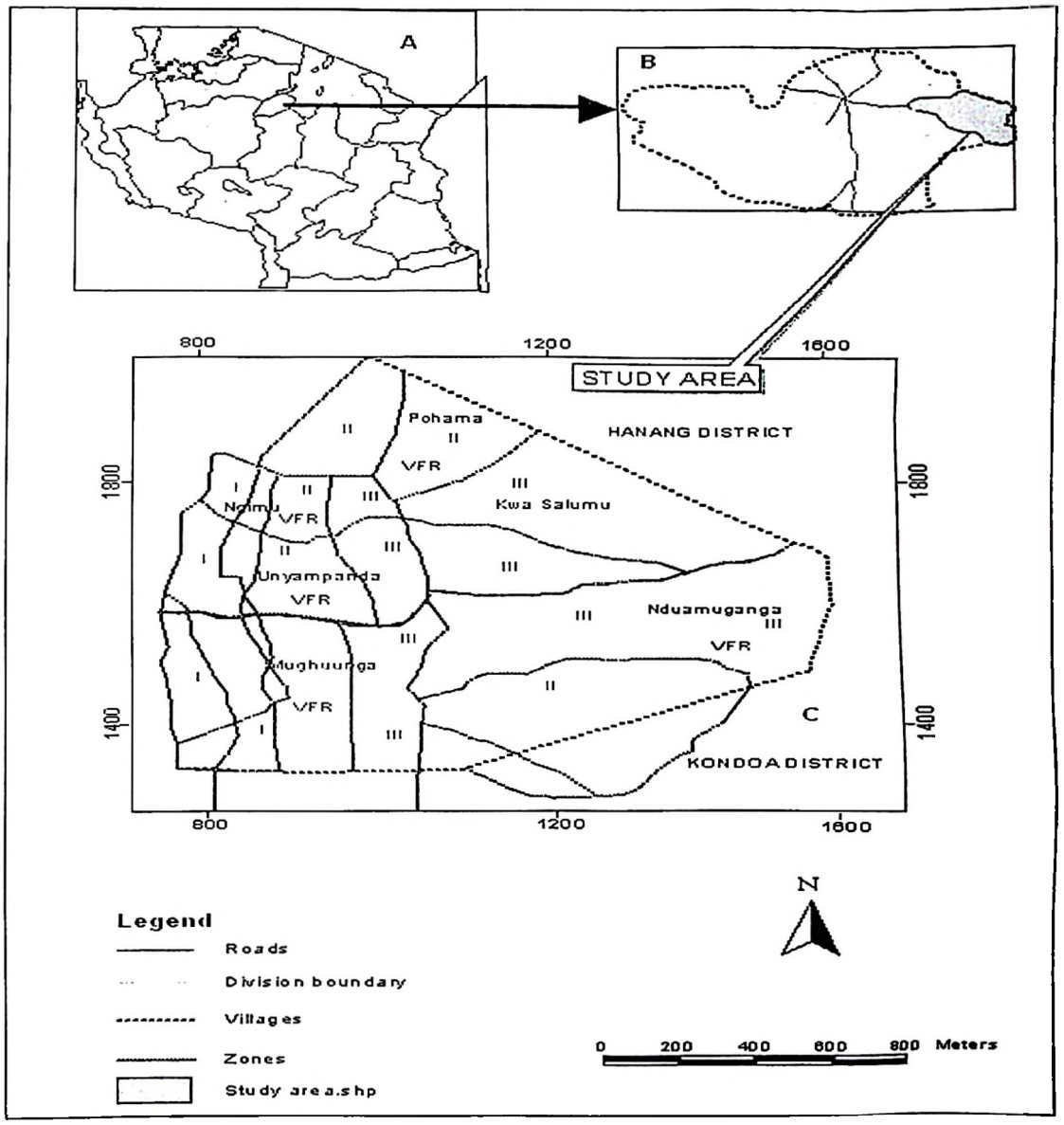


Figure 2: Map of Tanzania (A) showing the location of Singida District in Singida Region (B) and Mgori Division (C) showing the location of study villages and forest reserve zones (I-III)

3.1.2 Topography

The major part of the Mgori Division is a plateau with gentle slopes having non-specific directions of inclination with occasional outcrops. Altitude ranges from 1400 m to 1600 m a.s.l (Ikaku, 2002). Geologically, the area has a number of rocky outcrops forming hilly

formations, which are spectacularly looking. Two such areas, one is in the north and another in the south, form easily identifiable points for tracing the forest reserve borderline. Some elevated parts of the forest reserve provide spectacular scenes into the rift valley (Water Source Ltd (1996), cited by Ikaku, 2002). There are no permanent rivers in the Division. However, the area has a number of seasonal streams, such as Masiriva and Lyongwambindo, which do not have water during the dry seasons. Occasional small marshes and swamps locally known as "Mbuga" are apparent.

3.1.3 Geology and soils

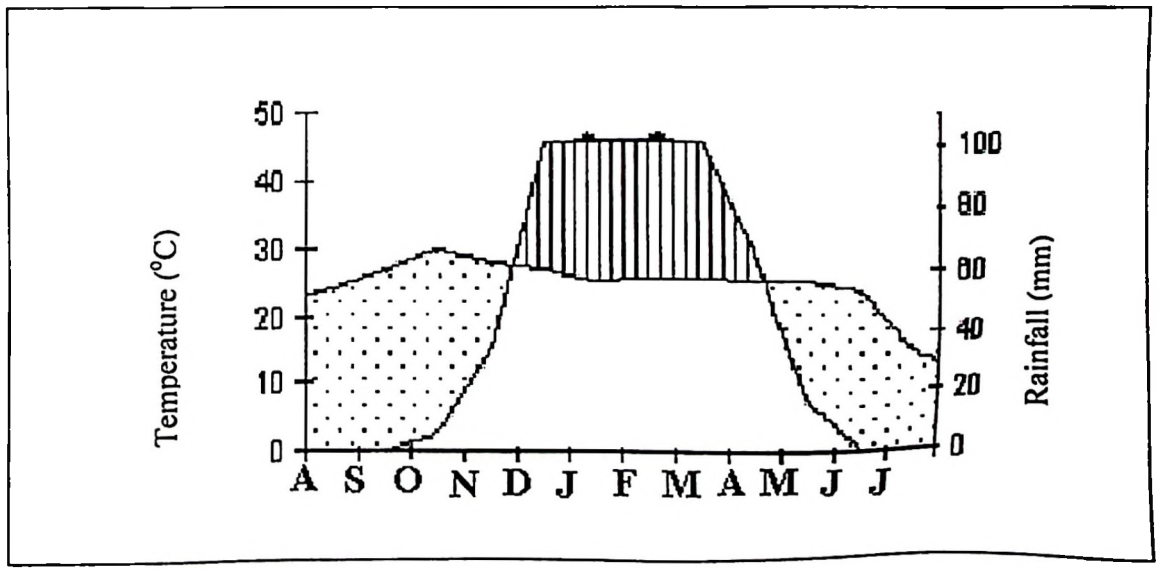
The Geology of the study area is typical of the whole Singida Region. The dominant rock is granite batholiths, which occasionally has been modified by basalt flows from old volcanoes (Water Source Ltd (1996), cited by Ikaku, 2002). The tops of the volcanic plateau comprise sandy loam soils of a fair fertility status and adequate depth for plant growth. In the valleys and lowlands, there are deposits of clays and loams (Ikaku, 2002). Erosion is pronounced on slopes. Gullies are eminent in poor vegetation cover areas.

In respect to hydrology, most of Mgori Division falls within the Mgori Forest Catchments and has an optimal value as rainwater sink (Water Source Ltd (1996), cited by Ikaku, 2002). Due to the presence of dense woodland thicket canopies, little of rainwater is being lost as run-off in most of the forest area. However, in areas where sandy loams are the dominating soil types, little of the precipitation is dispersing and percolating to paretic and intermediary water tables as standing water available for both humans and animals (Water Source Ltd (1996), cited by Ikaku, 2002).

3.1.4 Climate

A large part of Singida Region is in arid and semi arid belt. An average annual rainfall ranges from 500 mm to 800 mm with an average annual rainfall of 790 mm (meteorological station located at Nduamughanga Primary School near Mgori Forest Reserve) (Ikaku, 2002). The area is characterized with two main seasons namely wet and dry. The wet season starts from November and ends at the end of April, with a dry spell in January. The dry season is from May to October.

An average annual temperature varies within a range of 15° C to 30° C depending on the season and altitude (Fig. 3). The coldest month in the year is July while the hottest period is during October to November. The relative humidity (RH) at noon rises from 36% in the driest months to 58% during the wet season. Wind speed is usually high during the dry season.



Source: Data obtained from Tanzania Meteorological Agency - Nduamughanga Primary School

Figure 3: Climatic diagram showing mean annual temperature and mean annual rainfall for the last 20 years (1980-2000), Singida District, Tanzania

3.1.5 Vegetation

The whole area is typical of savannah woodland dominated by miombo species. Based on its location and its vegetation type, it lies entirely within the Forest-Grassland Mosaic i.e. Somalia-Maasai Regional Centre of Endemism (White, 1983). The vegetation cover is mainly composed of *Julbernardia globiflora, Brachystegia speciformis, Combretum zeyheri, Lannea schimperi, Commiphora mossambicensis, Pretocarpus angolensis, Combretum molle* and *Lonchocarpus bussei*. The commercial forest species are few and far between with only about 70 trees/ha and a total standing volume of less than 20 m^3 ha^{-1} (Water Source Limited (1996), cited by Ikaku, 2002). According to Malimbwi and Mwansasu (1994), the valuable tree species found in the forest include *Pretocarpus angolensis, Afzelia guanzensis, Dalbergia melanoxylon* and *Brachystegia* species.

3.1.6 Population

According to the National population census of 2002, the population size of Mgori Division was 25 751 people with a growth rate of 2.3%. Ngimu ward has the population size of 14 974 people, while Mgori ward has 10 777 people. The population size for the studied villages is presented in Table 2.

Table 2: Population distribution around Mgori Forest Reserve, Singida District, Tanzania

Village	1988	2002	Households
Ngimu	3200	3738	561
Pohama	1089	2991	444
Unyampanda	2531	1663	223
Mughuunga	1345	1362	161
Nduamughanga	1 140	1 382	368

Source: URT, 2003

3.1.7 Land use and economy

Agriculture is the main stay of the economy in the study area. Cropping and livestock keeping are the dominant form of land use. The major food crops grown are sorghum, sweet potatoes, millet and maize. Cash crops include sunflower and groundnuts. Cotton used to be one of the most important cash crops but recently has lost ground due to a number of reasons, the major one being low market prices. Women are involved in basketry and pottery. However, marketing of these and other products remain a problem, particularly for remote areas like Nduamughanga. Roads are inaccessible especially during the rainy seasons. Forestry activities are also part of land use in the area. The villagers rely very much on forest resources particularly for fuel wood, building materials and non-wood forest products (NWFPs) such as mushroom, vegetable, medicinal plants, honey and other items.

3.2 Data Collection

3.2.1 Research design

A cross-sectional research design was adopted in this study, of which the collection of information was done at one point. The design is recommended by several studies (e.g. De Vaus, 1993; Bailey, 1998) and was adopted for both socio-economic and ecological surveys.

3.2.2 Socio-economic survey

Four villages namely Ngimu, Pohama, Unyampanda and Mughuunga were purposively selected. Data were collected using three methods namely focus group discussion (FGD), structured interviews and key informant interview. The three methods majored on collecting information on socio-economies of local communities, and institutional and

governance arrangements in VFRs. Before the actual data collection, the data collection tools and methods were pre-tested at Nduamughanga village, which was not involved in the study.

Focus Group Discussion

In each selected village, the focus group discussion (FGD) was carried out by conducting discussions in small groups formulated by different actors of different age and sex. Each group was composed of 7 - 10 members to allow high participation. Four FGDs were held in each selected village. The FGD was guided by a well-structured checklist. Data collected during the FGD include institutional and governance arrangements, and some socio-economic information.

(i) Institutional arrangement

Information collected during FGD included demarcation of village forest reserves, preparation of village forest management plans and by laws, formation of village forest committees, formation of Mgori Forest Coordinating Committee and monitoring the conditions of forests. Assessment of effectiveness of various institutions such as committees, village government, district council and MNRT was also done and given scale as 1 poor otherwise 4 very effective. Stakeholders were also identified during the process.

(ii) Governance arrangement

During the FGD, the villagers agreed on the set eight dimensions of governance as proposed by Singhal (2006). These dimensions are participatory, accountability, transparency, equitability, follow the rule of law, responsiveness, consensus and effectiveness. During the FGDs, sub dimensions were also proposed and agreed upon.

These sub dimensions were incorporated in the questionnaire as shown in Table 3 and section II of Appendix 1.

Table 3: Definitions of dimensions of good governance through sub dimensions used for assessing governance of Village Forest Reserves at Mgori Forest Reserve in Singida District, Tanzania

Dimension	Sub dimensions
Participatory	Collaboration with local governments
	Collaboration with other villagers
	Collaboration with NGOs/CBOs
	Participation in decision making
	Participation in distribution of revenues
	Participation in forest management
	Participation in village development activities
Accountability	Distribution of village accounting reports
	Delivered what is promised for
	Reviewing meeting minutes
	Openly explaining the rationale for the decision
	Acknowledging that work is completed
	Sharing lessons learned as well as recommendations
	Accepting good and bad
Transparency	Existence of communication and information
	Attendance to village government meetings
	Existence of open meetings
	Existence of financial disclose statements
	Existence of openness from village leaders
	Existence of criticism
	Giving and accepting apologies
Equitability	Treating each other with respect and dignity
	Concern for others no matters the rank
	Fair resource allocation and utilization
	Focus on the issue, not the person
	Gender based perspectives and participation
	Equal distribution of revenues
	Equal contribution to development activities
Follow the rule of law	Applying national forest policy
	Abiding to the law
	Existence of regulations
	Existence of by laws
	Adhering to the established policies, practices and processes
	Fair treatment on case by case in court
	Respecting boundaries and jurisdictions
Effectiveness	Doing right things regardless of consequences
	Reducing offenses
	Improving forest conservation
	Improving household wellbeing
	Development of village facilities
	Being close to central and local governments
	Reducing corruption

Table 3 cont:

Dimesnion	Sub dimesnions
Follow the rule of law	Applying national forest policy
	Abiding to the law
	Existence of regulations
	Existence of by laws
	Adhering to the established policies, practices and processes
	Fair treatment on case by case in court
	Respecting boundaries and jurisdictions
Effectiveness	Doing right things regardless of consequences
	Reducing offenses
	Improving forest conservation
	Improving household wellbeing
	Development of village facilities
	Being close to central and local governments
	Reducing corruption
Consensus	Existence of committee agreements
	Existence of village meeting agreements
	Existence of agreements at household level
	Existence of agreements in meetings with local government officials
	Existence of agreements with district council representatives
	Existence of sharing and be receptive to opinions given
	Existence of agreements in planning and bylaw settings
Responsibility	Willingness to take responsibility for action and outcome
	Acknowledging assigned role
	Obeying assigned activity
	Staff and volunteers working towards common goal
	Gaining collective inputs
	Trustful when given responsibility
	Responding to any matter arise

These sub dimensions were given scores from 1 = poor to 4 = very high performance.

(iii) Socio-economies

Information on socio-economies of the villagers was collected in which cultural, social and economic benefits were pointed out. The cultural benefits were spiritual, taboos and cultural practices. The social benefits were prestigious for owning the forest, networks and existence of forest resources.

Economic information focused on constructing wealth index of households (Reutlinger and Knapp, 1980; Sahn, 1989; Minot *et al.*, 2006; Raitz, 2006). Income, food security, housing, education, accessibility to clean water and health services were listed and given assessment. In assessing, the wealth status of the household, the categories are as presented in Table 4. Low status of any component scores one while very high scores four. This was involved in the questionnaire for the respondents to rank. The information was collected for development of wealth index of households.

Table 4: Economic indicators for assessment of wealth of individuals or households at Mgori Forest Reserve, Singida District, Tanzania

Economic indicator	Level	Assessment	Ranking
Income per year (TAS)	1000 – 50 000	Low	1
	50 000 – 100 000	Relatively high	2
	100 000 – 150 000	High	3
	150 000+	Very high	4
Status of food security in terms of availability from individual production	1 – 3 months	Low	1
	3 – 6 months	Relative high	2
	6 – 9 months	High	3
	Year round	Very high	4
Status of food security in terms of quality of food based on number of meals taken a day	Not sure	Low	1
	One meal	Relatively high	2
	Two meals	High	3
	Three meals	Very high	4
Housing condition based on construction materials	Mud walls + thatched roofing	low	1
	Brick + thatched roofing	Relatively high	2
	Mud walls + iron sheet roofing	High	3
	Brick + iron sheet roofing	Very high	4
Accessing clean water in terms of distance to the source	Very Long	Low	1
	Long	Relatively high	2
	Not so long	High	3
	Short	Very high	4
Education in terms of children's level of education	None	Low	1
	Primary school	Relatively high	2
	Secondary	High	3
	Post secondary	Very High	4
Health in terms of affordability of services	Cannot afford	low	1
	Cannot easily afford	Relatively high	2
	Can afford	High	3
	Can easily afford	Very high	4

Structured interviews

For structured interview, questionnaire survey was conducted, in each selected village. A simple random sampling design was used for selecting households. At least 5% of households were sampled randomly using the village roster/register as the sampling frame. The study decided to increase the number of households to be 60 for every selected village for better representation as according to Bailey (2004) the minimum required sample to draw statistical inference in social survey is 30 respondents. This is because most villages in the study had households ranging from 200 to 350. The total sample size was therefore 240 households. The selected sample was reasonable and acceptable for statistical analysis.

The questionnaire was formed of different types of closed and open-ended questions (Appendix 1). Closed-ended questions allowed a respondent to give answers by selecting the given choices, while open-ended questions allowed the respondent to explain from own expressions. The questionnaire was administered to heads of households, although other members of households either represented or collaborated with the heads of the households. In-depth personal approach was adopted during the administration of the questionnaire in which interviewer was asking questions from the structured questionnaire to respondent.

Key informant interviews

Key informant interview was held to cross check the answers given by the respondents. Forest and agricultural officers from regional and district levels, community leaders, members of committees, officials from Orgut and Land Management Programme (LAMP) organizations, village leaders and elders formed this part of data collection method. The

key informant interview followed immediately after the administration of questionnaire. In the interview process, a well-structured checklist was used to guide the discussion.

2.2.3 Assessment of forest resource base and status

Forest resource base was assessed through forest inventory. Forest inventory was used to determine tree density, basal area, volume, species richness and encroachment. A total of 136 sampling units/plots of the size 0.1 ha were established in the study forest as shown in Table 5. Although size of plots depends on the size of the study forest, a recommended size of plots is at least 0.1 ha (Aldred and Alemdag, 1988). Using sampling intensity (SI) of 0.05%, the sample size and number of sampling units were computed as:

$$Ha = FRA * SI$$

Where Ha = sample size (ha) at sampling intensity of 0.05%

FRA = Forest reserve area (ha)

SI = Sampling intensity (0.05%)

N = number of sampling units, which is FRA * SI/0.1ha

A cluster approach was adopted as a sampling design in allocating sampling units in each of the Village Forest Reserve. The clusters were randomly allocated in the population along transect lines (Fig. 4). In each cluster, six 20 x 50 m (0.1 ha) sized plots were established. In each plot, nested plots of the size 10 x 25 m were established. The distance between plots and transects was 200 m. In Ngimu VFR, there were 4, 3, 3 plots in the established clusters, but in other VFRs, in each cluster, 6 plots were laid.

Table 5: Sample size and number of sampling units used in Mgori Forest Reserve, Singida District, Tanzania

VFR	Area coverage (ha)	Sampling intensity (%)	Required sample (ha)	Number of plots
Ngimu	1966	0.05	0.98	10
Pohama	10 856	0.05	5.43	54
Unyampanda	7250	0.05	3.63	36
Mughuunga	7270	0.05	3.64	36
Total	**27 342**	**0.05**	**13.68**	**136**

The information collected from each plot included: identification and record of all tree/shrub species; measurement of the diameter at breast height (dbh) of all trees with a minimum dbh of 2 cm using diameter tape and/or caliper; and estimate of the height of three trees in the categories smaller, medium and largest using Sunto Hypsometer.

Plant identification was done with the help of a local plant identifier and district foresters. Species names were recorded in both vernacular and scientific names directly in the field. For plants that could not be identified in the field, voucher specimens were collected for identification in herbarium and/or by a systematic botanist.

An assessment of human induced physical damages on plants/trees based on stem cuttings, debarking, debranching and fire occurrence categorized into new and old damages was done in each sampling unit as recommended by Scott (1997). New and old damages were assessed through examining fresh and rot signs respective.

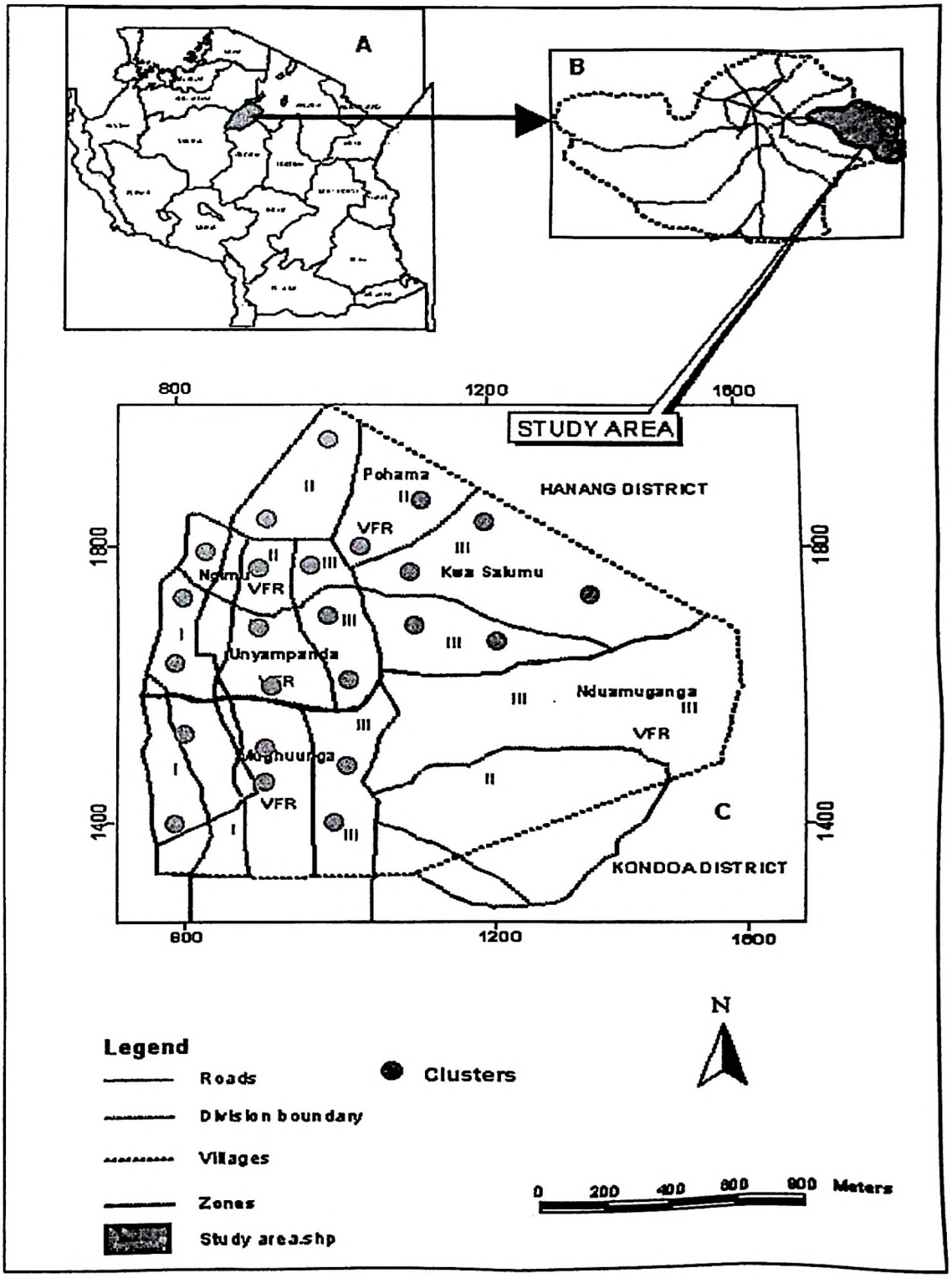


Figure 4: Map showing selected clusters for inventory at Mgori Forest Reserve, Singida District, Tanzania

3.4 Data Analysis

3.4.1 Socio-economic data

Both qualitative and quantitative methods were used in analyzing the data of which descriptive and inferential statistical analyses were employed. In the descriptive statistical analysis, frequencies, percentages, means and variations were computed, while in inferential statistical analysis, multiple linear regression, t-test and ANOVA were conducted. Various indices were also developed. Before conducting regression analysis, Principal Components Analysis (PCA) was performed to select the most appropriate variables for the model.

(i) Development of index variables for governance

In each village, indices were developed for dimensions of good governance (Table 3). The development of these indices involved development of a set of statements, which were included in the questionnaire administered to the villagers. Each dimension was explained by seven statements or sub dimensions. Each statement was given scores as 1 for poor and 4 for very high. These statements were then used in calculating the index variables as adopted from Hortland (1993):

(i) Dimension indices

$$DI = \sum(y_{ij}/Y_{max}) \qquad (i = 1, 2, \text{-----}x; j = 1, 2, \text{-----} n)$$

Where:

DI = Dimension index for, such as participatory, accountability transparency and equitability, among others

y_{ij} = Frequency of score to an individual sub-dimension of the main dimension

y_{max} = Maximum frequency of score to that sub-dimension, which is 28

x = Number of sub-dimensions determining factor, which is 7

n = Sample size, which is 240

(ii) Governance index

$GI = \sum(\sum(y_{ij}/Y_{max}))/n$

GI = Governance index

N = total number of dimensions, which is 8.

(ii) Development of wealth index

Wealth index was computed following Hortland (1993). The following was the formula used for calculating the wealth index:

$WET = \sum(y_{ij}/Y_{max})$ (I = 1, 2, ..., x, j = 1,2, ..., n)

Where:

WET = wealth index

y_{ij} = number of an individual indicator for wealth

Y_{max} = Maximum number of that indicator in the sample (28)

Y = Number of items considered as indicators for wealth (7)

n = Sample size (240)

(iii) Regression analysis

Principal Components Analysis (PCA) was performed before regression analysis. Factor loading through rotated component matrix, scree plotting and component plotting in rotated space were employed. Variables with loading factor above 0.3 were considered in

the regression analysis. Education and age were selected based on rotated component matrix method, which they had loading factor values above 0.3 (Table 6).

Table 6: Loading factor values for background characteristics as obtained from Principal Components Analysis

Variables	Component	
	1	2
Education level	0.941	0.045
Age	0.602	-0.190
Occupation	0.165	-0.074
Size of household	0.097	2.05
Marital status	-0.039	0.124
Sex	0.053	-0.088

Village guard committee was not selected for the regression analysis following the accepted concept of PCA as the loading factor was below 0.3 (Table 7).

Table 7: Factor loading values for institutional arrangement variables as obtained from Principal Components Analysis

	Component	
Variables	1	2
Ministry of Natural Resources and Tourism	0.823	-0.220
Village Government	0.749	0.227
District Council	0.522	0.276
Village Land Committee	0.389	0.084
Village Forest Committee	0.298	0.576
Village Guard Committee	0.233	0.602

Accountability, consensus, transparency and participatory dimensions were only to be selected for the regression analysis if rotating component matrix principal had to be

adhered to Table 8. However, following principal component plotting in rotated space, other dimensions were include except "Follow the rule of law" (Fig. 5).

Table 8: Factor loading values for governance arrangement variables as obtained after Principal Components Analysis

Variables	Component		
	1	2	3
Accountability	0.491	0.035	-0.081
Consensus	0.453	-0.041	0.027
Transparency	0.353	0.043	0.216
Participatory	0.321	0.483	-0.035
Equitability	0.250	0.234	0.227
Effectiveness	0.230	0.017	-0.089
Responsiveness	0.203	-0.495	-0.018
Follow the rule of law	-0.109	-0.012	0.581

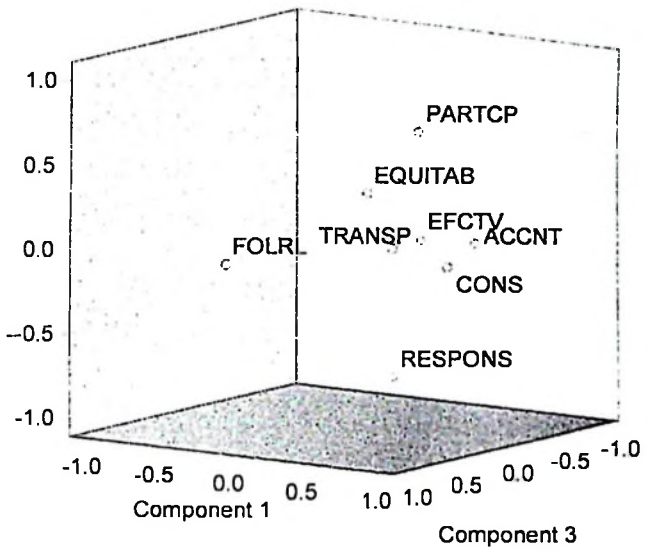


Figure 5: Component plotting in rotating space for governance arrangement variables as obtained after Principal Components Analysis

Regression model was used to identify relationship between wellbeing of households through computed wealth index and some selected background characteristics, institutional and governance arrangement variables (Tables 5, 6 and 7; Fig. 5). Wellbeing of individual households was hypothesized to be a positive function of the selected variables.

The regression model adopted was as follows:

$$WET = \beta_o + \beta_1(AGEHH) + \beta_2(EDULHH) + \beta_3(EFVFC) + \beta_4\ (EFVLC) + \beta_5(EFVGT) + \beta_6(EFDC) + \beta_7(EFCGT) + \beta_8(CONS) + \beta_9(PARTCP) + \beta_{10}\ (EFCTV) + \beta_{11}(ACCNT) + \beta_{12}(TRANSP) + \beta_{13}(RESPONS) + \beta_{14}(EQUITAB) + e_i$$

Where

WET	=	Wellbeing of individual households (calculated from section 3.4.1 (ii))
AGEHH	=	Age of head of household in years
EDULHH	=	Education level of head of household by number of years spent in school
EFVFC	=	Effectiveness of village forest committees (4 = very effective, while 1 = poor)
EFVLC	=	Effectiveness of village land committees (4 = very effective, while 1 = poor)
EFVGT	=	Effectiveness of village governments (4 = very effective, while 1 = poor)
EFDC	=	Effectiveness of District Council (4 = very effective, while 1 = poor)
EFCGT	=	Effectiveness of central government (4 = very effective, while 1 = poor)
CONS	=	Level of consensus (4 = Very high, while 1 = low)
PARTCP	=	Level of participation (4 = Very high, while 1 = low)
EFCTV	=	Level of effectiveness (4 = Very high, while 1 = low)
ACCNT	=	Level of accountability (4 = Very high, while 1 = low)
TRANSP	=	Level of transparency (4 = Very high, while 1 = low)
RESPONS	=	Level of responsiveness (4 = Very high, while 1 = low)
EQUITAB	=	Level of equitability (4 = Very high, while 1 = low)
β_o	=	Intercept
$\beta_{1\text{-}14}$	=	Parameters to be estimated
e_i	=	Random error term

3.4.2 Forest resource base data

Microsoft excels computer program was used for analyzing ecological and disturbances caused by human activities data. Post hoc test and ANOVA were also used. The ecological or forest resource base parameters computed include:

Stand parameters

(i) Density computed as the number of stems per hectare (N ha^{-1}).

(ii) Basal area (G) (m^2 ha^{-1})

$$G = \sum 3.14 \times D^2/4 \times 0.1ha$$

Where: D is the diameter at breast height for the measured trees/shrubs

(iii) Volume (V) (m^3 ha^{-1})

Volume was computed using allometric models developed by Malimbwi *et al.* (1995).

$$lnV = -10.145 + 2.69D$$

Where: *ln* is natural logarithm

V is volume (m^3)

D is a tree diameter at breast height (dbh) in cm

Species composition and diversity

Relative frequency (RF), relative density (RD), relative dominance (RDo), Importance Value Index (IVI), Shannon Weiner Diversity Index (H'), Index of Dominance (C), Species Diversity Index (SDI) and Species Evenness (E) were calculated for determination of composition and abundances and species diversity in the forests.

Species Importance Value Index (IVI) was calculated according to Kent and Coker (1992):

$IVI = (RF + RD + RDo)/3$

Where:

IVI = Species Importance Value Index

RF = Relative Frequency = (Frequency of one species)/(sum of all frequencies) x 100

RD = Relative Density = (Number of individuals of a species)/ (total number of individuals of all species) x 100

RDo = Relative Dominance = (Basal area of a species)/ (total basal area of all species) x 100

Species diversity was assessed by use of Shannon-Weiner diversity index, Simpson diversity index (Index of dominance) and species diversity index. The Shannon-Weiner diversity index was calculated according to Kent and Coker (1992) as:

$H' = -\sum p_i \ln p_i$

Where: H' = Shannon Weiner diversity index

p_i = The proportion of individual or the abundance of the i^{th} species expressed as a proportion of total cover (Relative abundance of a species)

ln = Natural logarithm

The Index of dominance was calculated as (Kent and Coker, 1992):

$C = \sum (n_i/N)^2$

Where:C = Index of Dominance

n_i = Number of individual species in the sample

N = Total number of species in the sample

The species diversity index was computed as (Kohl *et al.*, 1996):

$SDI = - \sum log_{10}(pi)/log_{10}(1/S)$

Where:

SDI = Species diversity index

S = the number of species at that site (VFR)

$P_i = n_i/N$

n_i = total number of individuals in the i^{th} species

N = total number of individual of all species

Species evenness (E) was computed as (Kent and Coker, 1992):

$E = H'/H'_{max}$

Where: $H'_{max} = \log_{10}(S)$

S is number of species in the site

3.5 Limitations of the Study

In the course of the study, some limitations were encountered. These among others include:

- Data collection problems: Respondents had problems in recalling past events especially income, crop yield, livestock owned and amount of forest products consumed by the households. However, the study solved the problem through spending more time in such aspects during the questionnaire administration. The problem was also solved by conducting FGDs, which helped getting overall estimates.

- Lack of indicators for assessing institutional and governance arrangements: However, the study established a normal way of assessing performance as very effective, effective, satisfactory and poor, which is a perception analysis.

- Direct contribution of CBFM to socio-economies: It was very difficult to establish the direct contribution of CBFM to socio-economies of local communities as there were no established socio-economies monitoring approaches in MFR. The problem was solved by conducting the perception analysis.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-economic Factors Influencing Wellbeing of Local Communities Surrounding Mgori Forest Reserve

Socio-economic characteristics considered in this study include sex, age, education level, marital status, occupation and household's size. This type of information is of importance as it determines the functional roles of the individuals who head households and how they influence wellbeing of the household.

4.1.1 Sex of respondents/heads of households

The study involved female and male-headed households, of which 22% were female-headed households and 78% were male-headed (Table 9). A chi-square test showed that sex of respondents was significantly ($p = 0.017$) different among villages. This provides an impression that the selection of respondents followed the required principle of randomization.

The sex of household head determines the responsibility of the individual for the economic wellbeing of the household. In gender perspective, women relative to men are disadvantaged in accessing society's economic resources and opportunities (Meinzen-Dick, 1997; Chingonikaya *et al.*, 2004; Chingonikaya and Maganga, 2007). However, it is assumed that household head must ensure the economic sustainability of the household irrespective of his or her sex.

Table 9: Socio-economic characteristics of households at Mgori Forest Reserve, Singida District, Tanzania

Variables	Percentage of response					
	Ngimu (n = 60)	Pohama (n = 60)	Unyampanda (n = 60)	Mughuunga (n = 60)	Overall (N = 240)	χ^2 and p values
Sex						
Male	71.7	90.0	81.7	68.3	77.9	χ^2= 10.15
Female	28.3	90.0	18.3	31.7	22.1	p = 0.017
Age						
35 - 44	23.3	36.7	31.7	28.3	30.0	χ^2= 15.374
45 - 54	31.7	36.7	43.3	46.7	39.6	p = 0.081
55 - 64	26.7	18.3	23.3	18.3	21.7	
65+	18.3	8.3	1.7	6.7	8.8	
Marital status						
Single	18.3	6.7	-	13.3	9.6	χ^2= 26.34
Married	66.7	90.0	83.3	83.3	80.8	p = 0.002
Widow	8.3	-	11.7	3.3	5.8	
Divorced	6.7	3.3	5.0	-	3.8	
Household size						
1 - 3	28.3	11.7	11.7	16.7	17.1	χ^2= 45.718
4 - 6	20.0	50.0	48.3	33.3	37.9	p = 0.069
7 - 9	20.0	20.0	20.0	20.0	20.0	
10+	31.7	18.3	20.0	30.0	25.0	
Education level of heads						
None	8.3	15.0	1.7	10.0	8.8	χ^2= 29.774
Adult education	60.0	73.3	88.3	85.0	76.7	p = 0.003
Primary	3.3	1.7	-	-	1.3	
Secondary	5.0	-	1.7	-	1.7	
Post secondary	23.3	10.0	8.3	5.0	11.7	
Occupation						
Farmer	90.0	96.7	93.3	100	95.0	χ^2= 9.837
Civil servant	6.7	-	5.0	-	2.9	p = 0.132
Old/sick	3.3	3.3	1.7	-	2.1	

4.1.2 Age

Four age categories were considered for households involved in this study (Table 9). An average age of the heads of the households was 50 ± 0.58 years and ranged from 37 to 80 years. This range was based on the fact that it was aimed at analyzing the socio-economic situation of the community in two distinct periods; before and after inception of CBFM. Literature shows that age is an important demographic factor when determining economic status of a household (CIMMTY, 1993; Deaton, 1997; Ishika, 2005). Mbwambo (2007) shows that in rural areas, households headed by old individuals have a tendency of facing food insecurity and general poverty. This has been observed in this study that the relationship between wellbeing of households and age was significantly negative (β = -0.141; p = 0.029) (Table 35). This shows that an increase in age reduces the wellbeing of a household.

4.1.3 Marital status

Out of the 240 respondents, 81% were married, while 10%, 6% and 4% were single, widowed and divorced individuals, respectively (Table 9). Marital status was significant different among villages (p = 0.002). The findings provide an impression that most of those involved in the study were mature. They were also likely to have been involved during implementation of CBFM in 1996.

4.1.4 Household size

The household size ranged from one to 13 persons with a mean of 5.3 ± 0.13 persons (Table 9). The ANOVA shows that there were variations in household size among villages (p = 0.069). About 38% had a family size of 4 to 6 persons. The average household size for Ngimu, Pohama, Unyampanda and Mughuunga was 5.2, 5.2, 5.4 and 5.4 respectively.

However, about 32% of households in Ngimu had high size above 10 persons compared to others (Table 9). The household size reported in this study is not quite different from that reported for Singida District in 2002 by the National Population Census (URT, 2003).

Household's size is a determinant of many functions. According to Lanjouw and Ravallion (1995), consumption and expenditure patterns are lined with the size of the household. This has a reflection on the distribution of the household income. In terms of adult equivalent, it determines income per capita, which is one of the strongest measures of income poverty (Meanokshi and Ray, 2000). Some studies use household size to distinguish between the poor and rich (Lanjouw and Ravallion, 1995; Dreze and Srinivasan, 1997; Wei, 2001; Lawson and Hulme, 2006). Several of these studies support the notion that large households are poor, but Kamuzora (2001) points out that household size may not be a measure of the poverty level of a household.

4.1.5 Education status

Individuals with an adult education level headed about 77% of the households (Table 9). Household heads that had post secondary education accounted for 12%, while those who had not attended formal education were 9%. Individuals, who had primary (1%) and secondary (2%) education, headed very few households. The results, further revealed χ^2 value of 29.774; $p = 0.003$. This showed that there were some significant variations of education status among villages. It is the fact that education level among heads of households influences their wellbeing (Person and Swanson, 1966; Yonghong and Katrina, 2007).

4.1.6 Occupation

Most of the respondents (95%) were peasants as opposed to civil servants who formed 3% (Table 9). The agrarian economy of rural communities in most of rural areas of Tanzania is well integrated with forest resource use. Understanding occupation of the population is important as it may determine the extent to which the society depends on forest resources.

4.2 Institutional Arrangements of CBFM and their Effectiveness

Among the steps taken to build adequate and effective institutional arrangements included demarcation of village forest reserves, preparation of village forest management plans and by laws, formulation of village forest committees, village land committees, forest guard committees and forest condition monitoring plans.

4.2.1 Security of access to land and tree tenure

Initially, when the villagers received responsibilities to manage their adjacent forests, they decided to demarcate the village forest reserves (VFRs). At first, the demarcation was done through marking boundaries between VFRs using paints on trees and rocks. This was important, as the respective villages could be responsible and accountable for their areas.

Later, the forest boundaries were marked with permanent beacons through government support. This gave the villagers a sense of security in ownership, legal and public basis to protect a resource that is known as "our village forest". This resulted into villagers respecting their boundaries, which in turn reduced conflicts among them. This has been echoed by different researches that local forest management systems based on indigenous organizations and centralized collective management by users can avoid the tragedy of commons (Arnold and Campbell, 1986; Fisher, 1989; Chopra *et al.*, 1990; Kajembe and

Kessy, 2000). Ostrom (1990) observed that co-management succeeds when biophysical and cultural boundaries are well defined. However, Hawkes (1996) emphasizes that the scale of a co-management unit should reflect political and ecosystem considerations, as well as the availability of resources.

In collaboration with Division Forest Officer, District Land Officer and various donors, the VFRs were mapped, zoned and given entitlement (Fig. 2). The VFRs were divided into three zones namely: Zone III known as a core zone for restrictive conservation of genetic resources where human activities were prohibited, except research; Zone II where some activities were allowed only at the supervision of technical personnel and Zone I where villagers were allowed to carry out some non-destructive activities throughout the year. The zonation found at MFR was not different from the zoning done in catchment forests and other community based forest management reserves in Tanzania and elsewhere in the world (Shaxon, 1989; Akitanda, 1991; Kigenyi *et al.*, 1997; URT, 1998, 2001).

4.2.2 Village Forest Management Plans and by-laws

Forest and Beekeeping Division and donors in collaboration with villagers prepared Village Forest Management Plans (VFMPs). The plans describe the VFRs location and boundaries and zonation for collection of forest products including dry wood, fruits, poles or timber or for non consumptive activities such as beekeeping. The plans were then used as guiding tools for management of the VFRs. At first, the emphasis in the plans was protection as villagers already had abundant resources around their homesteads. However, the villagers were allowed to harvest some products from the reserves under technical guidance from Forestry staff. The VFMPs, further, pointed out on how to handle issues

related to offences and cooperation with District Council. Wily (1996) presented similar conservation rules when studying Duru-Haitemba Forest Reserve.

Khatri-Chhetri (2006) showed no difference with the procedure made in Mgori Forest Reserve and most of Forest Reserves managed by communities in Nepal. Although, the case presented by the author indicated an existence of an authorized village forest user committees, which in this study, do not exist. Likewise, the case reports similar ownership patterns of land by village governments. Hawkes (1996) suggested that any co-management is most likely to succeed if it ensures the protection of local ecological and cultural systems. Plans and by laws if well set and agreed upon by all stakeholders can register substantial management achievement (Grainger *et al.*, 2006).

4.2.3 Village committees

The villages formed several village committees of about six to twelve members. In the committees, elders and women were included, of which the former applied their long experiences about the forest, while the latter accounted for gender issues and major users of the forest. These village committees were village forest committees (VFCs), Village forest guard committees (VFGCs) and village land committees (VLCs). Formation of VFCs was of most importance in CBFM as they take forest management responsibilities. Success of many CBFM initiatives may in one way or another be due to VFCs through the law enforcement process of which they are responsible (Wily, 2002; Kajembe *et al.*, 2003, 2004b, c). Grainger *et al.* (2006) avow that Joint Forest Management requires delegation of management authorities to a local user organization, rather than its retention by external groups. Resources and management functions must be owned and controlled by the involved partners and communities. The VFCs at this aspect are subcontracted as the

owners and controllers of forest resources on behalf of the communities. About 49% of respondents indicated that the VFCs were very effective, while 47% and 4% showed that they were effective and poor respectively (Table 10). Most of the respondents from Unyampanda (87%) and Ngimu (63%) viewed VFCs as very effective, while about 67% and 72% from Pohama and Mughuunga assessed the committees as effective. Although the level of the effectiveness of VFCS was rated high majority of villages the rating differed ($p < 0.0001$) significantly between villages (Table 10).

The study assessed the effectiveness of the committees based on perspectives of the villagers. Performance elsewhere determines effectiveness of any institution in implementing its goals (FAO, 2003c). The study adopted this model of assessment by setting up levels of performance as very effective, effective and poor.

Table 10: Response as to the performance of Village Forest Committees at Mgori Forest Reserve, Singida District, Tanzania

Performance/VFR	Percent of response				
	Ngimu (n = 60)	Pohama (n = 60)	Unyampanda (n = 60)	Mughuunga (n = 60)	Overall (N = 240)
Very effective	63.3	28.3	86.7	16.7	48.7
Effective	36.7	66.7	13.3	71.7	47.1
Poor	-	5.0	-	11.7	4.2

$\chi^2 = 69.01$; $p < 0.0001$

Kajembe *et al.* (2003) pointed out that existence of VFCs in Duru-Haitemba reduces the number of offences and builds a strong relationship between forestry staff and local communities. The performance of VFCs at MFR is not different from those operating at Duru-Haitemba Forest Reserve.

The study, further examined the performance of Village Forest Guard Committees (VFGCs). About 52% of responses indicated the performance of VFGCs as very effective (Table 11). Most of the respondents pointed out that the VFGCs performed very effectively for Mughuunga (77%) and Ngimu (63%) VFRs, while majority of the respondents from Unyampanda (60%) and Pohama (55%) indicated the VFGCs were effective in performance. It was noted that the level of performances among VFGCs differed from each other ($p < 0.0001$).

In most forest reserves under CBFM, the village forest guard committees make enforcement of the set rules in order to ensure individuals abide by the rules (Kajembe *et al.*, 2003, 2004b, c). The VFGCs protect the forest against non villagers and offenders from within the villages. These VFGCs normally operate on patrolling and reporting regime.

Table 11: Response as to the performance of Village Forest Guards Committees at Mgori Forest Reserve, Singida District, Tanzania

Performance/VFR	Percent of response				
	Ngimu (n = 60)	Pohama (n = 60)	Unyampanda (n = 60)	Mughuunga (n = 60)	Overall (N = 240)
Very effective	63.4	33.3	36.7	76.7	52.5
Effective	36.7	55.0	60.0	21.7	43.3
Poor	-	11.7	3.3	1.7	4.2

$\chi^2 = 76.19$; $p < 0.0001$

It was noted that the performance of VFCs and VFGCs was almost similar. This is probably explained by the fact that some members were in both VFCs and VFGCs. The performance rating is more or less similar to VFGCs operating at Duru-Haitemba

(Kajembe *et al.*, 2003). The results are also reflective of a significant reduction of the number of offences in each village.

The operational activities reported in this study are similar to Duru-Haitemba VFRs (Kajembe *et al.*, 2003), but they are different from Amani Forest Reserve (Meshack *et al.*, 2006). Probably the difference may be due to the fact that the two community managed forest reserves were under the supervision of external projects that is Land Management Programme (LAMP) under the sponsorship of SIDA (Wily, 1996, 1997), while the other is among the forest reserves that are under JFM.

The assessment of the performance of Village Land Committees (VLCs) is shown in Table 12. Majority of the respondents rated the performance of the VLCs as effective in Ngimu and Mughunga, very effective in Unyampanda and poor in Ngimu. Overall performance was rated as effective for all villages. Increased level of poor performance, if compared to other village committees is probably explained by the reason that some households, particularly those that had settlements and farms within and close to the forest reserves were removed from the areas. During the field visit (2006/07), the villagers at Pohama complained on their settlements being removed from within the forest reserve, while those from Mughuunga lamented that they lost their fertile farms. Despite, the case, the performance of VLCs remained effective.

Table 12: Response of the performance of Village Land Committees at Mgori Forest Reserve, Singida District, Tanzania

Performance/VFR	Percent of response				
	Ngimu (n = 60)	Pohama (n = 60)	Unyampanda (n = 60)	Mughuunga (n = 60)	Overall (N = 240)
Very effective	15.0	3.3	55.0	5.0	19.6
Effective	76.7	33.3	45.0	65.0	55.0
Poor	8.3	63.3	-	30.0	25.4

$\chi^2 = 50.07$; $p < 0.0001$

Village land committees were thought to be important in this study based on the fact that they are operational organs for setting and handling disputes and issues related to land distribution and land use (URT, 1999). Village land committees operate as per Village Land Act of 1999 (URT, 1999). During the FGDs, some of the participants lamented that their farms and settlements, which were close to and within the reserves were abandoned. Land, in most of villages in Tanzania is administered by the village government, while land at household level is granted on the basis of user rights and occupancy. The village government in this case has the *de jure* property right while the household is *de facto* owner. In such cases whenever needs arise for an entire community, the land can be taken for the particular needs. Management of MFR operates in these lines.

4.2.4 The Mgori Forest Coordinating Committee

It was noted that the villagers themselves formed the Mgori Forest Coordinating Committee (MFCC) to coordinate activities of the five villages on matters related to forestry. The Committee was formed by about 25 members, but in the committee, there should be at least four members from each village. The committee was chaired by a Councilor. However, a representative from Singida District Council has to attend the

meetings, which take place after every three months. Many problems related with forest dwellers, corrupt VFCs and encroachment are resolved during the meetings. Field visits wer also organized during the meetings in order to draw a joint decision in respect of their VFRs. The proceedings of the meetings were taken to District Council for action and information.

Assessment of the performance of the Mgori Forest Coordinating Committee showed that the committee was very effective (50%), effective (40%) and poor (10%) (Table 13). The trend of performance was similar to all VFRs, but there were some significant ($p < 0.0001$) differences in response of the performance of MFCC among villages.

Table 13: Response of the performance of Mgori Forest Reserve Coordinating Committee, Singida District, Tanzania

Performance/VFR	Percent of response				
	Ngimu (n = 60)	Pohama (n = 60)	Unyampanda (n = 60)	Mughuunga (n = 60)	Overall (N = 240)
Very effective	36.7	50.0	50.0	61.7	49.6
Effective	45.0	33.3	48.3	33.3	40.0
Poor	18.3	16.7	1.7	5.0	10.4

$\chi^2 = 53.09$; $p < 0.0001$

In several cases, coordinating committees harmonize more than one party (Nurse and Kabamba, 1999; Grainger *et al.*, 2006). This gives a better chance of performing well compared to any single committee, which is within the single party. Coordinating committee for Duru-Haitemba functions at similar level as the case in point (Kajembe *et al.*, 2003).

4.2.5 Forest condition monitoring

Donors, expatriate advisors and government foresters provided support for villagers around Mgori Forest Reserve to monitor the forest. The donor helped to fund much of the monitoring that has taken place so far, including data processing and analysis. The advisors helped to design the monitoring plan and gave guidance on interpreting and using the results for management of Mgori Forest Reserve (MFR). Monitoring is essential for planning sustainable management (FAO, 2003c) and helps villagers to know what and how much is required to be harvested without causing damage to the forest. Monitoring can, however, be costly and technically complicated.

Three forms of monitoring have been designed in MFR. These forms are forest monitoring permanent sample plots, patrols and fire management.

(i) Permanent Sample Plots

Seventeen visible permanent sample plots were established in February 1996 by by the Forestry and Beekeeping Division. For each one of the plots, four blind sampling locations for monitoring changes in, for example, growth or damage were set. The monitoring being done at MFR was participatory where different stakeholders were involved. This type of monitoring is highly technical and experienced technicians are required. On the other hand, the villagers helped to number the trees and install metal reference tags. The villagers also helped to provide local names of various tree/shrub species for easier identification.

Recently, through training, villagers involved have been capable of conducting monitoring and translation of the findings. During focus group discussion, it was noted from the

members of the VFCs that from 1996 to 2006, only three trees were damaged from the sample plots.

(ii) Patrols

Villagers are normally appoint patrolmen to patrol the VFRs. At the beginning, in 1996, 166 people were appointed, but some were dropped along the way due to their inefficiency. Up to 2006, there were only 100 patrolmen. When asked why the number had reduced drastically, respondents pointed out that some villages did not see the need as the number of offences had been declining since the introduction of patrol. The declining number of patrolmen was also due to changing patrolling regime, which led the crew to concentrate in sensitive areas with timber, water for wildlife and beehives. Decision to change the patrolling regime came after the patrolmen experienced difficulties in covering large areas of their respective VFR, some of which were not attractive to offenders.

Committee secretaries organized the patrols, while advisors helped devise forms for recording information on wildlife and forest resources. To encourage, the patrolmen to do their work, they were exempted from village development activities such as road construction and school building and other contribution to the village. During late 1990s, money was provided for field gears such as boots, caps, raincoats and anti-snake-bite kits for the patrols, but currently the distribution of these provisions has stopped. However, in tackling the problem, it was pointed out that the patrolmen had to get support for upkeep from the fines obtained from offenders, though this source has been dwindling as the number of offenders dropped. Further, the villagers have been looking for other sources to support the patrolling activities.

(iii) Fire Management

Fires damaged the forest every dry season. Most of these fires started outside the MFR in the neighbouring Hanag and Kondoa districts, which did not practice PFM. After several discussions at the VFC and MFCC levels, the latter decided to initiate control burning before the grasses become dry. According to the members of VFCs, the fires were set between April and June by the patrolmen and some members of VFCs. The system has worked and the forest is no longer severely damaged by fires. This management approach is quite common in miombo woodlands (Chidumayo, 1995), while in this case, control burning is planned at VFC meetings.

4.3 Governments and their Effectiveness in Practicing CBFM at Mgori Forest Reserve

Village, district and central governments were considered in the whole implementation process of CBFM at Mgori Forest Reserve.

4.3.1 Village government

On average, about 64% of respondents rated the village governments to be very effective (Table 14). The chi-square showed that the effectiveness of village governments varied among villages ($p < 0001$). Very few respondents (28%) rated Pohama village government as very effective.

Table 14: Response as to the performance of village governments at Mgori Forest Reserve, Singida District, Tanzania

Performance/VFR	Percent of response				
	Ngimu (n = 60)	Pohama (n = 60)	Unyampanda (n = 60)	Mughuunga (n = 60)	Overall (N = 240)
Very effective	63.3	28.3	53.3	76.7	63.8
Effective	35.0	53.3	43.3	20.0	37.9
Poor	1.7	18.3	3.3	3.3	3.3

$\chi^2 = 14.22$; $p < 0001$

Performance of village government was considered in this study as the main functional unit for CBFM. It is assumed that the village government is the organizer of planning and implementation processes (Wily, 1996). The study, therefore, felt the need of obtaining perceptions of the villagers on performance of the village government.

The effectiveness of village government in many forest reserves that are under CPFM has been reported (Kayambazinthu *et al.*, 2003; Kajembe *et al.*, 2003, 2004b, c; Shabaz and Ali, 2006; Blomley and Ramadhani, 2006). However, in other cases, ineffective performance of village government is caused by corrupt leaders (FAO, 2003c) and domination of elites within the group of forest users (Khatri-Chhetri, 2006). Participation of stakeholders in forest resources management is the only solution to ineffective performance of PFM at village level (Ostrom, 1997; FAO, 2003c). The results reported in this study are likely to be due to the fact that Tanzania had been a socialist state since independence, which has brought about institutionalizing village government as the decision-making authority in village settings (Nyerere, 1967; Nurse and Kabamba, 1999).

4.3.2 District council

Majority of respondents (75%) in all villages were of the view that the performance of District Council in improvement of CBFM was effective and the views varied significantly (χ^2 = 123.31; p < 0.0001) among villages (Table 15). Very effective performance of District Council was accounted for only 21%. Mchonvu (2003) indicated that district councils in Iringa community based projects played significant roles on establishing and developing them. The same is also reported in other parts in Tanzania where CBFM was undertaken (Blomley and Ramadhani, 2006; Blomley *et al.*, 2007).

Table 15: Response as to the performance of District Council at Mgori Forest Reserve, Singida District, Tanzania

Performance/VFR	Percentage response				
	Ngimu (n = 60)	Pohama (n = 60)	Unyampanda (n = 60)	Mughuunga (n = 60)	Overall (N = 240)
Very effective	8.3	40.0	18.3	18.3	21.2
Effective	88.3	60.0	75.0	76.7	75.0
Poor	3.3	-	6.7	5.0	3.8

χ^2 = 123.31; p < 0.0001

District council or government acts as a bridge between village governments and central government through Ministry of Natural Resources and Tourism (MNRT) or Donors and NGOs (Massawe, 2001 and URT, 2001). The district council also provides technical and management guidelines and advice through professional foresters who are employed by the council.

4.3.3 Ministry of Natural Resources and Tourism

About 34% of the villagers did not know the role of MNRT in management of the MFR and had the opinion that the performance of MNRT was ineffective. On the other hand about 40% of the respondents pointed out that MNRT was performing very effective, while 47% rated the performance of MNRT as effective (Table 16). Their responses also varied ($\chi^2 = 76.63$; $p < 0.0001$) significantly among the villages.

Table 16: Response as to the performance of MNRT at Mgori Rorest Reserve, Singida District, Tanzania

Performance/VFR	Percentage of response				
	Ngimu (n = 60)	Pohama (n = 60)	Unyampanda (n = 60)	Mughuunga (n = 60)	Overall (N = 240)
Very effective	41.7	34.0	31.7	50.0	39.6
Effective	58.3	35.0	60.0	33.3	46.7
Poor	-	30.0	8.3	16.7	13.7

$\chi^2 = 76.63$; $p < 0.0001$

Central government through MNRT contributed towards establishment of CBFM at MFR through formulation of policies, programmes, guidelines and acts (URT, 1998, 2001; 2002). However, these apply for the whole country. The MNRT in collaboration with SIDA assisted the implementation of CBFM at MFR.

The operation lines of CBFM at MFR are as in other areas where central government through MNRT works and this institution operates at macro level where the main operators at micro levels are local governments. It is therefore no wonder that many villagers fail to identify the functional roles of the central government, which has affected its rating responses as to its effectiveness.

4.4 Dimensions of Good Governance in Practicing CBFM at Mgori Forest Reserve

Eight dimensions of good governance in the implementation of CBFM were considered during FGDs (Table 3). These among others include participatory, accountability, transparency, consensus oriented, observing the rule of law, effectiveness and efficiency, responsibility and equitability. During FGDs, it was agreed that the governance of forest resources in VFRs was in line with and adhered to the goals of the National Forest Programme of 2002 (URT, 2002) that the governance of forest resources was about ownership, decision-making and power relations.

As it is presented in the National Forest Policy of 1998, Nation Forest Programme of 2001 and Forest Act of 2002, the governance of forest resources is positioned into three categories namely central government, local government and community levels (URT, 1998, 2001, 2002). Through the three categories, endeavours major on implementation of a coordinated set of laws, programs, action plans, and institutional arrangements regarding forest resources management, which are directed towards enabling the achievement of national goals of environmental protection, biodiversity conservation, poverty reduction, socio-economic development, and good governance.

4.4.1 Level of participation

The level of participation was rated satisfactorily by 45% of respondents, while 42% rated it as high (Table 17). In most of the VFRs, the level of participation was rated as satisfactory and high. The Chi-square test showed that there were strong differences in levels of participation across the villages ($p < 0.0001$) among villages.

Table 17: Response as to the level of participation at Mgori Forest Reserve, Singida District, Tanzania

VFR/Levels	Percentage of response			
	Poor	Satisfactory	High	Very high
Ngimu (n = 60)	-	71.7	11.7	16.7
Pohama (n = 60)	-	48.3	36.7	15.0
Unyampanda(n = 60)	-	41.7	51.7	6.7
Mughuunga (n = 60)	-	18.3	66.7	15.0
Total (N = 240)	-	**45.0**	**41.7**	**13.3**

$\chi^2 = 45.77$; $P < 0.0001$

This shows that involvement of villagers in any activity pertaining to the VFRs was neither very poor nor outstanding. This level is expected in Tanzania as CBFM is at its early stage of development. This view is also shared by Blomley and Ramadhani (2006). However, Menzies (2004) asserts that despite PFM encourages among others empowering local communities and promoting participatory governance, many forest reserves have not yet achieved good governance. Active and continuous participation of co-management partners in planning, decision-making, implementation and evaluation are essential in generating a sense of ownership and commitment to the process (Pomeroy *et al.*, 2001).

4.4.2 Level of accountability

The level of accountability at MFR was rated satisfactory by 62% of the respondents with very low proportion of respondents rating it as poor (Table 18). A similar trend was also shown in individual VFRs. Table 18, also revealed that the level of accountability was significantly different among VFRs ($p = 0.004$).

Table 18: Response as to the level of accountability at Mgori Forest Reserve, Singida District, Tanzania

	Percentage of response			
VFR/level	Poor	Satisfaction	High	Very high
Ngimu (n = 60)	6.7	65.0	21.7	6.7
Pohama (n = 60)	3.3	76.7	18.3	1.7
Unyampanda (n = 60)	1.7	60.0	35.0	3.3
Mughuunga (n = 60)	-	45.0	50.0	5.0
Total (N = 240)	**2.9**	**61.7**	**31.3**	**4.2**

$\chi^2 = 24.01$; $p = 0.004$

Accountability is an obligation, which many developing countries fail to achieve (UNDP, 1997; Dahal *et al.*, 2001; Brown *et al.*, 2002; Gani and Duncan, 2004). This provides no doubt that even in this study, the responsible institutions might have a similar problem. However, the study relies on the perceptions of the respondents, despite many studies use similar approaches (e.g. Dahal, 2003; Singhal, 2006).

4.4.3 Level of transparency

Table 19 shows the response of respondents in regard to levels of transparency of responsible individuals assigned to carry out activities in management of MFR. Despite high variability between villages, majority of the respondents (56%) were of the opinion that transparency was satisfactory. However, relatively high proportion (37%) agreed that transparency was high. A significant difference was also observed among the VFRs ($p < 0.0001$). This shows that transparency, participatory and accountability at MFR are at similar level.

Table 19: Response as to the level of transparency at Mgori Forest Reserve, Singida District, Tanzania

VFR/Level	Percentage of response			
	Poor	Satisfactory	High	Very high
Ngimu (n = 60)	6.7	68.3	15.0	10.0
Pohama (n = 60)	-	83.3	15.0	1.7
Unyampanda(n = 60)	-	38.3	53.3	8.3
Mughuunga (n = 60)	-	35.0	65.0	-
Total (N = 240)	**1.7**	**56.3**	**37.1**	**5.0**

$\chi^2 = 70.95$; $p < 0.0001$

Transparency is an output of a democratic function (Isham *et al.*, 1997; Gani and Duncan, 2004; Kaufmann and Bellver, 2007), which many countries fail to achieve (Lambsdorf, 2001). This study relied on the existence of communication and information, village government and village forest committee meetings and the concept of giving and accepting apologies as presented in Table 3.

4.4.4 Level of equitability

The study looked at the level of the villagers having an access to forest resources, extension services and important infrastructure such as school and health facilities (Table 3). On this matter about 52% of respondents admitted that the level of equitability was high (Table 20). Table 20, further, shows that the levels of equitability were significantly different among VFRs ($\chi^2 = 63.29$; $p < 0.0001$).

Table 20: Response as to the level of equitability at Mgori Forest Reserve, Singida District, Tanzania

VFR/level	Percentage response			
	Poor	Satisfactory	High	Very high
Ngimu (n = 60)	11.7	68.3	16.7	3.3
Pohama (n = 60)	1.7	48.3	50.0	-
Unyampanda (n = 60)	5.0	40.0	55.0	-
Mughuunga (n = 60)	1.7	13.3	85.0	-
Total (N = 240)	**5.0**	**42.5**	**51.7**	**0.8**

$\chi^2 = 63.29$; $p < 0.0001$.

High equitability reported in this study is similarly reported by Schmitt (2003) and Girman and Tsegaye (2004), but these studies considered fair distribution of and access to benefits and forest products obtained in forest reserves under CBFM.

4.4.5 Level of consensus

The level of consensus in the management of the MFR was rated satisfactory by 50% of respondents and significantly differed from VFRs ($\chi^2 = 40.94$; $p < 0.0001$) (Table 21). However, the study asserts that the trend for the level of consensus was not so different from the other dimensions applied in this study for examining governance of MFR. Consensus in decision making among stakeholders plays a great role in protection of their interests (Uphoff, 1992). This applies to the same in success of CBFM elsewhere (Singhal, 2006; Grainger *et al.*, 2006).

Table 21: Response as to the level of consensus at Mgori Forest Reserve, Singida District, Tanzania

VFR/level	Percentage of response			
	Poor	Satisfactory	High	Very high
Ngimu (n = 60)	5.0	61.7	26.7	6.7
Pohama (n = 60)	3.3	68.3	28.3	-
Unyampanda (n = 60)	10.0	33.3	55.0	1.7
Mughuunga (n = 60)	-	36.7	63.3	-
Total (N = 240)	**4.6**	**50.0**	**43.3**	**2.1**

$\chi^2 = 40.94$; $p < 0.0001$

4.4.6 Level of effectiveness

Table 22 shows the ratings on the level of effectiveness in CBFM at MFR. Majority (63%) of the respondents rated the level of effectiveness of CBFM as satisfactory and had significant difference between villages ($\chi^2 = 31.38$; $P < 0.0001$).

Table 22: Response as to the level of effectiveness and efficiency at Mgori Forest Reserve, Singida District, Tanzania

VFR/level	Percentage of response			
	Poor	Satisfactory	High	Very high
Ngimu (n = 60)	-	76.7	18.3	5.0
Pohama (n = 60)	-	76.7	21.7	1.7
Unyampanda (n = 60)	3.3	46.7	45.0	5.0
Mughuunga (n = 60)	-	50.0	50.0	-
Total (N = 240)	**0.8**	**62.5**	**33.8**	**2.9**

$\chi^2 = 31.38$; $P < 0.0001$

The level of effectiveness is reported in terms of the status of forest resource base, number of offenses, development village facilities and livelihoods of local communities (Landmann, 1988; Kofinas, 1998; Singleton, 1998; TERI, 2007). Grainger *et al.* (2006) on

the other hand put much emphasis on involvement of stakeholders in decision-making process in any form of PFM.

The past restrictive and top-down approach has kept the level of awareness low among stakeholders creating mistrust between the people and administration. PFM is probably reversing the situation. Governance can be seen as the outcome of the effectiveness of a society's institutions. If the institutions are appropriate and effective, the outcome should be good governance (Duncan, 2003).

4.4.7 Level of responsibility

Analysis of responsibility in this study considered actions being performed by villagers in different committees and development activities. The level of responsibility was generally high for MFR (47%) (Table 23). Table 23 also reveals that levels of responsibility significantly differed among VFRs ($\chi 2 = 37.20$; $P < 0.00019$).

Table 23: Response as to the level of responsibility at Mgori Forest Reserve, Singida District, Tanzania

	Percentage of response			
VFR/level	Poor	Satisfactory	High	Very high
Ngimu (n = 60)	6.7	21.7	70.0	1.7
Pohama (n = 60)	5.0	58.3	35.0	1.7
Unyampanda (n = 60)	6.7	41.7	41.7	10.0
Mughuunga (n = 60)	-	60.0	40.0	-
Total (N = 240)	**4.6**	**45.4**	**46.7**	**3.3**

$\chi 2 = 37.20$; $P < 0.0001$

Horn (2000), cited by Robertson and Lawes (2005), reviewing PFM projects in South Africa observed similar level of responsibility undertaken by local communities adjacent to forest reserves. Obiri and Lawes (2002) assert that sustainability of PFM practices require positive attitudes of local communities to accept responsibility. However, the level of responsibility of local communities in CBFM is higher in Nepal and India than reported in this study (Singhal, 2006), but the fact remains that in Tanzania CBFM is at the earliest stage compared to the two cases.

4.4.8 Level of observing the rule of law

Abiding to the law as an indicator of CBFM performance was assessed at the level of villagers and other stakeholders obeying the set regulations and by-laws in the process of VFR management as means of keeping discipline among stakeholders. It was revealed that majority (61%) of respondents had the view that there was high discipline in the process as a result of CBFM operations (Table 24). A chi-square test also showed that there were some significant differences on the ratings among villages ($p < 0.0001$).

Table 24: Response as to the level of observing the rule of law at Mgori Forest Reserve, Singida, Tanzania

	Percent of response			
	Poor	Satisfactory	High	Very high
Ngimu (n = 60)	-	20.0	75.0	5.0
Pohama (n = 60)	-	13.3	55.0	31.7
Unyampanda (n = 60)	1.7	35.0	58.3	5.0
Mughuunga (n = 60)	-	21.7	55.0	23.3
Total (N = 240)	**0.4**	**22.5**	**60.8**	**16.3**

$\chi 2 = 32.28$; $p < 0.0001$

This situation was common to all villages involved the management of the CBFM giving an impression that participation by villagers in forest management has encouraged law enforcement, thus follow-up. In MFR, the villagers abided to the set regulations and by-laws as they participated in setting those regulations and by-laws in different committees. The responses may be connected with the declining number of offences. Wily (1998, 2002) and Khatri-Chhetri (2006) argue that good governance requires a fair legal and policy framework.

4.4.9 Governance index

Effectiveness and transparency were observed having high indices compared to others (Table 25). On average governance index for MFR was 0.51, while governance indices for VFRs ranged from 0.49 for Mughuunga to 0.53 for Ngimu and dimensional indices were between 0.49 and 0.55 for levels of participation and transparency respectively.

Table 25: Indices for dimensions of governance at Mgori Forest Reserve, Singida District, Tanzania

Dimension index/VFR	Ngimu (n = 60)	Pohama (n = 60)	Unyampanda (n = 60)	Mughuunga (n = 60)	Overall (N = 240)
Participatory index	0.51	0.52	0.46	0.48	0.49
Accountability index	0.52	0.48	0.51	0.47	0.49
Transparency index	0.54	0.56	0.49	0.51	0.53
Equitability index	0.55	0.52	0.47	0.49	0.51
Responsibility index	0.53	0.53	0.52	0.49	0.52
The rule of law index	0.49	0.51	0.52	0.49	0.50
Effectiveness index	0.59	0.58	0.49	0.53	0.55
Consensus index	0.49	0.50	0.54	0.45	0.50
Governance index	**0.53**	**0.52**	**0.50**	**0.49**	**0.51**

The governance index obtained in this study shows that the governance of MFR is at 51%, which is a satisfactory performance. The governance index reported in this study is similar to Singhal (2006), but it is higher than that reported by Gani and Duncan (2004).

The governance index at MFR may reflect the fact that CBFM is at its early stages in Tanzania. The satisfactory level of governance index at MFR is also reflected in the respondent's responses as to levels of the eight pillars or dimensions of good governance. The overall response as to all dimensions of good governance at MFR was rated satisfactory by 48%, high by 43% and very high by 6% of the respondents.

4.5 Influence of CBFM on Socio-Economies of Local Communities

Socio-economies of local communities in this study were examined mostly in the lines of capital assets forming up livelihoods. These included household income, consumption of forest products, influence land ownership, influence of CBFM on soil fertility, influence of CBFM on tree planting and tree farms, influence of CBFM on water resources, influence of CBFM on social capital and influence of CBFM on wellbeing.

4.5.1 Households income

An average annual income of households at MFR is presented in Table 26. The average income before CBFM inception was 151 346 ± 16 877 TAS. On the other hand, the average household income almost doubled to 299 247 ± 32 654 TAS after CBFM inception, which is a significant ($p < 0.001$) difference in household income resulting from CBFM. The average income for all VFRs was also significantly ($P < 0.0001$) different for the two periods.

Table 26: Average annual income of households at Mgori Forest Reserve, Singida District, Tanzania

Village forest reserve	Average income (TAS)		
	Before CBFM	After CBFM	t-value
Ngimu (n = 60)	235 966.67	410 583.33	2.954***
	±59 064.01	±116 027.65	
Pohama (n = 60)	85 305.00	238 578.33	3.991***
	±23 212.48	±47 107.53	
Unyampanda (n = 60)	139 380.00	263 480.83	9.843***
	±15 379.80	±25 662.16	
Mughuunga (n = 60)	144 731.67	284 346.67	9.349***
	±12 357.15	±25 263.23	
Average (N = 240)	**151 345.83**	**299 247.29**	**8.120*** **
	±16 876.65	**±32 653.89**	

***Significant at $p < 0.0001$:

Despite the significant differences reported in Table 26, the average annual income did not reflect the reality as the respondents reported only the amount of cash income obtained annually. This situation is also applicable to many rural areas in Tanzania as well as other countries in the developing world where cash income is considered, but not income in kind (URT, 2003).

Further, the results were indicative due to the fact that most farmers had difficulties in recalling and recording cash income received in a year. Most difficulties arose in recalling the amount of cash income the respondents generated before introduction of CBFM.

The income indicated in the study reflected the direct contribution of CBFM as the model always advocates improving livelihoods of the local communities (Hobley, 1996; Blomley and Ramadhani, 2006). On the other side, it might be influenced by other factors, which

adhere to the National Strategy for Growth and Reduction of Poverty (NSGRP). However, a proportion of the household's income obtained through sales of forest products (Table 27) such as charcoal, honey, mushrooms, fibre, gums, medicinal materials, firewood and poles was identified, which were activities encouraged by Forest Department in the District Council during the whole course of implementation of CBFM.

Contribution of forest products to household's cash income was not significantly ($p = 0.98$) different before and after inception of CBFM in all villages (Table 27). However, the average proportion of income through sales of forest products was 18.33 ± 1.08% and 18.34 ± 0.94% before and after CBFM inception.

Table 27: Proportion (%) of household's income through sales of forest products at Mgori Forest Reserve, Singida District, Tanzania

Village forest reserve	Before CBFM	After CBFM	t-value	p-value
Ngimu (n = 60)	11.38 ± 2.13	9.96 ± 2.81	0.47	0.644
Pohama (n = 60)	18.26 ± 2.44	15.90 ± 1.99	1.66	0.104
Unyampanda (n = 60)	22.1 ± 1.77	24.41 ± 1.64	1.66	0.101
Mughuunga (n = 60)	16.42 ± 1.63	16.21 ± 1.29	0.13	0.894
Average (N = 240)	**18.33 ± 1.08**	**18.34 ± 0.94**	**0.98**	**0.995**

Yadama *et al.* (1996) showed that 50% of household's income in Andhra Pradesh State, India was from sales of NWFPs. According to Gauthier *et al.* (1998), NTFPs contributed about 5 – 27% of household's income in Yucatán Peninsular in Mexico. Cavendish (2000) showed that forest products in some rural areas account for more than 40% of the annual household's income. The CBFM at Mgori is, therefore, likely to influence the income at household level, because the villagers were encouraged to involve in non-farm income

generating activities such as beekeeping, charcoal making, selling of poles and firewood since its inception.

Further, per capita income of the villagers at MFR as a means for clarifying the income poverty was considered (Table 28). The per capita income was more than doubled after CBFM inception. This shows that CBFM had significantly contributed to reducing income poverty among communities at MFR.

Table 28: Per capita income at Mgori Forest Reserve, Singida District, Tanzania

Village forest reserve	Before CBFM (TAS)	After CBFM (TAS)	t-value
Ngimu (n = 60)	41 551.53 ± 8 455.35	72 210.66 ± 16 669.97	3.580***
Pohama (n = 60)	16 613.37 ± 4 193.01	52 302.85 ± 10 757.89	3.96***
Unyampanda (n = 60)	27 042.83 ± 2 410.95	52 064.89± 4 015.11	11.936***
Mughuunga (n = 60)	28 076.28 ± 2 379.74	57 204.10 ± 5 268.17	8.683***
Average (N = 240)	**28 471.00 ± 2 556.12**	**58 445.62 ± 5 223.22**	**9.233*** **

***Significant at $p < 0.0001$

Further, it was noted that income per capita for villagers was significantly ($p < 0.001$) different during the two periods. According to URT (2003), during the Population Census of 2002, an adult equivalent mean per capita income for rural areas in Tanzania was 14 134 TAS per month and 169 608 TAS per year.

The mean per capita adult equivalent reported in this study is therefore lower than the one reported by URT (2003). The differences may be explained by the fact that the reported mean in this study was considered only for the generated cash income. Income in kind and food expenditure was not considered. On the other hand, the per capita income reported by

URT (2003) is generalized for the whole country. Taking that into consideration, the study area is located in rurual areas and among the poorest regions in Tanzania.

Generally, the study is in line with other studies such as Pandey (2005), Blomley and Ramadhani (2006), Kajembe *et al.* (2004a, b, c) and Hombley *et al.* (2007). CBFM improves financial capital of local communities as households' income at MFR almost doubled after CBFM inception.

4.5.2 Consumption of forest products

The study considered some selected forest products, which were consumed by communities surrounding MFR (Table 29) and related costs saved through their consumption (Table 30). The products are those that are food sources such as wild vegetables, mushrooms, fruits, honey, roots, tubers, bush meat and edible insects; fibres, dyes and gums, medicinal materials, charcoal, firewood and poles.

The overall amount of forest products consumed by household yearly was not significantly different before and after CBFM and ranged from 484± 222 kg to 476 ± 270 kg before and after CBFM inception respectively. Corresponding costs saved by the household through consumption of forest products ranged from 6720 ± 2158 TAS to 14 299± 6411 TAS before and after CBFM inception respectively and was significantly different ($p = 0.042$). The results, therefore, show that consumption of forest products contributed to improved financial capital of households during CBFM.

Table 29: Annual average household forest product consumption at Mgori Forest Reserve, Singida District, Tanzania

Forest product	Before CBFM	After CBFM	t-value	p-value
Food items (kg) (n = 214)	86.78 ± 7.45	76.48 ± 4.22	1.572	0.117
Fibres, dyes and gums (kg) (n = 93)	103.72 ± 72.57	22.87 ± 3.93	1.126	0.264
Medicinal materials (kg) (n = 77)	65.42 ± 14.14	161.51 ± 79.49	1.324	0.190
Charcoal (bag) (n =136)	6.96 ± 2.31	5.06 ± 0.49	0.887	0.377
Poles (number) (n = 85)	104.12 ± 16.49	67.94 ± 10.52	2.464	0.016
Firewood (headload) (n = 240)	58.23 ± 2.35	71.19 ± 3.33	4.490	<0.0001

Table 30: Annual average cost (in TAS) saved by households through consumption of forest products at Mgori Forest Reserve, Singida District, Tanzania

Forest product	Before CBFM	After CBFM	t-value	p-value
Food items (n = 214)	17 053.04 ± 1 429.72	35 996.50 ± 2 416.62	11.696	<0.0001
Fibres, dyes and gums (n = 93)	3356.76 ± 820.65	7531.08 ± 1066.23	3.632	0.001
Medicinal materials (n = 77)	4036.62 ± 646.90	15 967.61 ± 3741.94	3.703	<0.0001
Charcoal (n = 136)	7553.68 ± 1105.94	11 396.32 ± 1083.53	3.521	0.001
Poles (n = 85)	4729.41 ± 694.19	4605.88 ± 510.95	0.155	0.877
Firewood (n = 240)	3591.25 ± 278.15	10 297.71 ± 549.21	11.728	<0.0001

The overall amount of forest food consumed by household per year during the time before and after inception of CBFM was not significantly different ($p = 0.117$), but it was higher during the time before than after its inception. The costs saved by the households through utilisation of forest food products were significantly different ($p < 0.0001$) and were higher during CBFM than before its inception.

Among objectives of CBFM is to create conditions whereby adjacent communities may benefit from forest resources. In villages where there are CBFM activities, the villagers are encouraged to grow crops, keep livestock and other related agriculture activities for improving the states of their economy, especially food security (Pandey, 2005; Mwembe, 2008). However, not only that agriculture produce auctions food security at household level, but also some forest products, either directly or indirectly consumed contribute to household food security (Hoddinot and Yohanness, 2002; Meshack *et al.*, 2006).

The findings of this study substantiate the importance of forest resources for the livelihoods of surrounding communities. These findings were similar to those reported elsewhere, although this study concentrated on village forest reserves, which were under CBFM model. For example, consumption of forest food products in rural areas of Tanzania as well as other developing countries in the world accounts for over 15 – 60% of food consumed in a household every year (Alloo and Rodgers, 1996; Makonda *et al.*, 1998; Cavendish, 2000; Mogaka *et al.*, 2001; Shackleton and Shackleton, 2004). A wide range of related costs is reported elsewhere (Kowero and O'ktinga'ati, 1990; Lintu, 1995; Alloo and Rodgers, 1996; Monela *et al.*, 2000).

Although some studies point out that wild foods are taken during odd seasons where particular households or communities run shortage of food (FAO, 1983a,b; Shackleton and Shackleton, 2004), the fact remains that wild food is important for livelihoods of rural households for a number of reasons. Some wild foods are cheap sources of nutritional values. For example, wild fruits provide vitamins A, C and folic acid (Saka, 1994; Msuya *et al.*, 2004), while others provide refreshments, flavours and aroma (Kochhar, 1981). Wild vegetables have potential nutritive values such as minerals and aromas for consumers

(Malaisse and Parent, 1985; Alloo and Rodgers, 1996), roots and tubers provide carbohydrates, bush meat and mushrooms are a source of protein and fats, and honey, some time, is used as medicine. Generally, several studies have pointed out that food from forests have significant potentials to socio-economies of households in rural areas (Alloo and Rodgers, 1996; Makonda *et al.*, 1998; Luoga *et al.*, 2000b; Msuya *et al.*, 2004).

The amount of fibres, dyes and gums consumed by households in this study was higher (103.72 ± 72.57 kg) during the period before than after CBFM (22.87 ± 3.93 kg), but was not significantly ($p = 0.264$) different. The overall costs saved to households due to consumption of fibres, dyes and gums were significantly ($p = 0.001$) different between the two periods. Some fibres have economic importance because they are used in constructions, weaving mats, baskets and trays. According to Makonda *et al.* (1998), over 82% of rural households in Geita, Tanzania use fibres for various purposes.

This study reports some substantial amount of natural dye and gums being utilized by rural households. These products have been reported by various studies that they are among others of economic importance for rural households (eg. Alloo and Rodgers, 1996; Makonda *et al.*, 1998). This provides evidence that gums and natural dyes are of significant important for livelihoods of rural households.

According to this study, traditional medicines are most important for rural poor households (Tables 29 and 30). About 30% of the total households utilised medicinal materials from the forest. Medicinal materials considered in this study were mainly barks, roots, tubers and leaves. The consumption of medicinal materials was not significant ($p = 0.190$) different between the two time periods, but the amount of medicinal materials collected

ranged from 65.42 ± 14.14 kg for time before CBFM to 161.51 ± 79.49 kg for during CBFM. Poor households are likely to opt for herbs and traditional healer's services, while the well-to–do households are able to afford modern health services (Luoga *et al.*, 2000a; Hamza *et al.*, 2004; Wright *et al.*, 2005). Similar results are also reported by Otieno (2000) that the consumption of medicinal materials in other places depends on economic status of households. Medicinal materials have various purposes as Alloo and Rodgers (1996) pointed out that medicinal materials are used not only for curative purposes but also for supernatural powers, misfortunes and economic purposes for healers and patients.

Before the inception of CBFM, amount of charcoal consumed in this study was 6.96 ± 2.31 bags, while during CBFM, the amount was 5.06 ± 0.49 bags, which was not significantly different ($p = 0.377$). Further, the study observed that consumption of charcoal led to households to save an amount of 7554 ± 1106 TAS and 11 396 ± 1084 TAS for the time period before CBFM and during CBFM respectively. This difference was statistically significant ($p = 0.001$).

The average amount of firewood consumed by household yearly in this study was 58.23 ± 2.35 headloads for the time before CBFM and 71.19 ± 3.33 headloads for the time after CBFM adoption. The study, further, observed that there were some significant ($p < 0.001$) differences in consumption of firewood by households during the time before and after inception of CBFM. Correspondingly, estimated costs of firewood saved to households due to its consumption were significantly different ($p = 0.01$) between the two time periods.

All households involved in this study use firewood as the major source of household energy and consumption of firewood was the highest compared to other forest products.

This was due to the fact that all communities adjacent to the forest reserve used firewood as a major energy source for cooking and heating. The observations made in this study are not different from other related studies (Monela and Kihiyo, 1999; Malimbwi *et al.*, 2000). Miombo woodlands are the main source of firewood and charcoal in Tanzania, which accounts for 95% of the country's energy supply (Malimbwi *et al.*, 2000; Monela *et al.*, 2000; Luoga *et al.*, 2000a, b). Availability, cheaper prices and reliability of wood based energy favour its high consumption in many rural communities.

The amount of poles consumed in this study was significantly ($p = 0.016$) different. The average number of poles consumed by the household in this study ranged from 104.12 ± 16.49 for time before CBFM and 67.94 ± 10.52 for during CBFM. Estimated costs for poles consumed by households in this study averaged to 4729 ± 694 TAS for the time before CBFM and 4606 ± 511 TAS for during CBFM. The estimated costs of poles were not significantly ($p = 0.877$) different between the two periods.

The quantity of poles used by communities adjacent to MFR after CBFM was lower than what was consumed before the CBFM inception. This means that CBFM and other development programmes have enabled many households to use bricks for construction of houses. Elsewhere, it is reported that poles from forests are largely utilized for construction purposes. For example, according to Mbeyale and Monela (2000), over 82% of households adjacent to the Amani Nature Reserve in Tanzania utilize poles for house construction. The observation is quite common for many rural areas of Africa. Alloo and Rodgers (1996), Luoga *et al.* (2000a) and Shackleton and Shackleton (2004) provide several uses of poles including construction of houses, making fences and kraals, production of farm implements, making clubs, spears and production of kitchen utensils.

Extraction of forest products for household's consumption is important for livelihoods of rural communities. As other studies indicate that poor households most often rely on forest commodities and its reverse is true for rich households (Monela *et al.*, 2000; Kajembe and Kessy, 2000). The study indicated some differences in utilization of forest products during and before CBFM. Before the inception of CBFM, villagers used to collect forest products in the reserves without any restriction. After inception of CBFM, the collection of forest products has been restricted through introduction of zoning system and its by-laws. However, the villagers were allowed to collect forest products under set regulations as stipulated in MFR management plans. The local communities at MFR had opportunities to improve local beehives, forming economic groups such as for making charcoal in general land, collection of mushrooms and among others for domestic consumption and marketing purposes. The zonation at MFR is not different from the zoning done in catchment forests and other community based forest management reserves in Tanzania (Akitanda, 1991; URT, 1998; 2001). Economic activities for utilizing forest products and zonation system reflect to conservation of forest resources and improvement of socio-economies of local communities.

4.5.3 Influence of CBFM on natural capital

Natural capital has a wide range of assets that form up this capital (DFID, 1998; Pandey, 2005). However, this study considered land, forest, farm trees, soil fertility status and water availability as basic natural capital available to community around MFR. According to the World Bank (2000), share of assets ownership in rural context influences improvement of economic growth at household level.

4.5.3.1 Influence of CBFM on land ownership

Land ownership in villages surrounding MFR is slightly influenced by inception of CBFM as some settlements, which were within the reserve were abolished through law enforced from in CBFM management to favour conservation. It was observed that on average every household at MFR owned 3.11 ± 0.11 ha of land ranged between 2.63 ± 0.25 and 3.64 ± 0.20 ha for Mughuunga and Ngimu VFRs respectively (Table 31). However, about 40% of households owned 0.49 – 2.00 ha of land, while very few (1%) owned above 8.00 ha. Analysis of variance showed that land size owned by househdolds was significantly (p = 0.008) different among villages. The differences in land size owned by households are plausibly explained by the availability of village land as example Mughuunga had more land that is public and less population than Ngimu village. In Pohama, many farms and settlements were abandoned in the reserve during the implementation of CBFM.

Table 31: Land owned by households (ha) at Mgori Forest Reserve, Singida District, Tanzania

VFR/land size	0.45 – 2.00	2.10 – 4.00	4.10 – 6.00	6.10 – 8.00	>8.00	Min	Max	Mean
Ngimu (n = 60)	55.0	23.3	18.3	-	3.3	0.49	9.80	2.63±0.25
Pohama (n = 60)	51.7	28.3	18.3	-	1.7	0.49	8.82	2.91±0.23
Unyampanda (n = 60)	31.7	50.0	16.7	1.7	-	0.49	6.37	3.24±0.17
Mughuunga (n = 60)	23.3	41.7	30.0	5.0	-	0.98	7.35	3.64±0.20
Total (N = 240)	**40.4**	**35.8**	**20.8**	**1.7**	**1.3**	**0.49**	**9.80**	**3.11±0.11**

SS = 33.86; df = 3; MS = 11.29; F = 4.05; p-value = 0.008

Community Based Forest Management may have influenced the pattern of land ownership around MFR. This is because after abandonment of settlements and farms in the MFR new areas were acquired by clearing land from the general land (59%). Other means of land

acquisition, which may not be directly related to CBFM, include inheritance (36%) and purchase (5%) (Table 32).

Table 32: Means of land acquisition after abandonment of settlements and farms in Mgori Forest Reserve, Singida District, Tanzania

	Percent of response				
Means of acquisition	Ngimu (n = 60)	Pohama (n = 60)	Unyampanda (n = 60)	Mughuunga (n = 60)	Total (N = 240)
Clearing forested land	55.0	55.0	66.7	58.2	58.8
Through inheritance	40.0	38.3	30.0	36.7	36.2
Through purchasing	5.0	6.7	3.3	5.0	5.0

$\chi^2 = 2.55$; $p = 0.863$

Linking ownership of land and livelihoods of rural communities may be explained by the fact that it influences crop production, which influences food security at the household level (World Bank, 2000). However, Singh *et al.* (2002) asserts that ownership and size of farmland does not mean productivity, rather efficiency in production.

The study further looked at the adequacy of land owned by households, of which about 75% of all the households admitted to have adequate land as opposed to only 25% of households that had not adequate land (Fig. 6). However, the assessment of adequacy of land at the household level was based on perceptions of respondents.

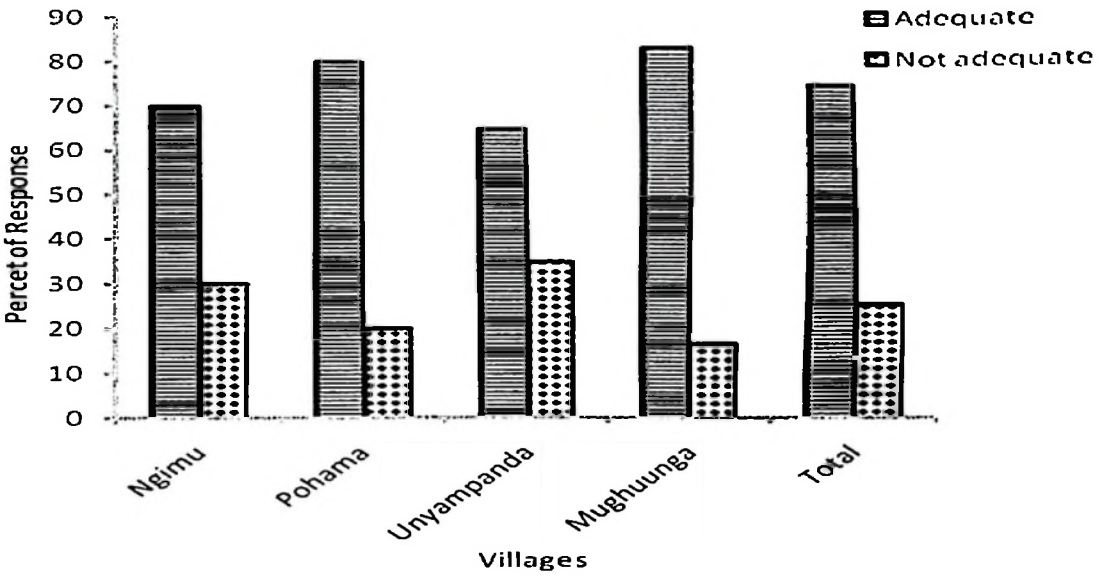


Figure 6: Response as to land adequacy after CBFM at Mgori Forest Reserve, Singida District, Tanzania

The study also assessed if there had been some changes in land size owned by the households at MFR. About 52% of the respondents pointed out that, their households had increased their land size, 35% had no change in their land size, while 13% of had their land area decreased (Fig. 7). Households at Unyampanda and Mughuunga did not experience any decrease in the land they owned.

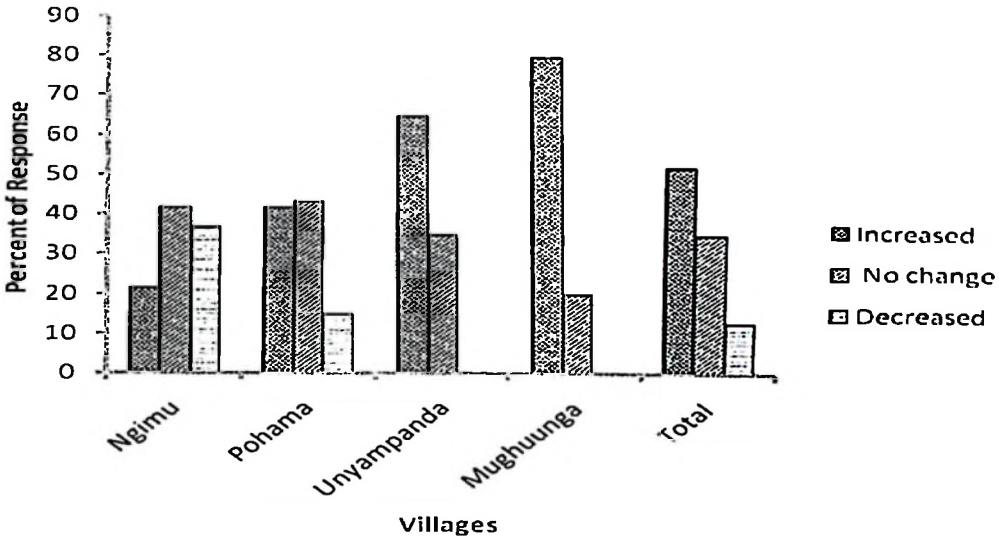


Figure 7: Change in household land size after CBFM inception at Mgori Forest Reserve, Singida District, Tanzania.

Plausible reasons for change in land size owned by households were clearing of forest from general land and abandoning of farming in forest reserves during implementation of CBFM. Generally, increasing demand for land due to increasing population might have influenced the decline in land size at household level.

4.5.3.2 Influence of CBFM on soil fertility

When the respondents were asked to place existing status of soil fertility in their farms as adequate or not adequate, about 51% pointed out that there was inadequate soil fertility in their farms was inadequate, while about 49% of them indicated that there was an existence of soil infertility in their farms (Fig. 8). About 56% of the households had experienced no change in terms of soil fertility in their farms, while 24% and 20% experienced some changes in increase and decrease respectively (Fig. 9).

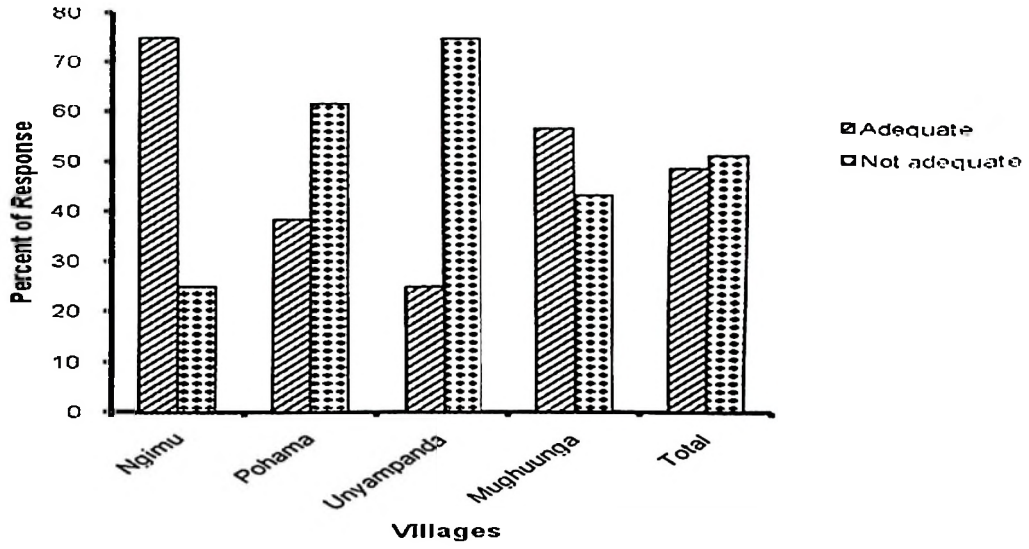


Figure 8: Response as to the status of soil fertility after CBFM at Mgori Forest Reserve, Singida District, Tanzania

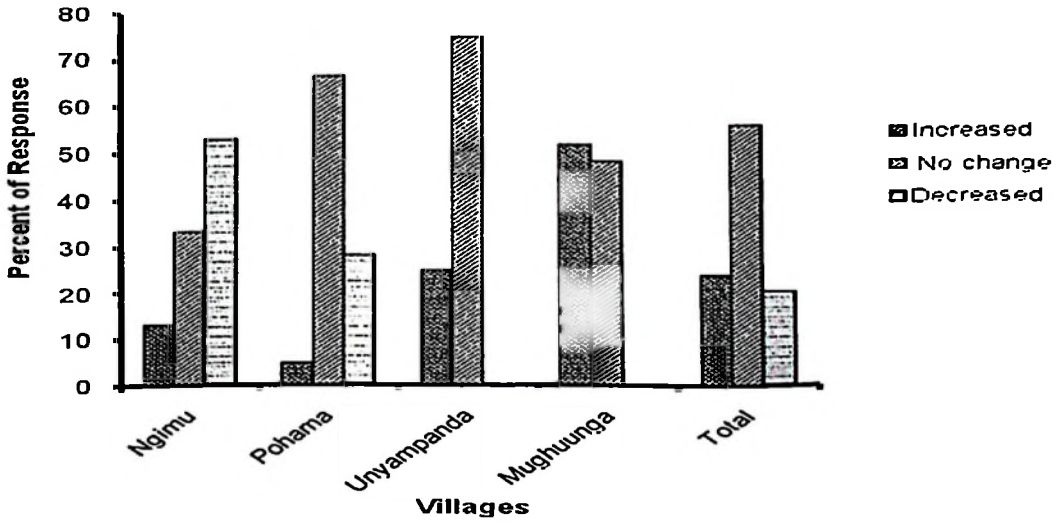


Figure 9: Response as to the change in soil fertility status after CBFM inception at Mgori Forest Reserve, Singida District, Tanzania

Soil fertility plays a great role in farm productivity (Nair. 1993). Several studies consider soil fertility as an important natural asset that influences livelihoods of rural communities where agriculture is the main stay of their economy (Smaling, 1998: Defoer and Budelman, 2000; Swinton and Quiroz, 2003). Soil fertility was considered important in assessing natural capital at MFR.

Decline in soil fertility status is a major problem in most developing countries especially in Sub Saharan Africa (SSA) (Nair, 1993). On the other hand, the increase in soil fertility in this study is probably explained by the fact that the villagers under PFM had been encouraged to grow trees in their farms. This is possible because majority of the villagers grew or retain legume tree species such *Cassia* spp and *Acacia* spp.

One of the objectives of PFM is to improve livelihoods of local communities through various ways including education on management of their capital assets such as land management to increase farm productivity. IFPRI (2002) asserts that soil fertility has a strong direct positive impact on income, while agro-climatic conditions such as higher rainfall and altitude have an indirect positive income effect.

4.5.3.3 Influence of CBFM on household tree farms and trees

This study revealed that villagers in MFR grew or retained trees on farms or homesteads. Every household had grown at least 77 ± 24 trees and the ANOVA showed that there were no significant differences in number of trees grown among villages (Table 33) ($p = 0.766$). It is a known fact that one of the objectives of CBFM, apart from improving livelihoods, is to protect, regenerate and manage forest resources. Growing of trees on farms or around homesteads is also part of CBFM (Pandey, 2005). Trees owned by a household make up

part of the natural capital for the household. Therefore, CBFM seems to have influenced this natural capital positively, which has potential to influence the socio-economic status of the society over time.

Table 33: Response as to the number of trees owned by households after CBFM inception at Mgori Forest Reserve, Singida District, Tanzania

VFR/Trees	Percent of response						
	0 - 30	31 - 60	61 - 90	91+	Min	Max	Mean
Ngimu (n = 60)	38.3	31.7	21.7	8.3	0	4000	85 ± 66
Pohama (n = 60)	45.0	31.7	20.0	3.3	0	4000	73 ± 67
Unyampanda (n = 60)	-	28.3	30.0	41.7	5	850	112 ± 22
Mughuunga (n = 60)	3.3	11.7	38.3	46.7	0	120	40 ± 4
Total (N = 240)	**21.7**	**25.8**	**27.5**	**25.0**	**0**	**4000**	**77 ± 24**

SS = 161799.7; df 3; MS = 52933.24; F = 0.38; p-value = 0.766

Trees on farms or around homesteads have a tendency of influencing livelihoods of rural households (Mbwambo and Chingonikaya, 2005; Mwakalobo *et al.*, 2005). This is attributed to the fact that they provide security to the households as they act as standing bio assets (Nduwamungu *et al.*, 2004). Some trees on farms influence enrichment of soil fertility during cropping. They also provide fodder and shades for livestock (Nair, 1993). Furthermore, some trees on farms provide fuel wood, food, medicinal materials, poles and timber for various community uses.

The study, further, examined the adequacy of trees grown by household at MFR. Majority of respondents (68%) indicated that the trees, which were grown by households, were not adequate. Only 32% of them pointed out that the trees grown were adequate (Fig. 10).

Figure 10: Response as to adequacy of number of trees grown by households after CBFM inception at Mgori Forest Reserve, Singida District, Tanzania

The results showed that tree planting activities in MFR were not adequate. The number of trees grown by households in MFR was lower than those in areas where JFM was in operational (Meshack *et al.*, 2006). Differences in approach and climatic conditions may influence tree planting activities in the mentioned forest reserves.

In regard to the influence of CBFM on tree planting and management about 47% were of the opinion that there has been no change on trees planted and managed after inception of CBFM. On the other hand, a good proportion of respondents (35%) saw an increase in the number of trees planted after CBFM inception (Fig. 11).

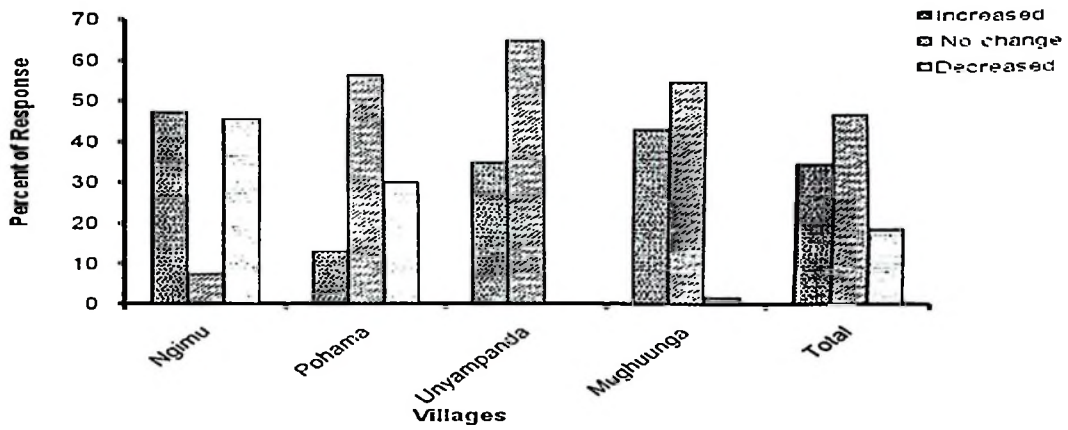


Figure 11: Response as to the change in number of trees grown by household since the beginning of CBFM at Mgori Forest Reserve, Singida District, Tanzania

4.5.3.4 Influence of CBFM on water for human consumption

About 71% of respondents at MFR admitted that water availability was not adequate (Fig. 12). Availability of water is one of the natural assets that form natural capital. CBFM at MFR tried to influence availability of water by encouraging participation of villagers in construction of water wells.

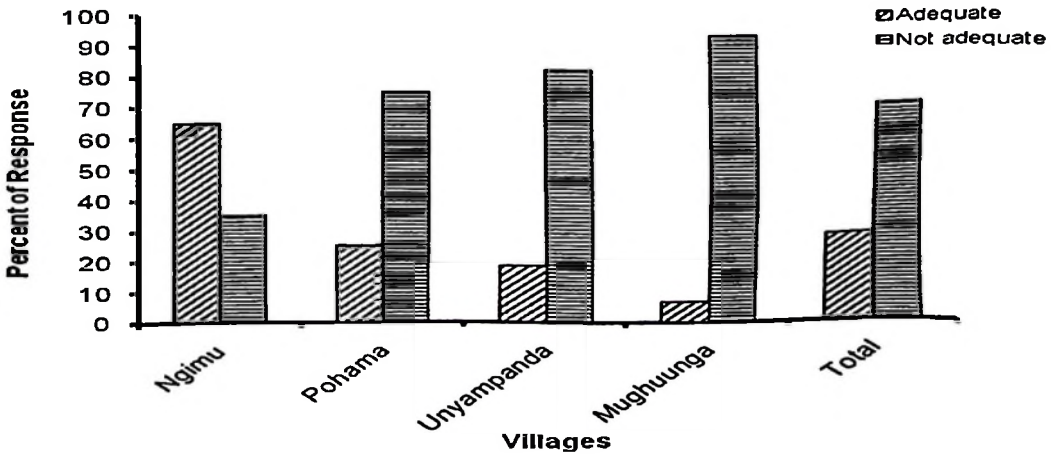


Figure 12: Response as to the adequacy of water after CBFM inception at Mgori Forest Reserve, Singida District, Tanzania

Unavailability of water at MFR was high at Mughuunga village (93%), followed by Unyampanda (82%) and Pohama (75%) villages. Majority of the households (93%) collected water from distances over one kilometre (Fig. 13). Very few households (7%) had collected water at a short distance, which within one kilometre.

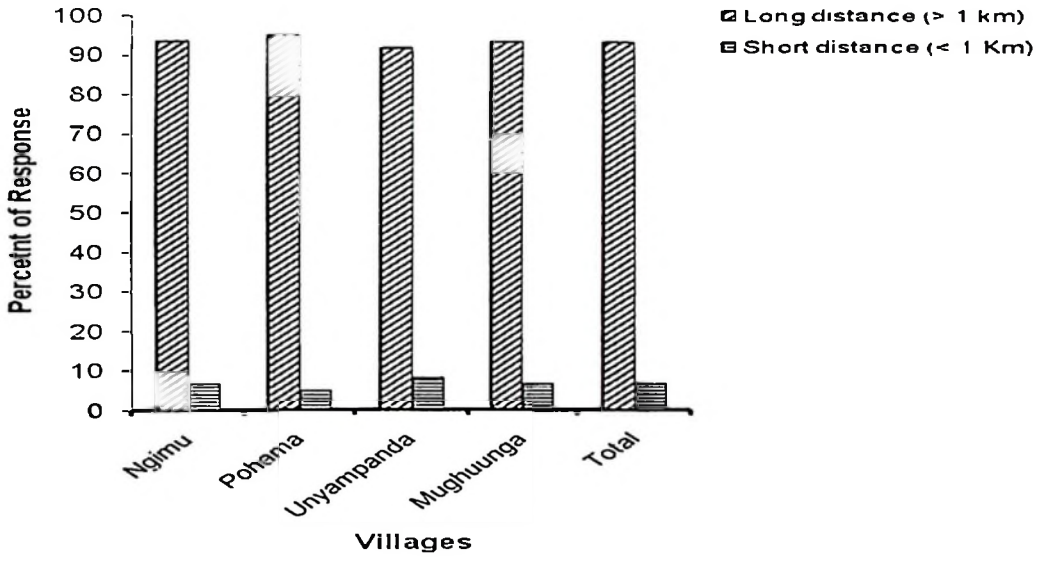


Figure 13: Response as changes in the distance to water source to the after CBFM inception at Mgori Forest Reserve, Singida District, Tanzania

The study, also, examined if there were some changes in availability of water since the inception of CBFM. About 61% of respondents pointed out that there had been no any change in water availability, while 30% of them indicated a decrease in water availability. Only 9% admitted an increase in water availability (Fig. 14).

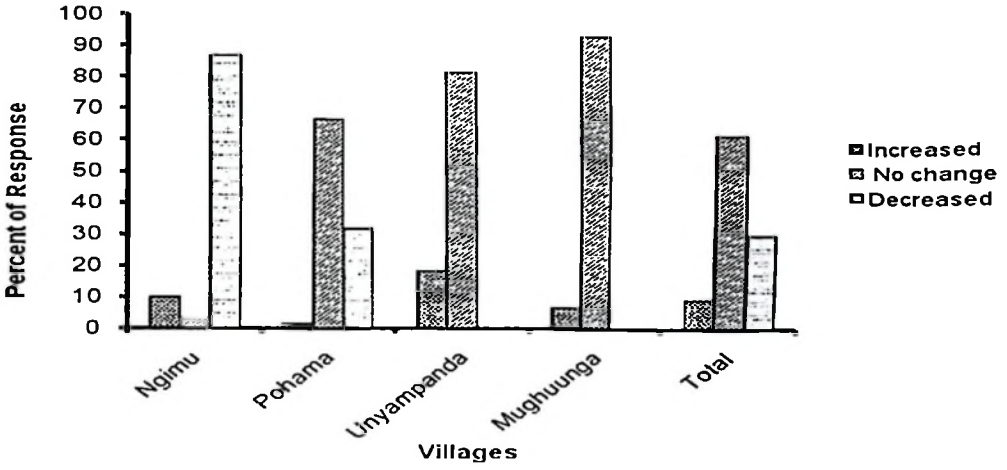


Figure 14: Response as to the change in availability of water for human consumption after CBFM inception at Mgori Forest Reserve, Singida District, Tanzania

Those who observed increase in water availability and decrease in distance to water sources seem to reside near constructed water wells. Scarcity of water at MFR is explained by the reason that Singida Region as a whole is in semi arid zone. The study area is characterized by seasonal rivers and swamps that probably influenced the unavailability of water. However, the decline in water availability for human consumption is a function of many factors such as rainfall patterns, low economic status and absolute wells.

Distance from water sources is an important component that influences labour efficiency. Studies elsewhere show that women spend more time in fetching water than farm work and home chores (WBG, 1999; Zuckerman, 2002; UNDP, 2005b). In line with the study, it is difficult to draw whether the water wells constructed were due to the existence of CBFM per see, but also due to government's efforts to improve water supply projects, but Isango (2004) reported that local communities were given incentives by the government and SIDA by constructing the wells during implementation of CBFM.

4.5.4 Influence of CBFM on social capital

The study revealed that most of the households built their social capital through spiritual (65%) and cultural (42%) groups. On the other hand, involvement in committees (20%), leadership (15%) and economic groups (14%) was among important ways for construction of social capital especially in relation to CBFM (Table 34).

Table 34: Involvement (%) of members in various groups/committees/leadership after CBFM inception at Mgori Forest Reserve, Singida District, Tanzania

Variable/VFR	Ngimu (n = 60)	Pohama (n = 60)	Unyampanda (n = 60)	Mughuunga (n = 60)	Total (N = 240)	χ^2 value
Cultural groups	21.7	70.0	23.3	51.7	41.7	5.95***
Committees	38.3	21.7	18.3	3.3	20.4	2.31***
Economic groups	21.7	11.7	23.3	-	14.2	8.03**
Leadership	30.0	16.7	11.7	1.7	15.0	6.35***
Spiritual groups	20.0	61.7	88.3	88.3	64.6	10.23***

**significant at p = 0.001; ***significant at p < 0.0001

The Chi-square test showed that involvement of members of households in cultural groups, committees economic groups, leadership and spiritual groups was significantly different betwen villages ($p < 0.01$).

Involvement of members in different cultural, economic and social goups as well as in committees has been reported to increase knowledge and power among the members in their communities. Different studies show that CBFM has improved group cohesion and provided a platform for other development activities in villages (Malla, 2000; Kajembe *et al.*, 2003; Pandey, 2005). Some studies (Wily and Dewees, 2001; Ghate and Mehra, 2003) point out that CBFM increased facilitation of empowerment of local communities through

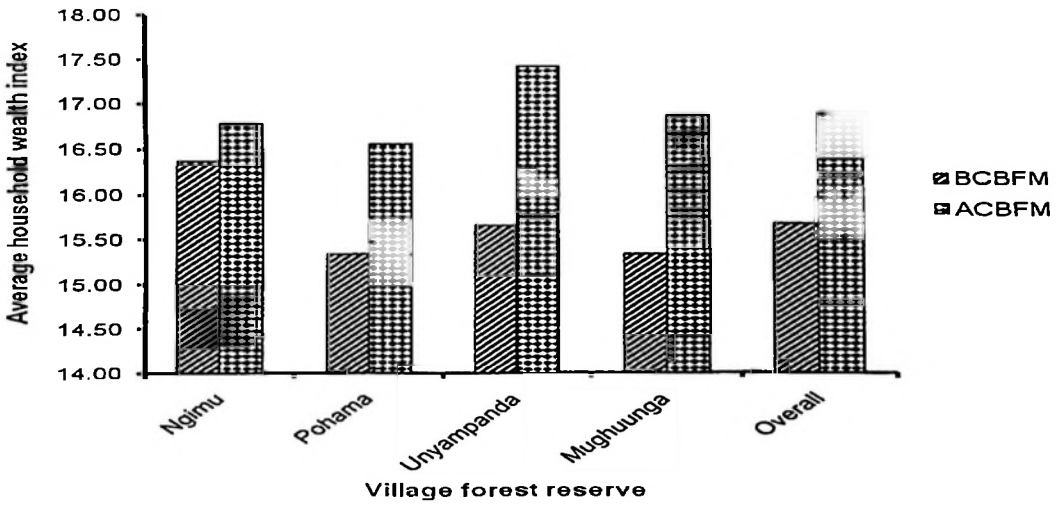
devolution of power on management of forest resources. Meetings provide a platform to communicate and interact with each other, enhance the understanding among the villagers, and in turn, each person knows village assets (Pandey, 2005). Further, besides discussions on forests related issues, they also consider each other's problems.

Rights to own resources, participation in decision-making and involvement in community development activities are observed to exist in villages where PFM is being practiced in Tanzania (Kessy *et al.*, 2005; Blomley and Ramadhani, 2006; Blomley *et al*, 2007). Ostrom (1997) and Amanor (2003) point out that ownership patterns establish an existence of a strong social capital in any community as the ownership of resources builds a sense of confidence.

Most of VFRs in Tanzania operate through instituting their own by-laws, principles and organization structures. For example, village forest committees, village environmental/natural resources committees, village government committees, village land committees, patrolmen and forest coordinating committees encourage a wide extension of networks among members in communities. Well explained cases include among others the Duru-Haitemba Forest Reserve (Kajembe *et al.*, 2003) and Kiteto forest reserve (Blomley and Ramadhani, 2006). Similar situation is reported in Nepal (Shepard and Gill, 1999; Dokharel, 2001), Lazoor, Iran and Mapelane Forest Reserve in south east coast of South Africa (WRI *et al.*, 2003). This is likely leading to an argument that involvement of any member of a household in any of the socio-economic groups, committees and leadership contributes to improvement of livelihoods of the household.

4.5.5 Wealth index of households

Based on wellbeing indicators for individual households it was observed that wealth index increased significantly after CBFM inception ($t = 3.901$; $p < 0.0001$) (Fig. 15). The assessment of wellbeing of households was based most on perceptions of respondents in recalling past income, food security, accessibility to clean water, housing conditions, affordability of health services and education status as well as the set categories proposed during FGDs (Table 5).



$t = 3.901$; $p < 0.0001$

Figure 15: Wealth index of households at Mgori Forest Reserve, Singida District, Tanzania (BCBFM = Before CBFM; ACBFM = After inception of CBFM)

Several studies have assessed wealth status of household based on assets ownership (e.g. Hortland, 1993; Simon, 2006). In measuring and comparing wealth status of different individuals, it is important to develop a single unit of measure (Hortland, 1993). Most studies adopt wealth index for comparison purposes (Prescott-Allen, 2001; Simon, 2006). However, this study used wellbeing indicators for development of wealth index of the

individual households as adopted from Prescott-Allen (2001). Increased wealth status of individual households after PFM inception is documented in Pandey (2005), however, Simon (2006) documented in adoption of agroforestry technologies. This provides evidence that in any community where technology or practice introduced properly, there is an improvement of wellbeing of households.

Increased wellbeing of local communities in forests managed under PFM has been reported elsewhere (Kajembe *et al.*, 2004a, b, c; Robertson and Lawes, 2005; Pandey, 2005; Khatri-Chhetri, 2006; Meshack *et al.*, 2006; Chingonikaya *et al.*, 2008) as it had been observed at MFR.

Increasing economic status in the country is geared to a number of factors (URT, 2005), of which the most important are transformation of economic structures and existence of social and economic programmes such as TASAF, PEDP and SEDP that cover the whole country which might have some influence in improving wellbeing of household. However, increased wellbeing at MFR might be influenced by CBFM as well, because it is part of poverty reduction strategies articulated in NSGRP/MKUKUTA.

With reference to the role of CBFM on socio-economies of local communities, the study established relationship between wellbeing at household and some selected variables through a multiple regression model (Table 35).

Table 35: Factors influencing household wellbeing after CBFM inception at Mgori Forest Reserve, Singida Distict, Tanzania

Variables	Standardized Coefficients				Collinearity Statistics	
	Beta	Std. Error	It-statl	p-value	Tolerance	VIF
AGEHH	-0.141	0.015	-2.204	0.029	0.916	1.092
EDULHH	0.006	0.139	0.086	0.932	0.792	1.263
EFVFC	-0.002	0.319	-0.024	0.981	0.549	1.820
EFVLC	0.137	0.297	1.722	0.086	0.593	1.686
EFVGT	0.105	0.252	1.013	0.312	0.350	2.854
EFDC	0.189	0.235	2.279	0.024	0.547	1.829
EFCGT	-0.161	0.170	-2.097	0.037	0.639	1.566
CONS	0.026	0.254	0.363	0.717	0.707	1.414
PARTCP	0.208	0.218	2.941	0.004	0.753	1.328
EFECTV	0.015	0.253	0.227	0.821	0.864	1.158
ACCNT	0.029	0.271	0.370	0.712	0.630	1.587
TRANSP	0.054	0.238	0.784	0.434	0.797	1.255
RESPONS	0.117	0.227	1.731	0.085	0.818	1.223
EQUITAB	0.005	0.260	0.074	0.941	0.695	1.440
Constant	-	1.618	9.238	0.000	-	-

SS = 169.13; df = 14; MS = 12.08; F = 2.92; $p < 0.0001$; $R^2 = 39.2$

The analysis showed that background characteristics mainly age and level of education, effectiveness of institutions and dimensions of good governance had significant influence on household welbeing ($p < 0.0001$; $R^2 = 39\%$) (Table 35).

The regression results also showed multicollinearity by examining tolerance and the Variance Inflation Factor (VIF). The results indicated that the independent variables involved in the model have no any influence on each other as their values are above the

recommended 0.1 and below 5 for tolerance and VIF values respectively (Stine, 1995). This generally shows that wellbeing of households at MFR has strong linear relationship with the selected variables.

Age of respondents, effectiveness of village forest committees and central government through MNRT showed a negative correlation with wellbeing of households, while the rest of the independent variables had positive correlation with the dependent variable. Effectiveness of village land committees, village governments, district council and levels of participation and responsiveness showed a significant ($p < 0.1$) positive relationship with wellbeing of households. However, age and effectiveness of MNRT showed a significant ($p < 0.05$) negative relationship with wellbeing of households. It is a known fact that linear, negative β coefficient of independent variables affects negatively the dependent variable, but positive β coefficients most often affect dependent variable positively (Stine, 1995).

The results provide an impression that increasing level of education of heads of households increases wellbeing at the household level. Other studies have observed the same elsewhere (Cruz-Doña and Alan, 2000; Bookwalter and Dalenberg, 2004; Handa *et al.*, 2004). Handa *et al.* (2004) observed that an adult's schooling brings important benefits to households in terms of higher levels of income and consumption as well as important benefits to communities as a whole. Negative correlation between age of respondents and wellbeing of households provides an explanation that plausibly the older the household heads the less the ability of the individuals to fully involve in productive activities.

The positive significant correlation between effectiveness of village land committee and district council and wellbeing of households is explained by the fact that an operationalisation of CBFM has much to do with the efforts of district council and land distribution (Pandey, 2005). These institutions operate mostly on lines of improving protection of the village forest reserves and livelihoods of local communities (Chingonikaya *et al.*, 2008).

The positive significant correlation between wellbeing of households and levels of participation, effectiveness, transparency and responsiveness shows that these dimensions of good governance at MFR had direct link with livelihoods of local communities as the main objectives of PFM are to improve livelihoods of communities and conservation of forest reserves (Iddi, 2002; Pandey, 2005; Blomely and Ramadhani, 2006). The results provide an assumption that in meeting up the objectives, CBFM approach emphasizes much on participation of stakeholders in development activities by being responsive, effective and transparent. The level of participation in governance is a key explanatory element of success or failure of any co-management system neglecting other dimensions of governance (Deither, 1999). Results obtained through regression analysis convince that institutions and dimensions of good governance involved in CBFM at MFR influenced wellbeing of households. The influence had also been observed in analyzing change of wealth index between two respective periods that the index almost doubled after CBFM inception.

4.6 Influence of CBFM on the Forest Resource Base

Stand parameters such stem density, basal area and volume, species diversity and level of human damages to the forest were considered as measures of the forest resource base.

4.6.1 Stem density

Overall stem density in MFR was 591 ± 195 stems ha^{-1}. Ngimu VFR had the highest stem density (855 ± 262 stems ha^{-1}), while Pohama VFR had the lowest stem density (493 493 ± 113 stems ha^{-1}) (Table 36). Post hoc test showed that the stem density in Ngimu VFR was significantly ($p < 0.05$) different from any other VFR. On the other hand the rest of the VFRs had no significant ($p > 0.05$) difference in stem density (Table 37). The diameter distribution for the MFR after CBFM inception is presented in Fig. 16, while prior to, is in Appendix 1.

Table 36: Tree density (stems per hectare) at Mgori Forest Reserve, Singida District, Tanzania

	Diameter at breast height (cm)			
VFR	≤ 10	11 - 20	> 20	Total
Ngimu	483 ± 158	222 ± 95	150 ± 52	855 ± 262
Pohama	220 ± 80	194 ± 72	79 ± 40	493 ± 113
Unyampanda	286 ± 41	164 ± 51)	45 ± 29	495 ± 135
Mughuunga	236 ± 93	216 ± 78	68 ± 43	520 ± 166
Average	**264 ± 99**	**199 ± 26**	**86 ± 45**	**591 ± 195**

Table 37: Multiple comparisons using post hoc test for stem density among Village Forest Reserves in Mgori Forest Reserve, Singida District, Tanzania

(I) VFRs	(J) VFRs	Mean Difference (I-J)	Std. Error	p- value.
Ngimu	Pohama	360.56(*)	51.18	<0.0001
	Unyampanda	359.21(*)	52.83	<0.0001
	Mughuunga	334.44(*)	53.14	<0.0001
Pohama	Ngimu	-360.56(*)	51.18	<0.0001
	Unyampanda	-1.35	31.48	0.966
	Mughuunga	-26.11	31.99	0.416
Unyampanda	Ngimu	-359.21(*)	52.83	<0.0001
	Pohama	1.35	31.48	0.966
	Mughuunga	-24.77	34.58	0.475
Mughuunga	Ngimu	-334.44(*)	53.14	<0.0001
	Pohama	26.11	31.99	0.416
	Unyampanda	24.77	34.58	0.475

*The mean difference is significant at the 0.05 level.

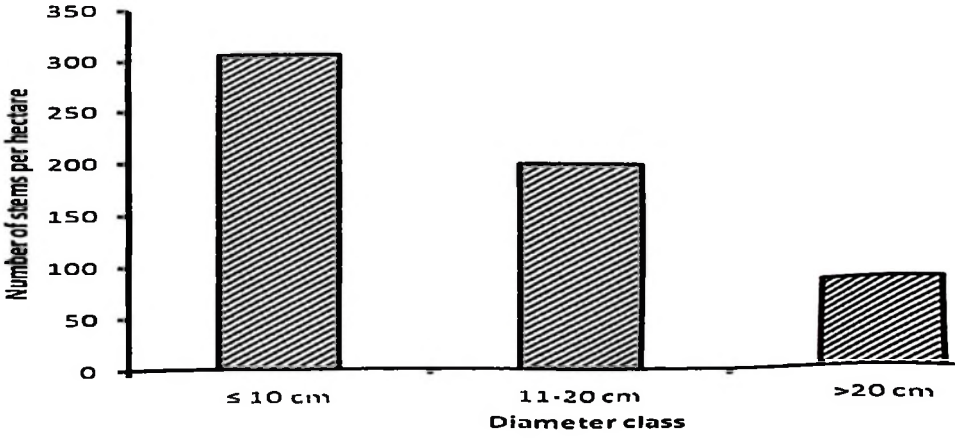


Figure 16: Tree diameter distribution in Mgori Forest Reserve, Singida District, Tanzania

The high difference in stem density between Ngimu and other VFRs observed at MFR is due to the reason that most of the abandoned settlements were within the remaining VFRs. During the inventory, many patches of growing thickets were observed. This is possibly argued that CBFM influenced regeneration of trees/shrubs in the reserve although tree density after CBFM inception was significantly ($p = 0.004$) lower than before (Table 38). The possible reason of the difference is Malimbwi and Mwansasu (1994) reported the stem density for all five VFRs, while this study had only four VFRs. Approaches used during inventory work were also different. Malimbwi and Mwansasu (1994) used circular plots and recorded all the trees with dbh about 0 cm and above, while this study used rectangular plots and recorded only the trees with at least 2 cm dbh.

Table 38: Comparison of stocking parameters between pre CBFM (1994) and post CBFM inception (2007) in Mgori Forest Reserve, Singida, Tanzania

Stocking parameter	1994*	2007	Itl	p-value
Stems per hectare (N ha^{-1})	1006 ± 8	591 ± 195	3.05	0.004
Basal area (m^2 ha^{-1})	9.03 ± 0.11	11.68 ± 5.24	26.07	< 0.0001
Wood volume (m^3 ha^{-1})	45.26 ± 3.07	65.99 ± 29.58	3.37	0.002

*1994 results were synthesized and modified from Malimbwi and Mwansasu (1994)

The tree/shrub density reported in this study is within the ranges reported by different studies in the miombo woodlands of Tanzania (Malimbwi and Mwansasu, 1994; Nduwamungu, 1996; Isango, 2004, 2007; Backeus *et al.*, 2006). The diameter distribution of miombo woodland stands confirm to De iocourt's q factors procedure with stems frequencies decreasing with increase in dbh (inverse J-distribution). Such distribution is a common characteristic of natural forest with a mixture of trees of all age classes. This provides an indication that the stocks are developing with adequate regeneration and stable population structure (Nduwamungu, 1996; Njana, 1998; Isango, 2007). The diameter class

distribution reported in this study is similar to other studies (Isango, 2004; 2007). Since most of these studies were carried in reserved forests. the similarity with this study provides an indication that CBFM has led to improved regeneration and maintenance of trees/shrubs in MFR.

4.6.2 Basal area

The basal area of the MFR varied from 9.65 ± 3.88 to 18.50 ± 5.31 $m^2 ha^{-1}$. Pohama VFR had the lowest basal area, while Ngimu VFR had the highest (Table 39). The basal area in MFR was not significantly different between the VFRs (p = 0.002), but the basal area was significantly different (p = 0.012) between Pohama and Mughuunga VFRs (Table 40).

Basal area distribution in MFR was significantly (p < 0.0001) different between pre and post CBFM (Table 38). This shows that during CBFM, trees were growing without disturbances. Before CBFM inception basal area was reported to be higher (4.20 $m^2 ha^{-1}$) at diameter class 11 – 20 cm than any other diameter classes (Malimbwi and Mwansasu, 1994) , while after CBFM inception, the basal area is the highest in the diameter class above 20 cm dbh compared to other classes.

Table 39: Basal area (m^2 ha^{-1}) distribution of tree/shrub species at Mgori Forest Reserve, Singida District, Tanzania

VFR	Diameter at breast height (cm)				
	< 5	5 - 10	11 - 20	> 20	Total
Ngimu	0.32 ± 0.14	1.54 ± 0.47	4.86 ± 2.39	11.78 ± 4.70	18.50 ± 5.31
Pohama	0.09 ± 0.05	0.92 ± 0.92	4.12 ± 1.70	4.52 ± 2.93	9.65 ± 3.88
Unyampanda	0.13± 0.08	0.74 ± 0.33	4.16 ± 1.92	7.29 ± 2.67	12.32 ± 5.19
Mughuunga	0.15 ± 0.19	0.89 ± 0.37	6.89 ± 5.91	4.22 ± 3.06	12.16 ± 6.77
Overall	**0.13 ± 0.13**	**0.91 ± 0.42**	**4.92 ± 3.61**	**5.72 ± 3.69**	**11.68 ± 5.24**

Table 40: Multiple comparisons using post hoc test for basal area among Village Forest Reserves at Mgori Forest Reserve, Singida District, Tanzania

(I) VFRs	(J) VFRs	Mean Difference (I-J)	Std. Error	p- value.
Ngimu	Pohama	2.13	1.56	0.174
	Unyampanda	1.18	1.61	0.465
	Mughuunga	-0.37	1.62	0.822
Pohama	Ngimu	-2.13	1.56	0.174
	Unyampanda	-0.95	0.96	0.324
	Mughuunga	-2.49 (*)	0.98	0.012
Unyampanda	Ngimu	-1.18	1.61	0.465
	Pohama	0.95	0.96	0.324
	Mughuunga	-1.55	1.06	0.145
Mughuunga	Ngimu	0.366	1.62	0.822
	Pohama	2.49(*)	0.98	0.012
	Unyampanda	1.55	1.06	0.145

*The mean difference is significant at the 0.05 level.

This gives an impression that CBFM improved conservation of MFR allowing tree growth tobig size and hence increase in basal area. The distribution of basal area based on diameter class followed a J-shaped trend, in which the basal area increases with increase in diameter classes and smaller diameter trees had the lowest basal area (Fig. 17).

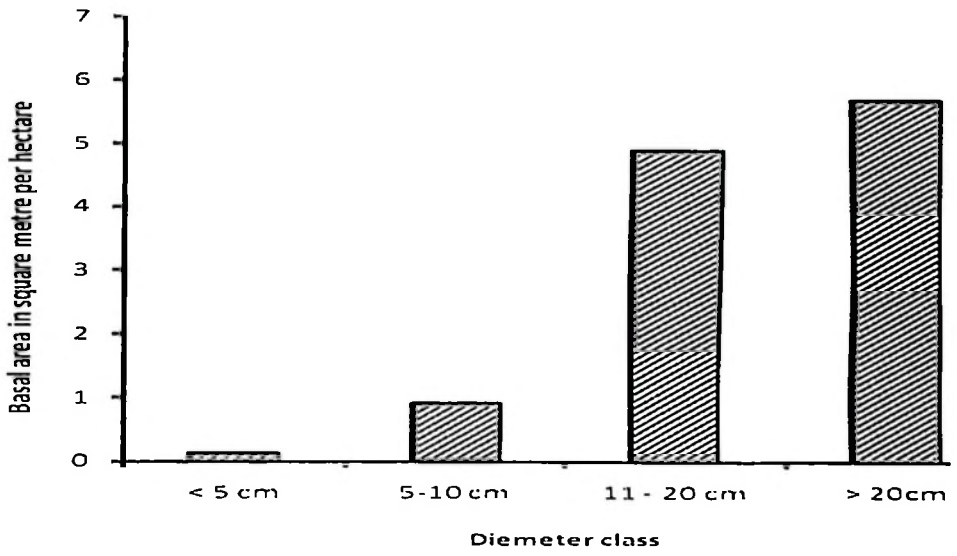


Figure 17: Basal area (m^2 ha^{-1}) distribution at Mgori Forest Reserve, Singida District, Tanzania

The average basal area (11.7 m^2 ha^{-1}) reported in this study is within ranges reported by different studies in miombo woodlands (Strang, 1974; Malibwi and Mwansasu, 1994; Nduwamugu, 1996; Malimbwi and Mugasha, 2000; Malimbwi, 2003; Isango, 2004; Isango, 2007). Malimbwi and Mwansasu (1994) obtained an average basal area of 9.03 m^2 ha^{-1} in the same Forest Reserve, while Isango (2004) reported a range of 10 to 14 m^2 ha^{-1}. The similarity of basal area in the same forest between 1994 and 2007 indicates that trees/shrubs in miombo woodlands grow very slowly. Evidence is provided by Campbell (1996). However, the slight increase in basal area (11.68 ± 5.24 m^2 ha^{-1}) compared to 9.03 m^2 ha^{-1} observed by Malimbwi and Mwansasu (1994) may be attributed to be influenced by CBFM.

4.6.3 Wood Volume

The wood volume in the MFR is presented in Table 41 and its distribution based on diameter is presented in Fig. 18. The study revealed that the mean wood volume for MFR

was 65.99 ± 29.58 m^3 ha^{-1} ranging from 54.49 ± 19.15 (Pohama VFR) to 104.47 ± 30.02 m^3 ha^{-1} (Ngimu VFR).

Table 41: Mean volume (m^3 ha^{-1}) distribution by diameter at Mgori Forest Reserve, Singida District, Tanzania

VFR	Diameter at breast height (cm)				
	< 5	5 - 10	11 - 20	> 20	Total
Ngimu	1.79 ± 0.78	8.70 ± 2.68	27.45 ± 13.48	66.54 ± 26.56	104.47 ± 30.02
Pohama	0.51 ± 0.30	5.22 ± 2.20	23.25 ± 9.58	25.50 ± 16.53	54.49 ± 19.15
Unyampanda	0.75 ± 0.45	4.18 ± 1.87	23.49 ± 10.83	41.19 ± 15.07	69.61 ± 21.93
Mughuunga	0.83 ± 0.05	5.05 ± 2.07	38.94 ± 33.37	23.86 ± 7.28	68.67 ± 38.26
Average	**0.76 ± 0.72**	**5.14± 2.36**	**27.79 ± 20.38**	**32.30 ± 20.82**	**65.99 ± 29.58**

Post hoc test showed that the difference in wood volume between VFRs was significant ($p < 0.05$) different, except between Unyampanda and Mughuunga VFRs (Table 42).

There was also a significant difference in wood volume between pre (Malimbwi and Mwansasu, 1994) and post CBFM ($p = 0.002$) (Table 38). Increased wood volume during CBFM asserts that the model had contributed to reducing human disturbances especially illegal tree cuttings and logging in the reserve thus improving the timber volume in the forest.

The distribution of wood volume by diameter class showed a J-shaped pattern. This is not different from Malimbwi and Mwansasu (1994) (Appendix 14). Temu (1980), Kielland-Lund (1990), Malimbwi *et al.* (1995), Nduwamungu (1996) and Isango (2004; 2007) observed the same. This reveals that in studies elsewhere in miombo ecosystem volume increases with increasing dbh of tree species.

Table 42: Multiple comparisons using post hoc test for wood volume among Village Forest Reserves at Mgori Forest Reserve, Singida District, Tanzania

(I) VFRs	(J) VFRs	Mean Difference (I-J)	Std. Error	p- value.
Ngimu	Pohama	49.99(*)	9.41	<0.0001
	Unyampanda	34.42(*)	9.80	0.001
	Mughuunga	35.87(*)	9.77	<0.0001
Pohama	Ngimu	-49.99 (*)	9.41	<0.0001
	Unyampanda	-15.56(*)	5.93	0.010
	Mughuunga	-14.12 (*)	5.88	0.018
Unyampanda	Ngimu	-34.42(*)	9.80	0.001
	Pohama	15.58(*)	5.93	0.010
	Mughuunga	1.45	6.49	0.823
Mughuunga	Ngimu	-35.87(*)	9.77	<0.0001
	Pohama	14.12 (*)	5.88	0.018
	Unyampanda	-1.45	6.49	0.823

*The mean difference is significant at the 0.05 level.

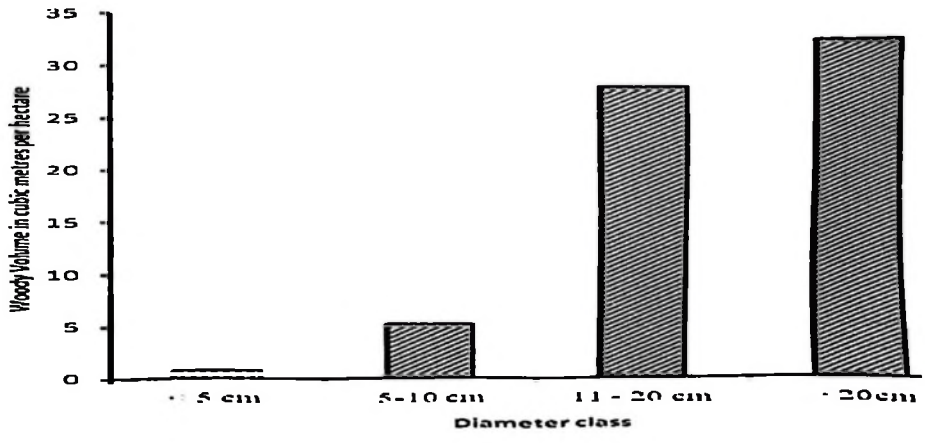


Figure 18: Distribution of mean wood volume (m^3 ha^{-1}) by diameter at Mgori Forest Reserve, Singida District, Tanzania

Other studies have shown that wood volume for miombo woodlands in Tanzania ranges from 39 to 120 m^3 ha^{-1} (Nduwamungu, 1996: Malimbwi and Mugasha 2000; Chamshama *et al.*, 2004; Isango, 2007). Nduwamungu (1996) observed a mean volume of 71 m^3 ha^{-1}, while Malimbwi and Mugasha (2000) observed a maximum volume of 110 m^3 ha^{-1} in Miombo woodlands of Rufiji and Isango (2007) observed a volume value of 65.7 m^3 ha^{-1} in Iringa. The reported volume shows that CBFM has made it possible to maintain the wood volume in this forest within values equivalent to similar naturally growing and managed woodlands. This further may mean that the degtradation that would be expected under the pre CBFM open access egime has been checked by CBFM.

4.6.4 Tree and shrub species composition and dominance in the MFR

Seventy-nine tree species were identified in the MFR (Table 43), while during the pre CBFM, only 38 tree species were enumerated (Malimbwi and Mwansasu, 1994). Mughuunga VFR had the highest number of species, followed by Pohama and Unyampanda, but Ngimu had the lowest number of tree species. Mbwambo (2000) enumerated a total of 34 species in miombo woodlands adjacent to five villages in Tabora, while Isango (2007), Luoga (2000), Backeus (2006) and Malimbwi *et al.* (1998) enumerated a total of 81, 79, 86 and 95 tree/shrub species respectively. The reported tree/shrub species fall within the range reported by other studies for miombo forest reserves. High number of species enumerated during CBFM when compared to pre CBFM (Malimbwi and Mwansasu, 1994) shows that CBFM model has contributed to regeneration and /or recruitment to measureable diametaer classes of some tree/shrub species, which probably were being suppressed by frequent fires, farming and settlement in the reserve.

Table 43: Tree/shrub species richness and diversity indices at Mgori Forest Reserve, Singida District, Tanzania

VFR	Species richness	H'	C	SDI	E
Ngimu	30	2.54	0.03	38.46	1.81
Pohama	67	3.04	0.04	81.90	1.74
Unyampanda	64	2.97	0.11	80.57	1.06
Mughuunga	70	2.92	0.11	89.36	1.58
Overall	**79**	**2.87**	**0.07**	**72.57**	**1.55**

Shannon Weiner diversity index (H') for MFR ranged between 2.54 and 3.04 for Ngimu and Pohama VFRs respectively (Table 43). The overall value for MFR was 2.87.

According to Kent and Coker (1992), most often the value of the index lies between 1.5 and 3.5, while Krebs (1989) points out that the maximum value of the index should not exceed 5.0. High values of the index indicate high diversity of plants. Zahabu (2001) reported the index values of Kitulangalo Forest Reserve as ranging from 2.9 to 3.1, while Isango (2004) reported the value to be between 2.3 and 2.9. Munishi *et al.* (2004) observed that for montane rainforests in the Eastern Arc Mountains the value ranged from 2.9 to 3.3. However, the values reported in this study are lower than those reported by Nduwamungu (1996) (3.3 - 3.8), but higher than those reported by Isango (2007) (1.3 – 1.5) and Otieno (2000) (1.0 – 2.0) for community managed forest reserves in Iringa and Duru-Haitemba. The values given in this study provide an indication that the species diversity in MFR was high as would be for a normal miombo woodland ecosystem.

The dominance index (Simpsons Diversity Index) averaged 0.07 (0.03 to 0.11) (Table 43). The values reported in this study are higher than those reported by Nduwamungu (1996) in

Kitulangalo Forest Reserve (0.03 - 0.06) and Munishi *et al.* (2004) for Usambara and Uluguru mountain forests (0.04 to 0.05). On the other hand, the results are similar to those reported by Otieno (2000) for Duru-Haitemba Forest Reserve (0.16 to 0.47) with a mean of 0.09. The findings suggest that tree/shrub species at MFR are more diverse than Duru-Haitemba forest reserve, but less diverse than for montane forest (Munishi *et al.*, 2004) and Kitulangalo forest reserve (Nduwamungu, 1996).

Species diversity index (SDI) is among the measures of biodiversity (Kohli *et al.*, 1996). The SDI, in this study ranged between 38.46 and 89.36 for Ngimu and Mughuunga village forest reserves, respectively (Table 43). With exception of Ngimu VFR, the SDI values reported in MFR are higher than those reported for community managed forest reserve in Iringa, which ranged between 50.2 and 75.9 (Isango, 2007). This provides an impression that MFR has more stable vegetation than Community managed forest reserve in Iringa as reported by Isango (2007). Isango (2007) showed differences in SDI between time before (50.2) and after PFM inception (75.9). This ascertains that after inception of PFM at MFR, the SDI has increased.

The species evenness index was observed to range from 1.06 for Mughuunga VFR to 1.81 for Ngimu VFR with an average of 1.55 (Table 43). Species richness (SR) and evenness (E) are sometimes used to assess the stability of vegetation community (Kent and Coker, 1992). The species evenness values for this study are similar to other studies in the miombo ecosystem (Isango, 2007; Odum, 1971). High values for SDI and E confirm that the vegetation community in the reserve is of high species diversity and richness. The study, generally, confirms that the vegetation community in MFR is stable as for other similar woodlands elsewhere (Banda *et al.*, 2006; Bauckes *et al.*, 2006; Isango, 2007),

which shows the contribution of CBFM towards maintaining vegetation stability in the reserve.

The most dominant species based on the relative frequency (RF) was *Brachystegia spiciformis* followed by *Julbernardia globiflora*, *Brachystegia microphylla* and *Combretum molle*, while *Cassipourea mollis* was the least dominant (Table 44). The same trend was observed for dominance of tree/shrub species based on relative density (Table 45), dominance (Table 46) and IVI (Table 47).

Table 44: Species dominance by frequency of occurrence of the most abundant trees/shrubs in Mgori Forest Reserve, Singida District, Tanzania

Species/VFR	Ngimu	Pohama	Unyampanda	Mughuunga	Overall
Brachystegia spiciformis	10.47	12.29	11.66	10.71	11.28
Julbernadia globifolia	6.98	5.87	6.36	7.47	6.67
Brachystegia microphylla	4.65	6.98	9.19	5.19	6.50
Combretum molle	8.14	5.59	6.01	3.57	5.83
Commiphora mosambiensis	3.49	5.59	7.07	7.14	5.82
Combretum zeyheri	10.47	3.91	3.89	2.27	5.14
Dalbergia nitidula	9.30	2.23	0.35	3.25	3.78
Dalbergia stulmannii	8.14	3.91	0.71	1.62	3.60
Lochocarpus bussei	2.33	2.51	4.24	3.90	3.25
Cassipourea mollis	2.33	1.12	2.47	2.92	2.21

Table 45: Species dominance by density of the most abundant trees/shrubs in Mgori Forest Reserve, Singida District, Tanzania

Species/VFR	Ngimu	Pohama	Unyampanda	Mughuunga	Overall
Brachystegia spiciformis	24.36	28.95	29.23	27.82	27.59
Julbernadia globifolia	17.55	7.45	10.94	15.28	12.81
Brachystegia microphylla	7.89	8.67	9.24	5.62	7.86
Commiphora mossambicensis	1.68	8.10	6.88	8.87	6.38
Combretum molle	7.20	4.05	5.64	3.25	5.04
Combretum zeyheri	5.82	4.05	2.88	3.04	3.95
Dalbergia stulmannii	9.86	3.82	0.39	0.94	3.75
Dalbergia nitidula	6.02	1.07	0.20	3.15	2.61
Lochocarpus bussei	1.28	1.22	2.56	3.10	2.04
Cassipourea mollis	1.18	1.41	1.11	2.26	1.49

Table 46: Species dominance by basal area the most abundant tree/shrub species in Mgori Forest Reserve, Singida District, Tanzania

Species	Ngimu	Pohama	Unyampanda	Mughuunga	Overall
Brachystegia spiciformis	27.19	32.58	20.13	51.07	32.74
Julbernadia globifolia	18.64	14.94	7.32	17.39	14.57
Brachystegia microphylla	9.65	10.47	6.92	7.22	8.57
Commiphora mosambiensis	0.69	11.61	8.38	4.69	6.34
Combretum molle	11.45	2.50	5.31	1.11	5.09
Dalbergia stulmannii	12.39	3.48	0.66	0.41	4.24
Combretum zeyheri	1.89	1.78	5.48	1.82	2.74
Dalbergia nitidula	5.86	0.58	0.16	1.49	2.02
Lochocarpus bussei	0.5	0.80	4.41	1.70	1.85
Cassipourea mollis	0.54	0.89	2.89	0.77	1.27

Table 47: Importance value index for the most abundant tree/shrub species in Mgori Forest Reserve, Singida District, Tanzania

Species	Ngimu	Pohama	Unyampanda	Mughuunga	Overall
Brachystegia spiciformis	62.01	73.82	61.02	89.61	71.62
Julbernardia globifolia	43.17	28.25	24.63	40.13	34.05
Brachystegia microphylla	22.19	26.12	25.34	18.03	22.92
Commiphora mossambiensis	5.85	25.29	22.32	20.70	18.54
Combretum molle	26.79	12.13	16.95	7.94	15.95
Combretum zeyheri	18.18	9.74	12.25	7.13	11.83
Dalbergia stulmannii	30.40	11.21	1.76	2.98	11.59
Dalbergia nitidula	21.18	3.88	0.71	7.88	8.41
Lochocarpus bussei	4.10	4.54	11.20	8.69	7.13
Cassipourea mollis	4.05	3.42	6.48	5.95	4.98

These tree species are the most dominant in the miombo woodlands (Frost, 1996; Chidumayo and Frost, 1996). White (1993) also presents that *Julbernardia*, *Brachystegia* and *Isoberlinia* are the most dominant genera in miombo woodlands.

The dominance pattern of the most abundant tree/shrub species in the MFR in terms of frequency, stem density and basal area is shown in Fig. 19, 20 and 21, respectively. With respect to frequency of occurrence, *Brachystegia spiciformis* was the most dominant species (11%), followed by *Brachystegia microphylla* (7%), *Julbernardia globifolia* (6%) and *Commiphora mossambicensis* (6%) (Fig. 19) with respect to stem density *Brachystegia spiciformis* (27%) was followed by *Julbernadia globifolia* (12%) and *Commiphora mossambicensis* (8%) (Fig. 20). On the basis of basal area, *Brachystegia spiciformis* was the most dominant (31%) cfollowed by *Julbernardia globiflora* (14%), *Brachystegia microphylla* (8%) and *Commiphora mossambicensis* (7%) (Fig. 21). The distribution of the most dominant tree species based on IVI showed similar trend (Fig. 22), but *Brachystegia*

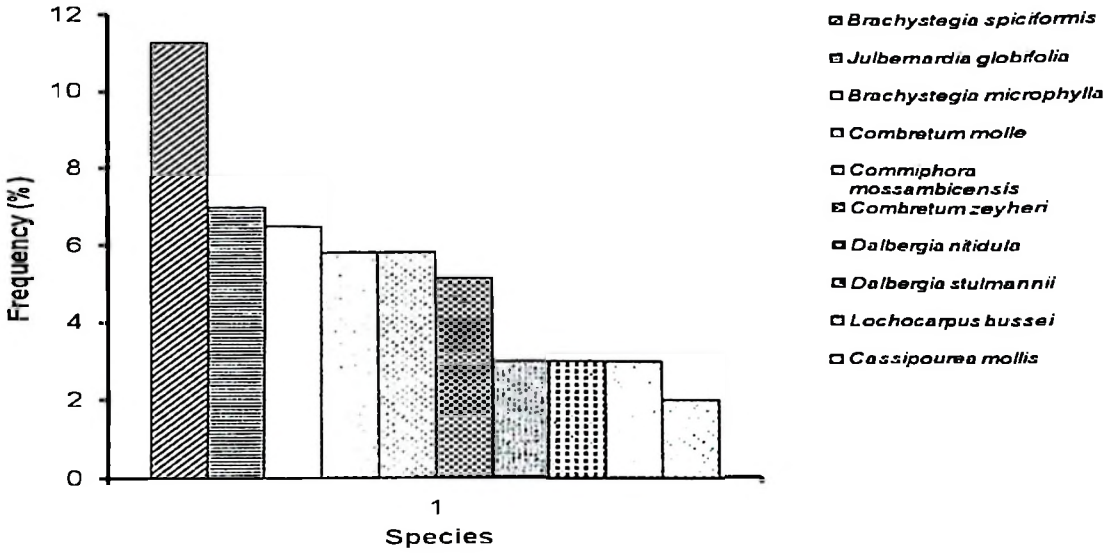


Figure 19: Distribution of important dominant tree/shrub species by frequency at Mgori Forest Reserve, Singida District, Tanzania

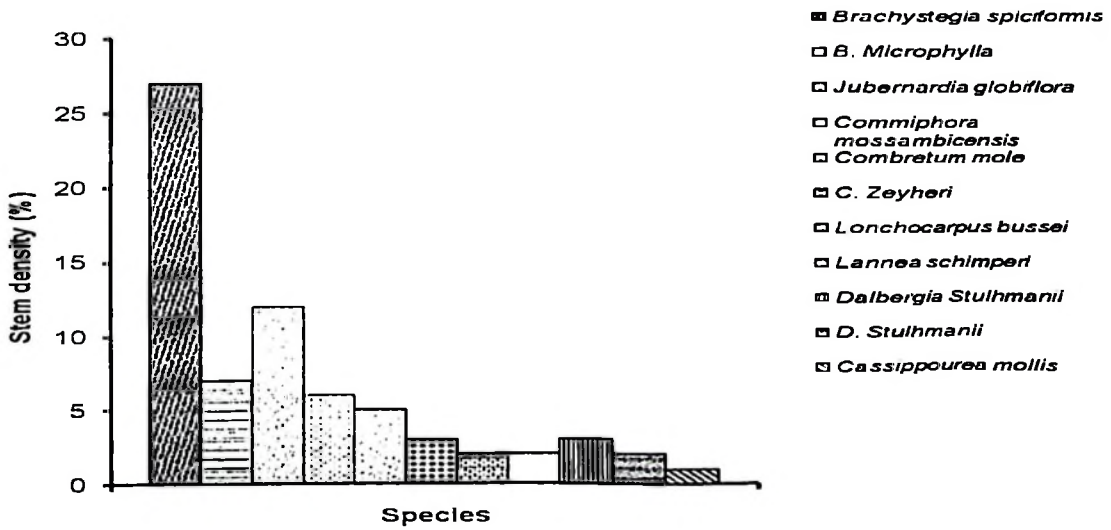


Figure 20: Distribution of important dominant tree/shrub species by number of stems at Mgori Forest Reserve, Singida district, Tanzania

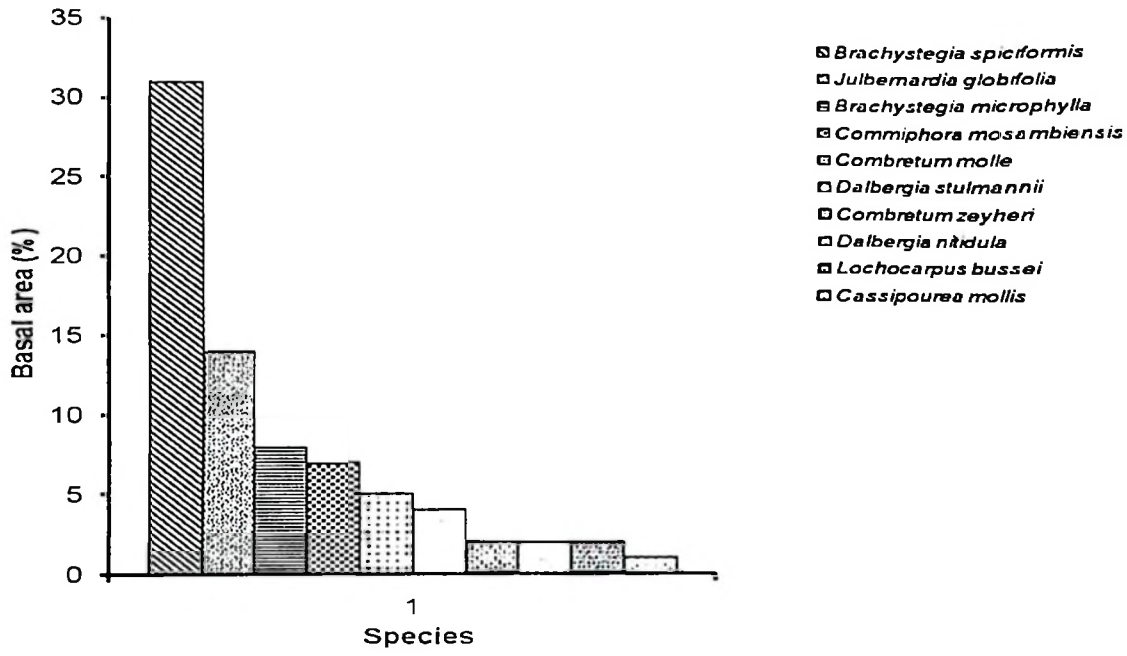


Figure 21: Distribution of important dominant tree/shrub species by basal area at Mgori Forest Reserve, Singida District, Tanzania

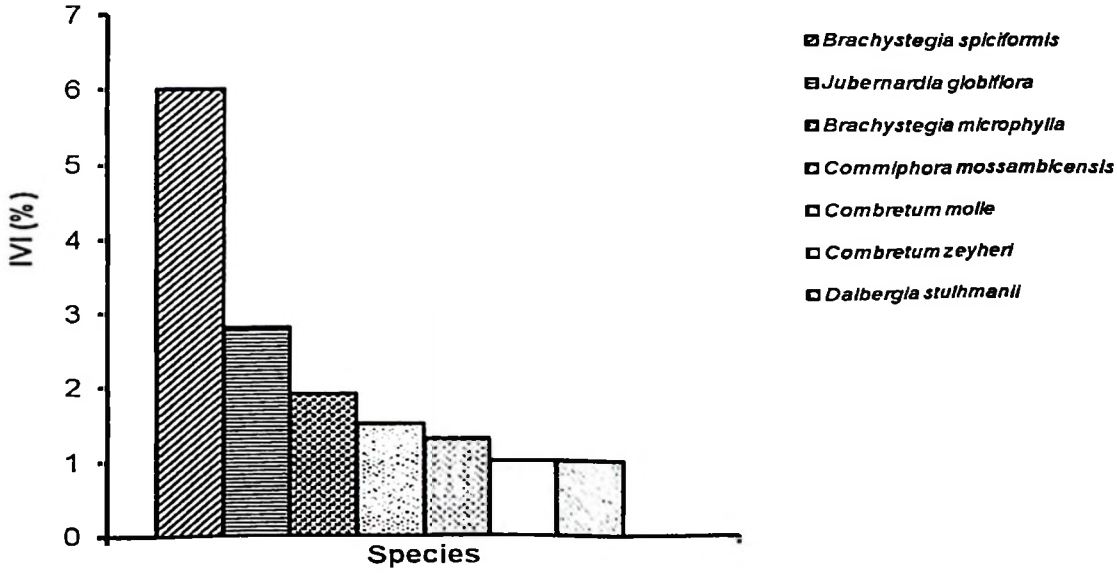


Figure 22: Distribution of important dominant tree/shrub species by IVI in Mgori Forest Reserve, Singida District, Tanzania

spiciformis accounted for 6%, while *Combretum zeyheri* and *Dalbergia stulhmanii* had 1% dominance.

The distribution of the tree/shrub species by frequency, stems, basal area and IVI shows that these were the most important dominant tree/shrub species in MFR. The frequency gives an approximate indication of the homogeneity of a stand. Studies elsewhere show that high values in higher frequency classes and low values in lower frequency classes indicate constant or similar species composition. On the other hand, existence of high values in lower frequency classes and low values in higher frequency classes indicate a high degree of floristic heterogeneity. This interprets that the species that appear in the lower frequency classes have irregular occurrence whereas those appearing in higher classes have regular horizontal distribution (Fig. 19).

According to Bekele (1994), stem density is not a better measure for determination of dominance of tree species than basal area. However, some studies use stem density to determine dominance of species in which high density indicates regular horizontal distribution of the particular species (Bauckes *et al.*, 2006; Isango, 2007). In this case, *Brachystegia spiciformis* has shown to have regular horizontal distribution in MFR. Species with the largest contribution in basal area can be considered as the most important woody species in the forest. *Brachystegia spiciformis* has also shown to be the most important tree species in MFR (Fig. 20 and 21).

For the sake of setting priority using IVI analysis woody species with high values are the most dominant tree species in the forest, but those species with lower values are less abundant and need monitoring management (Bekele, 1994). According to the analysis,

species such as *Dalbergia stuhlmanii*, *Combretum zeyh*eri and *C. molle* accorded the highest priority for conservation efforts (Fig. 22). The observation is similar to other previous studies such as White (1983), Chidumayo and Forst (1996) and Isango (2004, 2007) conducted in miombo woodland ecosystems. This entails that PFM has helped maintaining the biodiversity of miombo ecosystem in MFR to normal values common to woodlands elsewhere.

4.6.5 Forest Disturbance in the MFR

The study assessed the status of physical damages caused by human activities in the reserves as a measure of forest disturbance. The major parameters used in this assessment were stem cuttings, debarking, debranching and fire. The results reported in this study show that physical damages caused by human activities in the reserve have been reduced by 18% (Fig. 23). Out of 136 plots surveyed or selected for inventory data, only 21% showed existence of new stem cuttings, while old stem cuttings was 36% showing a reduction of 15% since CBFM inception (Fig. 24). New debarking was observed in only 10% of all the surveyed plots as compared to 27% of the old debarking signs observed in the plots (Fig. 25). This shows that since PFM inception, there was a reduction in debarking of trees in the reserve for about 17%. There was also a reduction of debranching, which accounted for 5% since PFM inception (Fig. 26), while fire occurrence in the reserve accounted for only 22% as compared to 57% in pre CBFM (Fig. 27).

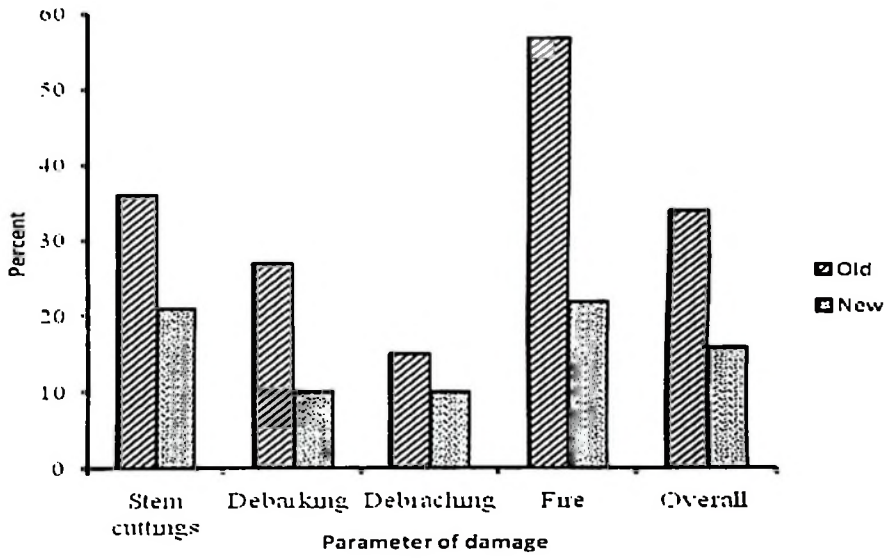


Figure 23: Physical damage (%) caused by human activities in Mgori Forest Reserve, Singida District, Tanzania

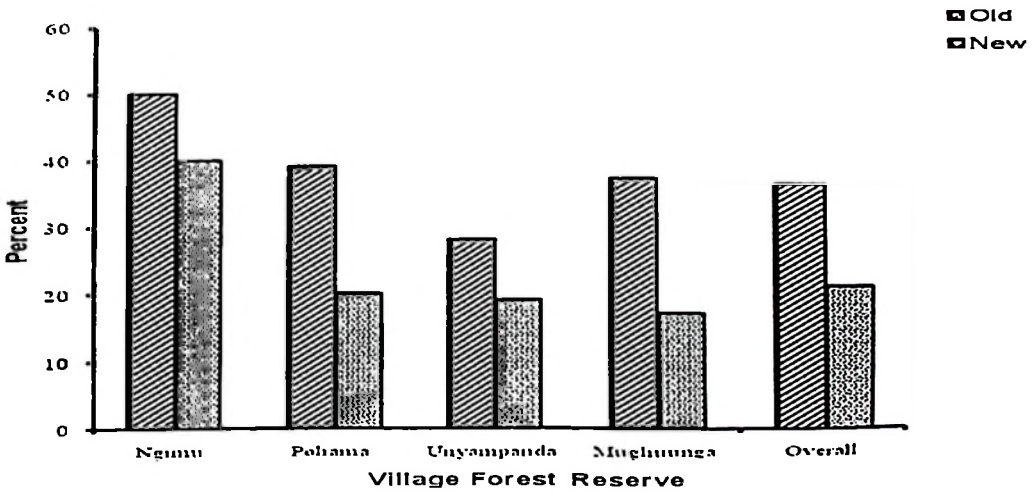


Figure 24: Stem cutting (%) caused by human activities in Mgori Forest Reserve, Singida District, Tanzania

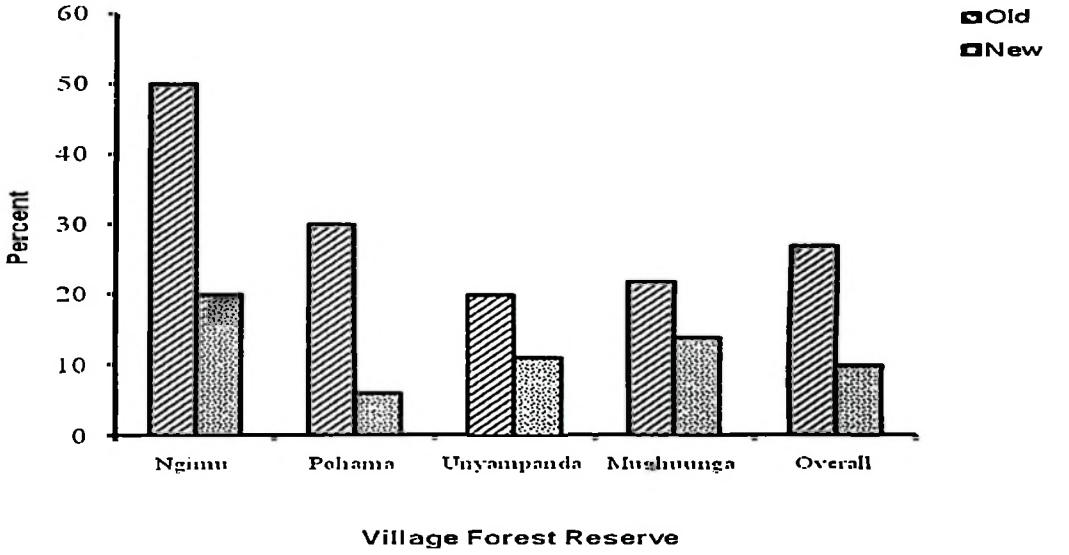


Figure 25: Debarking (%) caused by human activities in Mgori Forest Reserve, Singida District, Tanzania

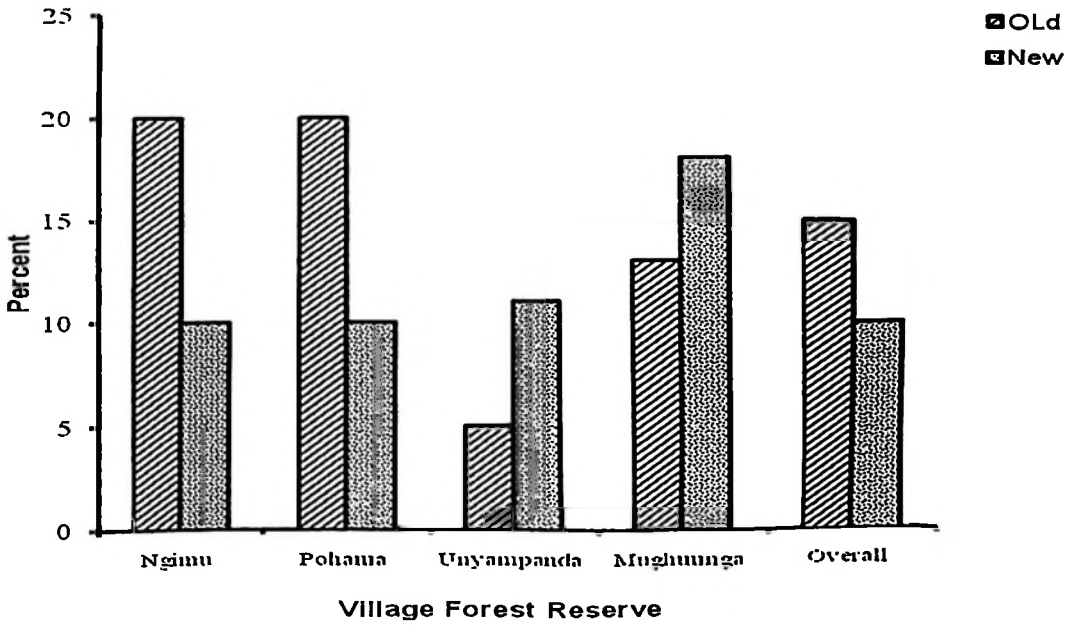


Figure 26: Debranching (%) caused by human activities in Mgori Forest Reserve, Singida District, Tanzania

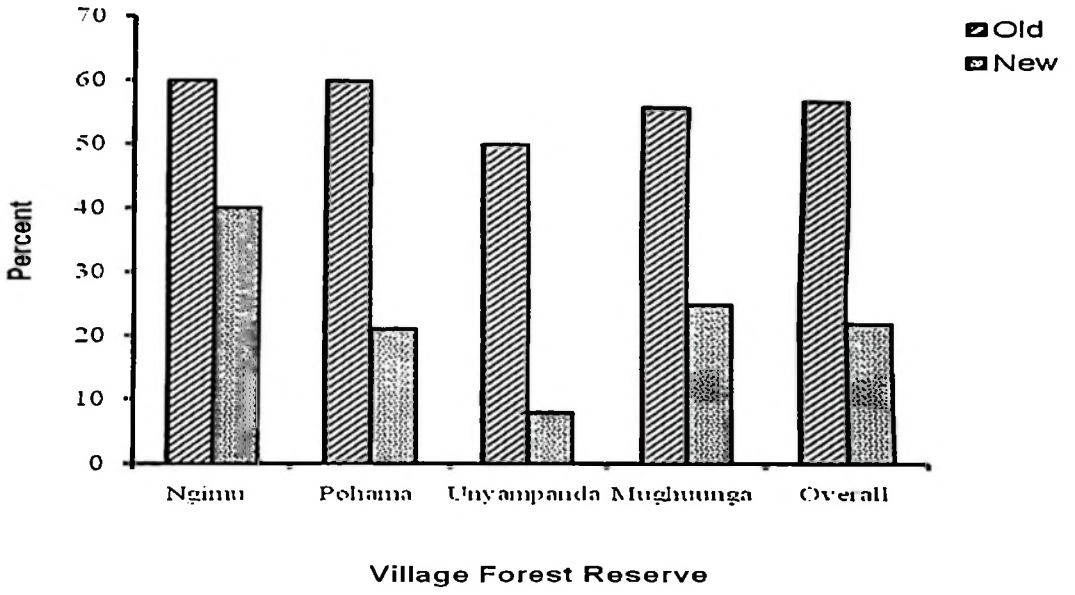


Figure 27: Incidence of fire (%) caused by human activities in Mgori Forest Reserve, Singida District, Tanzania

Reduction of disturbances caused by human activities in the MFR is similar to other studies conducted elsewhere (Kajembe *et al.*, 2003, 2004a, b; Luoga *et al.*, 2005a; Pandey, 2005; Meshack *et al.*, 2006; Mwembe, 2008). Reduction of tree cutting reported at MFR is also observed in other forest reserves under PFM (Kajembe *et al.*, 2003, 2004a; Meshack *et al.*, 2006; Mwembe, 2008). Kajembe *et al.* (2004a) showed that in Duru-Haitemba, fewer incidences of disturbance in terms of cutting trees for fuel wood and building poles were observed after CBFM inception. Mwembe (2008) reported the same for Pangani Basin Forest Reserve. Reduction of rates of debarking and debranching is also observed in many forest reserves after PFM inception (Kajembe *et al.*, 2004a; Mwembe, 2008). Debarking is usually done either for making beehives or to let the trees dry for firewood. Kajembe *et al.* (2004a) pointed out that debarking is done for collection of materials for beehives and medicine, while debranching is done for poles and firewood.

Reduction of rates of wild fire at MFR is explained by presence of village forest guards or patrol team and set management plans for fire control. However, this is not only the case for MFR, but also in other forest reserves in miombo woodlands (Kajembe and Kessy, 2000; Luoga, 2000; Malimbwi, 2003; Luoga *et al.*, 2004). In general, reduction of human disturbances in MFR after PFM inception is very high. Other studies pointed out that reduction of human disturbances in forest reserves managed by communities under the PFM model is due to the communities realizing the benefits of having the forests and awareness of the importance of forests for their livelihoods (Kumar, 2002; Nssoko, 2002; Wataru, 2003). However, other studies indicated that most often offenders hate punishments (Saigal, 1999; Kumar, 2002) and others hate to be involved in putting off fire when it breaks in the forests (Boer, 1998; Bahuguna, 1999).

Therefore, at MFR, reduction of human disturbances to the reserve is due to implementation of the PFM model. It is likely that the model has created awareness on the importance of forests to local communities and they feel that the forest reserve is part of their livelihoods.

4.7 Prospects and sustainability of forest resource based and socio-economies of local communities

Slightly increased of socio-economies such as income, social network and overall wealth indices among households provide indication that the CBFM will be maintained as the local communities receive benefits from it. Most of the variables used for assessing forest resource base were observed increasing after inception of CBFM. This, also, provides an indication that CBFM would lead to sustaining forest resource base at MFR.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study has documented information on CBFM model, institutions, governance, and contribution of CBFM to improvement of socio-economies and forest resources conservation at MFR.

Institutional arrangements in this study are in place operating in line with participatory forest management regime and framework. The study revealed that the most important institutions are demarcations and zonation, village committees, property rights, coordinating committee and monitoring committees. Both local and central governments are also important for the strength of CBFM at MFR. Reduction of the number of offences, patrolling groups and removal of settlements within and/or close to forest reserves are regarded as a success to management of forest reserves under the CBFM model. The District council was rated as highly effective, while the village government was rated as very effective in implementation of CBFM. This response provides a conclusion that village government and District councils are almost important in implementation of CBFM at MFR. However, the response to overall effectiveness of institutions at MFR was rated effective referring to neither poor nor very effective. This adheres to the duration of CBFM in Tanzania, which is at early stages of implementation and less than two decades.

Governance of MFR managed by communities was rated as satisfactorily good. Very few responses rated the level of dimensions of good governance as poor and very high. The response has led to further analysis of determining governance index and dimension

indices. The analysis has led to the conclusion that good governance at MFR is at satisfactory level. The conclusion is in line with the PFM model in Tanzania, which is less than two decades old, that high performance is yet to be achieved.

The results for annual households' income at MFR showed that income among local communities had been improving since CBFM inception. The increasing income among local communities had an implication that the households would be in a position of accessing to food security, education, health, water and accommodation services.

Consumption of forest products in households was significantly high. This provides a conclusion that although many households at MFR depend on agricultural based economy, they utilize some forest products for domestic and market purposes. The most important forest product consumed by households in large amount is firewood. The consumption of forest products in this study helped some households save some substantial amount of cash income when considered the values of the products. The contribution of sales of forest products to total income of households was also observed. This provides a conclusion that sales and consumption of forest products at household level lead to improving wellbeing of local communities at MFR.

Regression analysis results showed some positive relationships between wealth status of households and institutions and dimensions of good governance at MFR. This concludes that socio-economies of local communities surrounding MFR are closely related to output of CBFM in conservation of MFR.

Under CBFM, various activities were conducted in an effort to conserve the forest resources in MFR. Such activities included formation of various committees, establishment of monitoring plots and fire management plans. However, the VFGCs were observed facing problems associated with scarcity of resources such as money and protective gears.

Influence of CBFM to conservation of forest resources was analyzed in terms of stand parameters, tree species composition and diversity, and old and new human disturbances in the reserve. The study concludes that conservation of forest resources in the reserves under CBFM has been achieved as stand parameters and species composition and diversity indices were normal as for other protected forest reserves. Disturbances such as tree cutting, debranching, debarking and occurrence of wild fires were highly reduced in the reserve compared to time before CBFM inception. This gives the conclusion that CBFM reduces human disturbances in MFR. Generally, the study concludes that the CBFM paradigm introduced in Mgori Forest Reserve has been effective as the forest resources are being conserved, which provides impression that conservation of forest resources is likely to be sustainable.

It is, therefore, concluded that CBFM in Mgori Forest Reserve did improve socio-economies of surrounding local communities and forest resource base.

5.2 Recommendations

Based on this study, the following are recommended:

- The dimensions of good governance are essential in making CBFM successful and thus should be given attention in such approaches especially at early stages of CBFM practice.

- Requirement for technical input and financial support may limit operationalisation of effective CBFM in the country. There should be some investments to support some committees such as the VFGCs.

- Although, the objectives of CBFM are among others to improve conservation of forest resources and livelihoods of local communities, the livelihoods aspect seem not to feature adequately and possibly not well defined at MFR.

- Venturing for local community's development and alternative income generating projects are important to be emphasized in any forest reserve being managed under PFM paradigm. Most of forest reserves that are under, the communities gain very little from collective revenue due to either licenses for harvesting some forest products or tourist's fees.

- It is difficult to establish direct contribution of CBFM to livelihoods of local communities. As there are no established livelihoods monitoring approaches in PFM areas, periodic monitoring programme is required to be initiated.

- More studies are encouraged to be done to value and monitor different products and ecological processes. This is due to the reason that most of village forest reserves in Tanzania are not yet valued and monitored ecologically.

- Lastly, continuous assessment of ecological processes human physical damages in the village forest reserves is important as it provides clear picture of existence of the ecological values from time to time.

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APPENDICES

Appendix 1: Questionnaire

Prospects of Community-Based Forest Management in Sustaining Forest Resource base and Socio-economies of Local Communities in Tanzania: A Case Study of Mgori Forest Reserve, Singida

A: Household Identification:

Name.....Village.....Ward.....Division

District/Site.....Region.....

Date of Interview.....Name of Interviewer.....

B: Household Biodata:

1 Household size and composition

Person	P1	P2	P3	P4	P5	P6	P7	P8	P9	P11	P12	P13	P14	P15
Sex														
Age														
Education level														
Marital status														
Main occupation														
Work on farm														
Household head														

Sex	Education	Marital Status	Main occupation	Work on farm	Household head
1. Male	1. None	1. Single	1. Farmer	1. Full time	1. Adult male
2. Female	2. Primary	2. Married	2. Civil servant	2. Part time	2. Adult female
	3. Secondary	3. Widow	3. Self-employed	3. None	3. Orphans
	4. Post Secondary	4. Widower	4. Unemployed		
	5. Adult Education	5. Divorced	5. Education		
	6. Other	6. Immature	6. Housework		
		7. Other	7. Sick, old, young		
			8. Other		

2. Sources of Income

Give the sources of income and amount in Tshs obtained per year before and after introduction of participatory forest management (PFM)

Source	Before		After	
	Tick	Amount	Tick	Amount
Crop sales (name the crops)				
Livestock sales (name the products/livestock)				
Sales of forest products from farms (name them)				
Other sources (Specify)				

C: Economic Vales

3 Categories of forest products obtained by households at Mgori Forest Reserve, Tanzania. Please insert at the appropriate Remark place, S for *satisfied* and SN for *not satisfied*

Product	Before			After		
	Amount (ton, bags, kg, tin)	Estimated cash income (Tshs)	Remark[1]	Amount (ton, bags, kg, tin)	Estimated cash income (Tshs)	Remark[1]
Food items:						
Vegetables						
Roots						
Tubers						
Honey						
Fruits						
Beverage						
Mushrooms						
Others (specify)						
Woody item:						
Charcoal						
Firewood						
Poles						
Timber						
Handcrafts						
Carvings						
Others (specify)						
Medicinal:						
Roots						

Leaves						
Barks						
Others (specify)						
Other non-woody item:						
Fibres						
Natural dyes						
Gum						
Others (specify)						

4 The following Table below collects information on Livelihoods of forest dependency local communities. In **category I**, insert required information at appropriate place or select the given choices and **circle the number**. In **category II**, select the given choices and **circle the number**. Under the **remark**, ask question about the status before and after and insert in the appropriate place **1** = for an existence of changes in increase, **2** = for no change at all, **3** = for changes in decrease.

Form	Variables	Category I	Category II	Remark	
				Before	After
Natural capital	Land availability (Unit area)		1) Adequate 2) Not adequate		
	Land size (Unit area),		1) Adequate 2) Not adequate		
	Types of crops	1) Cereal 2) Commercial	1) Helpful 2) Not helpful		
	Types of livestock,	1)Cattle, 2) goats, 3) chicken, 4) others	1) Adequate 2) not adequate		
	Soil fertility,	-	1) Adequate 2) Not adequate		
	Water availability and uses.	For human consumption (per year), Distance from the source	1) Adequate 2) Not adequate 2) Long distance or 1) short distance		
	Forest (trees/shrubs, vegetation) (Numbers in farms/homesteads)		1) Adequate 2) Not adequate		

Physical capital	Forest products (timber and non-timber). (Unit in weight tons/Kgs)		1) Adequate 2) Not adequate		
	Production of products from forests. (Numbers)		1) Useful or 2) not useful		
	Crop yields (Unit in weight tons/Kgs)		1)Adequate or 2) Not adequate		
	Other assets (Hoes. carts. panga) (Numbers)		1)Adequate 2) Not adequate		
	Infrastructures: Roads. Markets Schools Health facilities	-	1)Access or 2)not access		
Financial capital	Variables	Quantity per year (Amount in US$)	Category		
	Income from sales of forest products		1)Enough 2) Note enough		
	Income from farming products.		1) Enough 2) Not enough		
	Income in kind.		1) Enough 2) Not enough		
	Remittances.		1) Enough 2) Not enough		
	Labour		1)Enough 2)Not enough		
Human Capital	Education for children (Number of children in school).		1) Satisfactory 2) Not satisfactory		
	Level of education				
	Type of house	1) Burnt brick + Aluminum roofing 2) Burnt brick + Thatched roofing 3) Un-burnt brick+ Aluminum roofing 4) un-burnt brick + Thatched roofing 5) mad walls + aluminum roofing 6) Mad walls + Thatched roofing	1)Good 2) Bad		

	Knowledge (**Frequency of attendance (seminars, meeting, extension visits)**)		1)Adequate or 2) adequate		
	Physical ability(**Number of sick members)**		1) Normal 2) normal		
Social capital	Culture (Number of member)		1) Presence 2) Absence		
	Committees (Number of member)		1) Presence 2) Absence		
	Groupings (Number of member)		1) Presence 2) Absence		
	Leadership (Number of member)		1) Presence 2) Absence		
	Spiritual/church (Number of member)	-	1) Presence 2) Absence		

5. Indicate the status of indicators of household well-being before and after the PFM

Indicators	Before	After
Income		
Food availability		
Quality of water		
Clean water		
Housing		
Education		
Health		

Income

1 = High

2 = Medium

3 = Low

Food availability

1 = Year round

2 = 6 –9 months

3 = 1 – 3 months

Quality of food

1 = High

2 = Medium

3 = Low

Clean water

1 = High availability

2 = Medium availability

3 = scarcity

Housing

1 = good (brick + iron sheet)

2 = satisfactory (brick + thatched roof)

3 = Poor (mad walls)

Education

1 = children- Post secondary school level

2 = children - Post secondary school level

3 = children- secondary school level

4 = children- primary school level

5 = children- not gone to school at all.

Health

1 = Health services can easily afford

2 = Health services can not easily afford

3 = Health services can not afford

D: Social values

6. Categories of intangible forest products obtained by households at Mgori Forest Reserve, Tanzania. Please insert at the appropriate place, **P** for *obtained* and **A** for *not obtained*

S/N	Intangible forest products	Before	After
1	Culture (circumcision, dancing items,)		
2	Spirituals/rituals (worshiping area)		
3	Taboos		
4	Recreational		
5	Education		
6	Prestigious (ownership, right of access)		
7	Social networking (friendships)		
8	Existence*		
9	Option*		
10	Bequest*		
11	Others (specify)		
12			

*Non-use values including option value from use values category

E: Governance of Village Forest Reserves

8. Institutions involved in Forest management and their effectiveness.

Institution	Tick	Effectiveness	Institution	Effectiveness
Forest committee			NGOs/CBOs (Name them):	
Land committee				
Water Committee				
Guard committee				
Village committee			Others (Name them):	
Village government				
Church				
Mosque				
District authority				
MNRT				
Traditional (Name them):				

Effectiveness: 1 = excellent 2 = Very effective 3 = Effective 4 = Moderately effective 4 = Poor

9. Power on control, access and decision making in forest resources under the PFM (tick where appropriate)

Variable	Control	Access	Decision making
Yes			
No			
If yes in what			
Forest products			
Land			
Water			
Distribution of benefits/cash from tourism/fees/revenue/tax/fines			
Infrastructure (roads/market/etc)			
Others (specify)			

In the table above, if the answer is NO. why? (Give explanation to every item)

Control: _____

Access_____

Decision-making_____

For the case of YES, how? (For each item)

Forest products_____

Land_____

Water_____

Distribution of benefits_____

Infrastructure_____

Others (specify)_____

10. Participation of individual villagers in forest resource management (Indicate number)

Involvement in institutions: (Name):	Adult Male	Adult Female	Male child	Female child	Adults	Children
1.						
2.						
3.						
4.						

11. Sub dimensions of seven pillars of good governance used for assessing governance of village forest reserves at Mgori Forest in Singida District, Tanzania

Dimension of good governance	**Sub dimensions**	**Indicate Presence or Absence**
Participatory	Collaboration with local governments	
	Collaboration with other villagers	
	Collaboration with NGOs/CBOs	
	Participation in decision making	
	Participation in distribution of revenues and	
	Participation in forest management	
	Participation in village development activities	
Accountability	Distribution of village accounting reports	
	Delivered what is promised for	
	Reviewing meeting minutes	
	Openly explaining the rationale for the decision	
	Acknowledging that work is completed	
	Sharing lessons learned as well as recommendations	
	Accepting good and bad	
Transparency	Existence of communication and information	
	Attendance to village government meetings	
	Existence of open meetings	
	Existence of financial disclose statements	
	Existence of openness from village leaders	
	Existence of criticism	
	Giving and accepting apologies	
Equitability	Treating each other with respect and dignity	
	Concern for others no matters the rank	
	Fair resource allocation and utilization	
	Focus on the issue, not the person	
	Gender based perspectives and participation	
	Equal distribution of revenues	

	Equal contribution to development activities	
Responsibility	Willingness to take responsibility for action and outcome	
	Acknowledging assigned role	
	Obeying assigned activity	
	Staff and volunteers working towards common goal	
	Gaining collective inputs	
	Trustful when given responsibility	
	Responding to any matter arise	
Follow the rule	Applying national forest policy	
	Abiding to the law	
	Existence of regulations	
	Existence of by laws	
	Adhering to the established policies, practices and processes	
	Fair treatment on case by case in court	
	Respecting boundaries and jurisdictions	
Effectiveness	Doing right things regardless of consequences	
	Reducing offences	
	Improving forest conservation	
	Improving household wellbeing	
	Development of village facilities	
	Being close to central and local governments	
	Reducing corruption	
Consensus	Existence of committee agreements	
	Existence of village meeting agreements	
	Existence of agreements at household level	
	Existence of agreements in meetings with local government officials	
	Existence of agreements with district council representatives	
	Existence of sharing and be receptive to opinions given	
	Existence of agreements in planning and bylaw settings	

12. Elements of good governance for Mgori Forest Reserve. In the table below insert **P** for presence and **A** for not presence (Reference I made to the table 11 above)

Element	P/A	Remark
Consensus oriented		
Participatory		
Follow the law		
Effective and efficient		
Accountable		
Transparency		
Responsive		
Equitable		

Remark: 1 = Poor, 2 = Satisfactory, 3 = High, 4 = Very high

13. Do you have any thing to tell about the whole situation of forest resources being managed under the PFM and its link to livelihoods and well-being of the people living around the forest? **Yes/No** (circle one). If yes what is it?_____

HANK YOU FOR YOUR COOPERATION

Appendix 2: Checklist for key informants and focus group discussion

Prospects of Community-Based Forest Management in Sustaining Forest Resource Base and Socio-economies of Local Communities in Tanzania: A Case Study of Mgori Forest Reserve, Singida

A: Types of resources owned by households

Natural resources

- Land
- Forests
- Ngitiri
- Grazing land
- Water
- Others

Man-made resources

- Assets (equipments)
- Knowledge
- Extension services
- Others

B: Sources of income of households

- Farm products
- Livestock sales
- Forest products sales

C: Governance of forest management

- Institutions involved in forest management (governments/committees)
  1) Formal, (2) Informal
- Power on control, access and decision making in forest resources management
  1) Forest products, 2) Land, 3) Water, 4) distribution of benefits, 5) Infrastructure , etc.
- Participation of individual villagers/households in forest management
  1) Institutional participation and membership

D: Dimensions of good governance

Sub dimensions of seven pillars of good governance used for assessing governance of village forest reserves at Mgori Forest in Singida District, Tanzania

Dimension of good governance	**Sub dimensions**	**Rank 1, 2, 3 or 4**
Participatory	Collaboration with local governments	
	Collaboration with other villagers	
	Collaboration with NGOs/CBOs	
	Participation in decision making	
	Participation in distribution of revenues and	
	Participation in forest management	
	Participation in village development activities	
Accountability	Distribution of village accounting reports	
	Delivered what is promised for	
	Reviewing meeting minutes	
	Openly explaining the rationale for the decision	
	Acknowledging that work is completed	
	Sharing lessons learned as well as recommendations	
	Accepting good and bad	
Transparency	Existence of communication and information	
	Attendance to village government meetings	
	Existence of open meetings	
	Existence of financial disclose statements	
	Existence of openness from village leaders	
	Existence of criticism	
	Giving and accepting apologies	
Equitability	Treating each other with respect and dignity	
	Concern for others no matters the rank	
	Fair resource allocation and utilization	
	Focus on the issue, not the person	
	Gender based perspectives and participation	
	Equal distribution of revenues	
	Equal contribution to development activities	
Responsibility	Willingness to take responsibility for action and outcome	
	Acknowledging assigned role	
	Obeying assigned activity	
	Staff and volunteers working towards common goal	
	Gaining collective inputs	
	Trustful when given responsibility	

	Responding to any matter arise	
Follow the rule	Applying national forest policy	
	Abiding to the law	
	Existence of regulations	
	Existence of by laws	
	Adhering to the established policies, practices and processes	
	Fair treatment on case by case in court	
	Respecting boundaries and jurisdictions	
Effectiveness	Doing right things regardless of consequences	
	Reducing offences	
	Improving forest conservation	
	Improving household wellbeing	
	Development of village facilities	
	Being close to central and local governments	
	Reducing corruption	
Consensus	Existence of committee agreements	
	Existence of village meeting agreements	
	Existence of agreements at household level	
	Existence of agreements in meetings with local government officials	
	Existence of agreements with district council representatives	
	Existence of sharing and be receptive to opinions given	
	Existence of agreements in planning and bylaw settings	

E: Human socio-economics

- Types of forest products obtained by households, before and after the PFM

  1) food item, 2) Woody item, 3) Medicinal, 4) Other non-woody item

- Quantity of the forest products obtained by households, before and after the PFM

  1) food item, 2) Woody item, 3) Medicinal, 4) Other non-woody item

- Intangible benefits obtained in the forests, before and after the PFM

  1) Rituals/spirituals, 2) Tradition and culture, 3) Aesthetic/ecotourism

- Indicator of household well-being before and after the PFM

  1) Income, 2) Food security, 3) Water, 4) Housing, 5) Education, 6) Health

- Livelihood indicators (Assets) described in the local communities before and after the PFM

1) Social capital (networks, neighbourhoods), 2) Physical capital, 3) Natural capital (Land, forest), 4) Financial capital, 5) Human capital (Education level, health, physical strength and ability).

F: Comments to improve the forest resource managements

- Strengths
- Weaknesses
- Any

HANK YOU FOR YOUR COOPERATION

Appendix 3: List of woody species found at Mgori Forest Reserve in Singida District, Tanzania

Botanical Name	Local Name	Botanical Name	Local Name	Botanical Name	Local Name
Acacia hockii	Munying'anyi	*Commiphora mosambiensis*	Muntonto	*Ozoroa insignis*	Munyongwampee
Acacia senegalsis	Mujighulu	Commiphora ngogensis	Mujuhu	*Pavetta schumanniana*	Munkuharii
Acacia sieberana	Mukese	*Commiphora ugogensis*	Musake	*Phylanthus ingleri*	Mubolomi
Acacia tortilis	Mughuunga	*Dalbergia melanoxylema*	Mufako	*Pleurostylia africana*	Mufafati
Acaia tanganyikensis	Mughangachuma	*Dalbergia nitidula*	Mubibi	*Pramna senensis*	Munyukinyuki
Accacia drepandobium	Mwandui	*Dalbergia stulhmanii*	Musisi	*Pseudolachostylis maprouneifolia*	Muranghambili
Adansonia digitata	Mwandui	*Dichrostachys cinerea*	Mutunduru	*Pterocarpus angolensis*	Muhinga
Afzelia quanzensis	Mukola	*Diospyros usambarensis*	Muriyoriyo	*Pterocarpus rotundifolius*	Musalaka
Albizia antunesiana	Munyingafumbu	*Dolichos oliveri*	Mughongoafage	*Pyrenacantha kaurabassana*	Muiro
Albizia harvei	Mupogowa	*Erythrina abyssinica*	Mupipiti	*Schreberia tricoclada*	Muuma
Albizia petersiana	Musimihi	*Euphorbia candelabrum*	Mwange	*Sclerocarya birrea*	Muhuvi
Albizia zetersiana	Mpilo	*Ficus stuhlmanii*	Musaghaa	*Shrebera trichoclada*	Mwama
Azanza garckeana	Mutongho	*Greela arborea*	Mudoghwe	*Solanum incanum*	Mutula
Boscia angustifolia	Mutii	*Grewia platyclada*	Musuna	*Strychnos cocculoides*	Mukuhughundu
Boscia salicifolia	Muhuka	*Hymenodictyon parvifolium*	Mukumiankoo	*Strychrios potaforum*	Mupande
Brachystegia microphylla	Mukinki	*Isoberlinia angolensis*	Mukonjee	*Terminalia mollis*	Mughuka
Brachystegia spiciformis	Mufumbu	*Jubernadia globiflora*	Mufumbu 2	*Terminalia sericea*	Mufuru
Bridelia duvigneaudii	Musekea	*Kigelia africana*	Mugunghu	*Tricalysia ruandensis*	Muhuti
Canthium burtii	Musule	*Lannea humilis*	Muhinti	*Vangueria infausta*	Mulade
Cassipourea mollis	Mutuampiti	*Lannea schimperi*	Mughumbu	Vangueria madascaensis	Mukukutu

Appendix 3: contuned.

Catunaregam spinosa	Mupongwa	*Lonchocarpus bussei*	Muvae	*Vitex mombassae*	Musasati
Cissus rubiginosa	Mubwammwaka	*Margaritaria discoidea*	Museka	*Xeroderris stunhlmannii*	Mujimbua
Combretum collinum	Mufafage	*Markamia lutea*	Mughwanda	*Ximenia caffra*	Mutundwi
Combretum molle	Murama	*Markamia obtsifolia*	Mulili	*Zanha africana*	Mujijiu
Combretum obovatum	Mughianduata	*Multidentia crassa*	Mukukumaka		
Combretum zeyheri	Muhanyati	*Mundulea sericea*	Muheruheni		
Commellina beghalensis	Mungo'ngo	*Ormmocarpum trichocarpum*	Murori		
Commiphora africana	Mulalahai	*Ormocarpum trichocarpum*	Musimbwa		

Appendix 4: Stand parameters at Ngimu Village Forest Reserve at Mgori Forest in Singida District, Tanzania

	DBH ≤ 5 CM			5 CM <DBH ≤10 CM			10 CM <DBH ≤ 20 CM			DBH > 20 CM			TOTAL			
PLOT	N	G	V	N	G	V	N	G	V	N	G	V	N	G	V	N/HA
1	23	0.33	1.87	28	1.72	9.69	19	4.09	23.10	10	8.88	50.15	80	15.02	84.82	800
2	17	0.20	1.12	19	1.32	7.47	21	6.26	35.33	6	3.69	20.83	63	11.46	64.75	630
3	20	0.27	1.50	36	2.22	12.54	22	4.19	23.64	18	14.70	83.02	96	21.37	120.70	960
4	14	0.19	1.06	12	0.68	3.84	23	5.76	32.56	11	7.74	43.74	60	14.38	81.20	600
5	21	0.34	1.93	27	1.50	8.45	12	2.38	13.45	13	9.25	52.26	73	13.47	76.10	730
6	16	0.23	1.27	20	1.30	7.34	15	2.79	15.74	13	9.65	54.49	64	13.96	78.86	640
7	32	0.43	2.41	41	2.25	12.69	47	10.76	60.75	21	12.49	70.56	141	25.92	146.41	1410
8	11	0.16	0.92	22	1.19	6.74	18	3.52	19.89	18	17.38	98.16	69	22.26	125.71	690
9	29	0.42	2.37	24	1.44	8.15	24	4.20	23.72	18	18.18	102.69	95	24.24	136.93	950
10	42	0.61	3.44	29	1.78	10.07	21	4.66	26.32	22	15.84	89.46	114	22.89	129.28	1140
MEAN	**23**	**0.32**	**1.79**	**26**	**1.54**	**8.70**	**22**	**4.86**	**27.45**	**15**	**11.78**	**66.54**	**86**	**18.50**	**104.47**	**855**
STDEV	**9**	**0.14**	**0.78**	**8**	**0.47**	**2.68**	**9**	**2.39**	**13.48**	**5**	**4.70**	**26.56**	**26**	**5.31**	**30.02**	**262**

Appendix 5: Stand parameters at Pohama Village Forest Reserve at Mgori Forest in Singida District, Tanzania

PLOT	DBH ≤ 5 CM			5 CM <DBH ≤10 CM			10 CM <DBH ≤ 20 CM			DBH > 20 CM			TOTAL			
	N	G	V	N	G	V	N	G	V	N	G	V	N	G	V	N/HA
1	3	0.05	0.28	6	0.24	1.36	26	5.78	32.65	16	8.83	49.87	51	14.90	84.16	510
2	1	0.02	0.11	7	0.32	1.81	17	3.66	20.67	7	3.18	17.96	32	7.18	40.55	320
3	0	0.00	0.00	2	0.13	0.73	24	4.99	28.19	14	8.83	49.87	40	13.95	78.79	400
4	0	0.00	0.00	4	0.25	1.41	23	4.53	25.59	6	2.80	15.82	33	7.58	42.81	330
5	0	0.00	0.00	16	0.82	4.63	15	3.30	18.64	15	8.10	45.75	46	12.22	69.02	460
6	6	0.10	0.56	33	1.99	11.24	7	0.78	4.41	2	2.42	13.67	48	5.29	29.88	480
7	4	0.08	0.45	10	0.63	3.56	7	1.37	7.74	17	11.91	67.27	38	13.99	79.02	380
8	5	0.09	0.51	21	1.36	7.68	14	2.12	11.97	8	7.32	41.35	48	10.89	61.51	480
9	2	0.03	0.17	21	1.04	5.87	5	0.80	4.52	9	5.60	31.63	37	7.47	42.19	370
10	0	0.00	0.00	19	1.25	7.06	18	4.00	22.59	10	4.89	27.62	47	10.14	57.27	470
11	7	0.11	0.62	7	0.46	2.60	22	4.27	24.12	6	2.88	16.27	42	7.72	43.60	420
12	9	0.15	0.85	11	0.62	3.50	13	2.47	13.95	5	2.34	13.22	38	5.58	31.52	380
13	6	0.05	0.28	7	0.38	2.15	12	2.29	12.93	5	2.96	16.72	30	5.68	32.08	300
14	6	0.08	0.45	8	0.51	2.88	14	2.94	16.61	6	2.59	14.63	34	6.12	34.57	340
15	2	0.04	0.23	14	0.74	4.18	13	2.21	12.48	4	1.84	10.39	33	4.83	27.28	330
16	11	0.12	0.68	13	0.81	4.58	21	4.35	24.57	9	4.72	26.66	54	10.00	56.48	540
17	4	0.06	0.34	29	1.58	8.92	15	3.41	19.26	11	7.76	43.83	59	12.81	72.35	590
18	2	0.02	0.11	16	1.02	5.76	17	3.42	19.32	7	3.73	21.07	42	8.19	46.26	420
19	11	0.16	0.90	16	1.01	5.70	21	4.60	25.98	22	17.30	97.72	70	23.07	130.31	700
20	6	0.07	0.40	21	1.04	5.87	19	4.65	26.26	5	2.50	14.12	51	8.26	46.65	510
21	11	0.16	0.90	20	1.15	6.50	24	5.69	32.14	8	5.64	31.86	63	12.64	71.39	630
22	11	0.12	0.68	11	0.63	3.56	28	7.01	39.59	9	5.05	28.52	59	12.81	72.35	590
23	6	0.08	0.45	19	1.11	6.27	9	1.94	10.96	10	5.45	30.78	44	8.58	48.46	440
24	5	0.06	0.34	18	1.12	6.33	18	3.42	19.32	6	3.19	18.02	47	7.79	44.00	470
25	17	0.23	1.30	26	1.47	8.30	19	3.54	19.99	8	4.17	23.55	70	9.41	53.15	700
26	9	0.14	0.79	23	1.54	8.70	32	7.87	44.45	8	4.17	23.55	72	13.72	77.49	720
27	8	0.12	0.68	18	1.13	6.38	15	3.53	19.94	4	2.01	11.35	45	6.79	38.35	450
28	7	0.12	0.68	26	1.35	7.63	13	3.59	20.28	8	4.53	25.59	54	9.59	54.17	540
29	4	0.04	0.23	24	1.42	8.02	23	4.87	27.51	16	10.58	59.76	67	16.91	95.51	670
30	8	0.14	0.79	20	1.14	6.44	34	7.69	43.44	5	3.44	19.43	67	12.41	70.10	670
31	6	0.08	0.45	19	1.07	6.04	19	4.40	24.85	6	3.31	18.70	50	8.86	50.04	500

Appendix 5: continued

32	5	0.09	0.51	25	1.35	7.63	21	4.21	23.78	9	5.63	31.80	60	11.28	63.71	600
33	9	0.11	0.62	14	0.78	4.41	13	2.95	16.66	7	4.04	22.82	43	7.88	44.51	430
34	5	0.07	0.40	15	0.90	5.08	19	3.77	21.29	10	5.33	30.11	49	10.07	56.88	490
35	9	0.12	0.68	21	1.14	6.44	24	5.15	29.09	8	5.57	31.46	62	11.98	67.67	620
36	4	0.06	0.34	20	1.02	5.76	17	4.14	23.38	8	4.48	25.30	49	9.70	54.79	490
37	4	0.04	0.23	16	0.95	5.37	18	3.40	19.20	3	1.37	7.74	41	5.76	32.53	410
38	6	0.10	0.56	25	1.44	8.13	5	0.91	5.14	5	4.05	22.88	41	6.50	36.71	410
39	3	0.04	0.23	22	1.49	8.42	15	2.98	16.83	6	3.01	17.00	46	7.52	42.48	460
40	8	0.11	0.62	15	0.80	4.52	12	2.73	15.42	7	3.20	18.07	42	6.84	38.63	420
41	6	0.07	0.40	12	0.74	4.18	14	3.07	17.34	7	3.10	17.51	39	6.98	39.43	390
42	6	0.08	0.45	13	0.75	4.24	28	5.84	32.99	5	1.99	11.24	52	8.66	48.91	520
43	8	0.10	0.56	11	0.74	4.18	24	4.27	24.12	1	0.49	2.77	44	5.60	31.63	440
44	6	0.10	0.56	17	0.97	5.48	30	6.37	35.98	9	4.96	28.02	62	12.40	70.04	620
45	8	0.12	0.68	12	0.79	4.46	18	4.03	22.76	5	2.09	11.80	43	7.03	39.71	430
46	4	0.06	0.34	11	0.62	3.50	25	5.10	28.81	4	2.35	13.27	44	8.13	45.92	440
47	4	0.06	0.34	17	0.97	5.48	25	5.53	31.24	4	1.72	9.72	50	8.28	46.77	500
48	10	0.13	0.73	7	0.46	2.60	19	3.95	22.31	9	5.36	30.27	45	9.90	55.92	450
49	17	0.23	1.30	9	0.53	2.99	36	8.69	49.08	7	3.39	19.15	69	12.84	72.52	690
50	10	0.15	0.85	14	0.83	4.69	28	5.37	30.33	13	6.20	35.02	65	12.55	70.89	650
51	6	0.10	0.56	5	0.35	1.98	20	4.75	26.83	3	1.14	6.44	34	6.34	35.81	340
52	9	0.13	0.73	16	0.95	5.37	21	4.55	25.70	9	4.17	23.55	55	9.80	55.35	550
53	10	0.13	0.73	20	1.22	6.89	33	6.35	35.87	8	3.58	20.22	71	11.28	63.71	710
54	12	0.20	1.13	11	0.76	4.29	25	4.69	26.49	5	2.56	14.46	53	8.21	46.37	530
MEAN	**6.407**	**0.09**	**0.51**	**16**	**0.92**	**5.22**	**19**	**4.12**	**23.25**	**8**	**4.52**	**25.50**	**49**	**9.65**	**54.49**	**494**
STDEV	**4**	**0.05**	**0.30**	**7**	**0.39**	**2.20**	**7**	**1.70**	**9.58**	**4**	**2.93**	**16.53**	**11**	**3.39**	**19.15**	**113**

Appendix 6: Stand parameters by species and diameter class at Unyampanda Village Forest Reserve at Mgori Forest, Singida District, Tanzania

	DBH ≤ 5 CM			5 CM <DBH ≤10 CM			10 CM <DBH ≤ 20 CM			DBH > 20 CM			TOTAL			
PLOT	N	G	V	N	G	V	N	G	V	N	G	V	N	G	V	N/HA
1	8	0.06	0.35	10	0.53	2.97	9	5.60	31.63	5	7.80	44.06	32	13.99	79.01	320
2	5	0.08	0.43	20	1.36	7.68	19	3.91	22.07	6	6.67	37.67	50	12.01	67.86	500
3	14	0.20	1.12	6	0.35	1.96	23	4.69	26.49	9	7.53	42.53	52	12.77	72.11	520
4	11	0.14	0.81	35	0.54	3.03	11	1.81	10.20	1	3.72	21.01	58	6.21	35.06	580
5	18	0.10	0.56	15	0.83	4.68	7	1.25	7.03	5	4.31	24.34	45	6.48	36.62	450
6	13	0.21	1.18	12	1.11	6.30	22	6.89	38.92	2	11.82	66.76	49	20.03	113.16	490
7	28	0.18	1.00	36	0.40	2.28	28	6.97	39.37	1	6.01	33.95	93	13.56	76.60	930
8	10	0.16	0.91	6	0.44	2.49	20	5.69	32.14	8	10.05	56.77	44	16.34	92.31	440
9	15	0.24	1.35	9	0.53	2.98	14	2.87	16.23	1	10.34	58.40	39	13.98	78.95	390
10	26	0.37	2.11	19	1.01	5.69	12	2.76	15.60	2	8.31	46.94	59	12.45	70.34	590
11	12	0.10	0.59	16	0.86	4.88	20	6.59	37.22	3	3.06	17.28	51	10.62	59.97	510
12	7	0.09	0.52	15	0.85	4.82	12	2.37	13.36	0	2.14	12.09	34	5.45	30.79	340
13	8	0.09	0.52	14	0.82	4.66	13	2.96	16.73	3	7.83	44.23	38	11.71	66.13	380
14	6	0.12	0.70	20	1.08	6.12	21	6.98	39.43	5	4.64	26.21	52	12.83	72.45	520
15	11	0.09	0.51	20	0.60	3.39	15	3.00	16.97	3	5.18	29.26	49	8.87	50.12	490
16	5	0.08	0.43	14	0.87	4.89	16	4.68	26.43	10	13.56	76.59	45	19.18	108.35	450
17	9	0.08	0.43	20	0.46	2.60	13	4.30	24.29	6	5.67	32.03	48	10.51	59.35	480
18	6	0.06	0.32	18	0.40	2.26	17	4.07	22.96	4	5.06	28.58	45	9.58	54.12	450
19	12	0.08	0.43	15	0.86	4.87	20	4.79	27.03	6	8.75	49.42	53	14.47	81.76	530
20	12	0.16	0.90	14	0.71	3.98	17	3.38	19.07	6	7.55	42.64	49	11.79	66.60	490
21	9	0.18	1.03	11	0.58	3.26	15	2.81	15.86	5	6.21	35.08	40	9.78	55.22	400
22	9	0.11	0.64	12	0.69	3.90	19	3.81	21.51	2	6.18	34.91	42	10.79	60.96	420
23	11	0.04	0.21	28	0.39	2.19	10	2.42	13.68	4	5.56	31.40	53	8.41	47.48	530
24	10	0.04	0.25	33	0.78	4.42	25	7.86	44.40	6	9.50	53.66	74	18.19	102.73	740
25	9	0.13	0.76	9	1.06	5.97	16	2.88	16.25	4	8.44	47.67	38	12.51	70.65	380
26	18	0.08	0.45	12	0.71	4.03	19	6.39	36.09	2	6.49	36.66	51	13.67	77.23	510
27	10	0.07	0.40	10	0.54	3.05	19	3.96	22.36	0	8.15	46.03	39	12.72	71.85	390
28	6	0.12	0.68	29	2.04	11.50	25	8.69	49.08	9	9.40	53.09	69	20.25	114.36	690

Appendix 6: continued

29	18	0.07	0.41	13	0.85	4.81	17	3.41	19.27	3	3.47	19.60	51	7.81	44.09	510
30	9	0.10	0.59	20	0.30	1.71	22	6.86	38.75	10	14.35	81.05	61	21.62	122.09	610
31	23	0.12	0.66	40	0.95	5.34	17	4.63	26.12	10	9.56	54.00	90	15.25	86.12	900
32	5	0.05	0.29	15	1.00	5.67	9	1.46	8.23	6	4.56	25.76	35	7.07	39.94	350
33	10	0.07	0.40	12	0.76	4.27	17	3.79	21.42	1	7.19	40.61	40	11.81	66.71	400
34	10	0.11	0.64	9	0.53	2.99	16	3.10	17.52	5	7.86	44.40	40	11.61	65.56	400
35	16	0.30	1.68	10	0.61	3.44	6	1.61	9.11	8	7.30	41.23	40	9.82	55.47	400
36	12	0.28	1.60	14	0.81	4.60	14	2.56	14.46	5	8.14	45.98	45	11.80	66.64	450
MEAN	**12**	**0.13**	**0.75**	**17**	**0.74**	**4.18**	**16**	**4.16**	**23.49**	**5**	**7.29**	**41.19**	**50**	**12.32**	**69.61**	**496**
STDEV	**6**	**0.08**	**0.45**	**9**	**0.33**	**1.87**	**5**	**1.92**	**10.83**	**3**	**2.67**	**15.07**	**13**	**3.88**	**21.93**	**135**

Appendix 7: Stand parameters at Mughuunga Village Forest Reserve at Mgori Forest in Singida District, Tanzania

	DBH ≤ 5 CM			5 CM <DBH ≤10 CM			10 CM <DBH ≤ 20 CM			DBH > 20 CM			TOTAL			
PLOT	N	G	V	N	G	V	N	G	V	N	G	V	N	G	V	N/HA
1	8	0.13	0.71	20	1.11	6.25	32	15.63	88.28	5	2.17	12.28	65	19.04	107.52	650
2	6	0.09	0.53	9	0.50	2.82	7	35.60	201.08	5	2.21	12.50	27	38.41	216.93	270
3	7	0.11	0.62	16	0.34	1.91	20	8.65	48.86	3	2.18	12.30	46	11.27	63.68	460
4	5	0.08	0.47	11	0.12	0.66	9	3.98	22.48	3	1.29	7.29	28	5.47	30.91	280
5	5	0.08	0.43	20	1.14	6.41	17	6.89	38.92	7	6.98	39.43	49	15.08	85.19	490
6	5	0.07	0.40	10	0.66	3.75	12	3.65	20.62	4	1.56	8.83	31	5.95	33.59	310
7	5	0.08	0.46	8	0.41	2.34	12	6.23	35.19	6	3.30	18.63	31	10.02	56.62	310
8	17	0.25	1.42	18	1.08	6.13	19	3.79	21.43	10	8.36	47.22	64	13.49	76.20	640
9	7	0.09	0.49	7	0.44	2.47	15	4.36	24.63	5	3.68	20.79	34	8.56	48.37	340
10	7	0.10	0.55	16	0.94	5.29	25	4.38	24.75	5	2.72	15.38	53	8.14	45.97	530
11	7	0.12	0.66	10	0.55	3.10	24	4.22	23.85	9	5.08	28.67	50	9.96	56.28	500
12	20	1.21	6.83	14	0.69	3.90	18	3.50	19.75	1	0.62	3.48	53	6.01	33.96	530
13	16	0.20	1.14	26	1.50	8.45	41	12.69	71.68	19	12.20	68.89	102	26.58	150.15	1020
14	16	0.22	1.25	15	0.78	4.40	25	6.98	39.43	11	6.26	35.38	67	14.24	80.45	670
15	11	0.15	0.82	23	1.22	6.91	24	4.27	24.10	2	1.13	6.41	60	6.77	38.25	600
16	9	0.12	0.70	19	1.04	5.90	16	6.35	35.87	5	2.53	14.29	49	10.05	56.75	490
17	10	0.14	0.78	20	1.13	6.38	29	10.62	59.98	8	4.56	25.73	67	16.44	92.88	670
18	11	0.18	1.03	23	1.38	7.82	34	7.27	41.06	20	15.36	86.76	88	24.19	136.66	880
19	8	0.15	0.82	12	0.84	4.75	13	2.66	15.01	7	3.90	22.03	40	7.54	42.61	400
20	6	0.09	0.52	12	0.76	4.27	13	1.97	11.11	3	6.80	38.41	34	9.62	54.31	340
21	5	0.08	0.45	21	1.15	6.49	13	2.21	12.50	11	6.54	36.91	50	9.98	56.35	500
22	5	0.08	0.47	12	0.69	3.90	27	4.66	26.32	9	5.07	28.65	53	10.51	59.34	530
23	10	0.17	0.95	21	1.34	7.57	29	5.36	30.28	12	6.09	34.39	72	12.96	73.20	720
24	7	0.11	0.60	18	1.11	6.24	22	3.88	21.93	5	2.20	12.45	52	7.30	41.22	520
25	5	0.07	0.38	13	0.70	3.96	24	5.18	29.26	6	2.43	13.72	48	8.38	47.33	480
26	5	0.08	0.45	7	0.41	2.29	21	3.83	21.62	3	3.68	20.79	36	7.99	45.15	360
27	5	0.07	0.39	10	0.62	3.50	21	4.07	22.97	7	4.03	22.77	43	8.79	49.64	430
28	7	0.12	0.66	18	1.15	6.48	29	4.95	27.99	5	2.23	12.62	59	8.45	47.74	590
29	5	0.08	0.47	10	0.62	3.50	14	3.33	18.79	7	3.18	17.95	36	7.21	40.71	360
30	11	0.16	0.91	12	0.68	3.84	29	8.90	50.27	6	2.66	15.03	58	12.40	70.05	580
31	6	0.10	0.59	14	0.89	5.03	16	3.02	17.04	9	3.61	20.39	45	7.62	43.05	450

Appendix 7: continued

32	9	0.16	0.88	26	1.60	9.01	29	12.63	71.34	0	1.25	7.07	64	15.63	88.30	640
33	6	0.10	0.55	21	1.40	7.88	26	12.53	70.77	13	8.00	45.19	66	22.02	124.39	660
34	4	0.06	0.36	12	0.75	4.24	18	4.12	23.30	3	3.50	19.77	37	8.44	47.67	370
35	10	0.14	0.79	12	0.74	4.18	15	3.35	18.95	5	2.14	12.07	42	6.37	35.98	420
36	11	0.17	0.96	24	1.58	8.95	31	10.39	58.69	9	4.22	23.82	75	16.36	92.42	750
MEAN	**8**	**0.15**	**0.83**	**16**	**0.89**	**5.05**	**22**	**6.89**	**38.94**	**7**	**4.22**	**23.86**	**52**	**12.16**	**68.67**	**521**
STDEV	**4**	**0.19**	**1.05**	**5**	**0.37**	**2.07**	**8**	**5.91**	**33.37**	**4**	**3.06**	**17.28**	**17**	**6.77**	**38.26**	**166**

Appendix 8: Species diversity indices at Ngimu forest reserve in Mgori Forest in Singida District, Tanzania

Species	FR	N	G	RF	RD	RDo	IVI	C/SI	H'	SDI	E	SR	C
Acacia tortilis	1	4	0.05	1.16	0.39	0.01	1.57	0.000	0.02	1.63	0.01		0.001
Accacia drepandobium	1	11	4.36	1.16	1.08	0.78	3.03	0.000	0.05	1.33	0.03		0.001
Albizia harvei	1	2	0.16	1.16	0.20	0.03	1.39	0.000	0.01	1.83	0.01		0.001
Boscia salicifolia	1	2	0.21	1.16	0.20	0.04	1.40	0.000	0.01	1.83	0.01		0.001
Boscia salicifolia	1	2	0.16	1.16	0.20	0.03	1.39	0.000	0.01	1.83	0.01		0.001
Brachystegia microphylla	4	80	53.62	4.65	7.89	9.65	22.19	0.006	0.20	0.75	0.14		0.001
Brachystegia spiciformis	9	247	151.14	10.47	24.36	27.19	62.01	0.059	0.34	0.42	0.23		0.001
Canthium burtii	1	16	6.81	1.16	1.58	1.23	3.97	0.000	0.07	1.22	0.04		0.001
Cassipourea mollis	2	12	3.01	2.33	1.18	0.54	4.05	0.000	0.05	1.30	0.04		0.001
Cissus rubiginosa	1	8	2.89	1.16	0.79	0.52	2.47	0.000	0.04	1.42	0.03		0.001
Combretum collinum	1	4	0.45	1.16	0.39	0.08	1.64	0.000	0.02	1.63	0.01		0.001
Combretum molle	7	73	63.63	8.14	7.20	11.45	26.79	0.005	0.19	0.77	0.13		0.001
Combretum obovatum	1	6	1.61	1.16	0.59	0.29	2.04	0.000	0.03	1.51	0.02		0.001
Combretum zeyheri	9	59	10.53	10.47	5.82	1.89	18.18	0.003	0.17	0.84	0.11		0.001
Commiphora mosambiensis	3	17	3.82	3.49	1.68	0.69	5.85	0.000	0.07	1.20	0.05		0.001
Commiphora ngogensis	1	4	1.26	1.16	0.39	0.23	1.78	0.000	0.02	1.63	0.01		0.001
Dalbergia nitidula	8	61	32.60	9.30	6.02	5.86	21.18	0.004	0.17	0.83	0.11		0.001
Dalbergia stulhmanii	7	100	68.90	8.14	9.86	12.39	30.40	0.010	0.23	0.68	0.15		0.001
Greela arborea	1	12	4.56	1.16	1.18	0.82	3.17	0.000	0.05	1.30	0.04		0.001
Jubernadia globiflora	6	178	103.62	6.98	17.55	18.64	43.17	0.031	0.31	0.51	0.21		0.001
Kigelia africana	1	9	3.08	1.16	0.89	0.55	2.60	0.000	0.04	1.39	0.03		0.001
Lonchocarpus bussei	2	13	2.76	2.33	1.28	0.50	4.10	0.000	0.06	1.28	0.04		0.001
Markamia obtsifolia	3	21	2.93	3.49	2.07	0.53	6.09	0.000	0.08	1.14	0.05		0.001
Pseudolachostylis maprouneifolia	1	8	4.56	1.16	0.79	0.82	2.77	0.000	0.04	1.42	0.03		0.001

Appendix 8: continued

Shrebera trichoclada	3	7	2.41	3.49	0.69	0.43	4.61	0.000	0.03	1.46	0.02		0.001
Strychnos cocculoides	1	4	0.58	1.16	0.39	0.10	1.66	0.000	0.02	1.63	0.01		0.001
Terminalia sericea	3	13	4.86	3.49	1.28	0.87	5.64	0.000	0.06	1.28	0.04		0.001
Vangueria infausta	1	5	2.57	1.16	0.49	0.46	2.12	0.000	0.03	1.56	0.02		0.001
Vangueria madascaensis	4	34	18.63	4.65	3.35	3.35	11.36	0.001	0.11	1.00	0.08		0.001
Vitex mombassae	1	2	0.12	1.16	0.20	0.02	1.38	0.000	0.01	1.83	0.01		
MEAN	**3**	**34**	**18.53**	**3.33**	**3.33**	**3.33**	**10.00**	**0.004**	**0.08**	**1.28**	**0.06**		
STDEV	**3**	**56**	**35.56**	**3.10**	**5.51**	**6.40**	**14.37**	**0.012**	**0.09**	**0.40**	**0.06**		
SUM	**86**	**1014**	**555.89**	**100.00**	**100.00**	**100.00**	**300.00**	**0.121**	**2.54**	**38.46**	**1.72**		

Appendix 9: Species diversity indices at Pohama Forest Reserve in Mgori Forest in Singida District, Tanzania

Species	FR	N	G	RF	RD	RDo	IVI	C/SI	H'	SDI	E	SR	C
Acacia hockii	1	7	0.30	0.28	0.27	0.04	0.59	0.000	0.02	1.41	0.01		0.001
Acacia senegalsis	2	3	0.77	0.56	0.11	0.11	0.78	0.000	0.01	1.61	0.00		0.001
Acacia sieberana	5	17	2.28	1.40	0.65	0.33	2.38	0.000	0.03	1.20	0.02		0.001
Acacia tortilis	9	55	8.98	2.51	2.10	1.30	5.91	0.000	0.08	0.92	0.04		0.001
Acaia tanganyikensis	2	7	2.47	0.56	0.27	0.36	1.18	0.000	0.02	1.41	0.01		0.001
Accacia drepandobium	3	8	0.96	0.84	0.31	0.14	1.28	0.000	0.02	1.38	0.01		0.001
Afzelia quanzensis	3	20	3.83	0.84	0.76	0.55	2.16	0.000	0.04	1.16	0.02		0.001
Albizia antunesiana	2	9	0.75	0.56	0.34	0.11	1.01	0.000	0.02	1.35	0.01		0.001
Albizia harvei	4	29	3.16	1.12	1.11	0.46	2.68	0.000	0.05	1.07	0.03		0.001
Albizia petersiana	2	10	0.71	0.56	0.38	0.10	1.04	0.000	0.02	1.32	0.01		0.001
Azanza garckeana	4	10	1.22	1.12	0.38	0.18	1.68	0.000	0.02	1.32	0.01		0.001
Boscia angustifolia	2	16	2.09	0.56	0.61	0.30	1.47	0.000	0.03	1.21	0.02		0.001
Boscia salicifolia	12	26	3.22	3.35	0.99	0.47	4.81	0.000	0.05	1.10	0.03		0.001
Brachystegia microphylla	25	227	72.35	6.98	8.67	10.47	26.12	0.008	0.21	0.58	0.12		0.001
Brachystegia spiciformis	44	758	225.20	12.29	28.95	32.58	73.82	0.084	0.36	0.29	0.20		0.001
Bridelia duvigneaudii	1	6	0.29	0.28	0.23	0.04	0.55	0.000	0.01	1.45	0.01		0.001
Canthium burtii	2	7	0.38	0.56	0.27	0.05	0.88	0.000	0.02	1.41	0.01		0.001
Cassipourea mollis	4	37	6.13	1.12	1.41	0.89	3.42	0.000	0.06	1.01	0.03		0.001
Combretum collinum	1	13	0.70	0.28	0.50	0.10	0.88	0.000	0.03	1.26	0.01		0.001
Combretum molle	20	106	17.26	5.59	4.05	2.50	12.13	0.002	0.13	0.76	0.07		0.001
Combretum obovatum	1	9	1.12	0.28	0.34	0.16	0.79	0.000	0.02	1.35	0.01		0.001
Combretum zeyheri	14	106	12.28	3.91	4.05	1.78	9.74	0.002	0.13	0.76	0.07		0.001
Commiphora africana	1	12	1.08	0.28	0.46	0.16	0.89	0.000	0.02	1.28	0.01		0.001
Commiphora mosambiensis	20	212	80.25	5.59	8.10	11.61	25.29	0.007	0.20	0.60	0.11		0.001
Commiphora ugogensis	7	30	3.79	1.96	1.15	0.55	3.65	0.000	0.05	1.06	0.03		0.001
Dalbergia melanoxylema	6	16	3.92	1.68	0.61	0.57	2.85	0.000	0.03	1.21	0.02		0.001
Dalbergia nitidula	8	28	3.98	2.23	1.07	0.58	3.88	0.000	0.05	1.08	0.03		0.001

Appendix 9: continued

Species	FR	N	G	RF	RD	RDo	IVI	C/SI	H'	SDI	E	S R	C
Dalbergia stulhmanii	14	100	24.06	3.91	3.82	3.48	11.21	0.001	0.12	0.78	0.07		0.001
Dichrostachys cinerea	3	11	0.65	0.84	0.42	0.09	1.35	0.000	0.02	1.30	0.01		0.001
Dolichos oliveri	1	8	0.96	0.28	0.31	0.14	0.72	0.000	0.02	1.38	0.01		0.001
Erythrina abyssinica	2	7	0.19	0.56	0.27	0.03	0.85	0.000	0.02	1.41	0.01		0.001
Euphorbia candelabrum	1	6	1.37	0.28	0.23	0.20	0.71	0.000	0.01	1.45	0.01		0.001
Ficus stuhlmanii	3	7	0.71	0.84	0.27	0.10	1.21	0.000	0.02	1.41	0.01		0.001
Greela arborea	5	14	1.97	1.40	0.53	0.28	2.22	0.000	0.03	1.24	0.02		0.001
Grewia platyclada	3	11	1.65	0.84	0.42	0.24	1.50	0.000	0.02	1.30	0.01		0.001
Isoberlinia angolensis	1	10	3.52	0.28	0.38	0.51	1.17	0.000	0.02	1.32	0.01		0.001
Jubernadia globiflora	21	195	103.25	5.87	7.45	14.94	28.25	0.006	0.19	0.62	0.11		0.001
Kigelia africana	1	15	2.95	0.28	0.57	0.43	1.28	0.000	0.03	1.23	0.02		0.001
Lannea humilis	2	17	3.28	0.56	0.65	0.47	1.68	0.000	0.03	1.20	0.02		0.001
Lannea schimperi	4	104	30.71	1.12	3.97	4.44	9.53	0.002	0.13	0.77	0.07		0.001
Lonchocarpus bussei	9	32	5.55	2.51	1.22	0.80	4.54	0.000	0.05	1.05	0.03		0.001
Margaritaria discoidea	2	8	1.91	0.56	0.31	0.28	1.14	0.000	0.02	1.38	0.01		0.001
Markamia obtsifolia	3	9	1.48	0.84	0.34	0.21	1.40	0.000	0.02	1.35	0.01		0.001
Multidentia crassa	1	8	0.42	0.28	0.31	0.06	0.65	0.000	0.02	1.38	0.01		0.001
Mundulea sericea	1	7	0.80	0.28	0.27	0.12	0.66	0.000	0.02	1.41	0.01		0.001
Ormocarpum trichocarpum	1	7	0.71	0.28	0.27	0.10	0.65	0.000	0.02	1.41	0.01		0.001
Ozoroa insignis	1	2	0.17	0.28	0.08	0.02	0.38	0.000	0.01	1.71	0.00		0.001
Phylanthus ingleri	1	4	0.17	0.28	0.15	0.02	0.46	0.000	0.01	1.54	0.01		0.001
Pleurostylia africana	2	5	0.50	0.56	0.19	0.07	0.82	0.000	0.01	1.49	0.01		0.001
Pranna senensis	1	8	1.25	0.28	0.31	0.18	0.77	0.000	0.02	1.38	0.01		0.001
Pseudolachostylis maprouneifolia	1	14	1.74	0.28	0.53	0.25	1.07	0.000	0.03	1.24	0.02		0.001
Pterocarpus angolensis	9	27	5.63	2.51	1.03	0.81	4.36	0.000	0.05	1.09	0.03		0.001
Pterocarpus rotundifolius	2	6	0.88	0.56	0.23	0.13	0.92	0.000	0.01	1.45	0.01		0.001
Pyrenacantha kaurabassana	1	5	0.38	0.28	0.19	0.05	0.53	0.000	0.01	1.49	0.01		0.001
Sclerocarya birrea	6	15	2.21	1.68	0.57	0.32	2.57	0.000	0.03	1.23	0.02		0.001

Appendix 9: continued

Species	FR	N	G	RF	RD	RDo	IVI	C/SI	H'	SDI	E	SR	C
Shrebera trichoclada	5	23	2.34	1.40	0.88	0.34	2.61	0.000	0.04	1.13	0.02		0.001
Solanum incanum	1	8	0.45	0.28	0.31	0.07	0.65	0.000	0.02	1.38	0.01		0.001
Strychnos cocculoides	1	3	0.15	0.28	0.11	0.02	0.42	0.000	0.01	1.61	0.00		0.001
Strychrios potaforum	11	38	3.76	3.07	1.45	0.54	5.07	0.000	0.06	1.01	0.03		0.001
Terminalia sericea	6	13	2.93	1.68	0.50	0.42	2.60	0.000	0.03	1.26	0.01		0.001
Tricalysia ruandensis	2	10	4.16	0.56	0.38	0.60	1.54	0.000	0.02	1.32	0.01		0.001
Vangueria infausta	3	10	0.30	0.84	0.38	0.04	1.26	0.000	0.02	1.32	0.01		0.001
Vangueria madascaensis	3	16	2.15	0.84	0.61	0.31	1.76	0.000	0.03	1.21	0.02		0.001
Vitex mombassae	5	15	12.25	1.40	0.57	1.77	3.74	0.000	0.03	1.23	0.02		0.001
Xeroderris stunhlmannii	10	17	2.44	2.79	0.65	0.35	3.80	0.000	0.03	1.20	0.02		0.001
Ximenia caffra	3	11	0.56	0.84	0.42	0.08	1.34	0.000	0.02	1.30	0.01		0.001
Zanha africana	1	8	1.26	0.28	0.31	0.18	0.77	0.000	0.02	1.38	0.01		0.001
MEAN	**5**	**39**	**10.32**	**1.49**	**1.49**	**1.49**	**4.48**	**0.002**	**0.05**	**1.22**	**0.02**		**0.001**
STDEV	**7**	**101**	**32.20**	**2.01**	**3.84**	**4.66**	**10.28**	**0.010**	**0.06**	**0.27**	**0.03**		**0.000**
SUM	**358**	**2618**	**691.29**	**100.00**	**100.00**	**100.00**	**300.00**	**0.11**	**3.04**	**81.90**	**1.66**	**19.31**	**0.044**

Appendix10: Species diversity indices at Unyampanda Forest Reserve in Mgori Forest in Singida District, Tanzania

Species	FR	N	G	RF	RD	RDo	IVI	C/SI	H'	SDI	E	SR	C
Acacia hockii	1	3	0.04	0.35	0.20	0.01	0.56	0.000	0.01	1.50	0.00		0.002
Acacia senegalsis	1	2	1.14	0.35	0.13	0.14	0.62	0.000	0.01	1.60	0.00		0.002
Acacia sieberana	5	10	2.63	1.77	0.66	0.32	2.74	0.000	0.03	1.21	0.01		0.002
Acacia tortilis	2	11	5.12	0.71	0.72	0.62	2.05	0.000	0.04	1.19	0.01		0.002
Acaia tanganyikensis	2	5	4.09	0.71	0.33	0.50	1.53	0.000	0.02	1.38	0.01		0.002
Accacia drepandobium	6	10	16.10	2.12	0.66	1.96	4.73	0.000	0.03	1.21	0.01		0.002
Adansonia digitata	4	7	2.36	1.41	0.46	0.29	2.16	0.000	0.02	1.29	0.01		0.002
Afzelia quanzensis	3	8	2.50	1.06	0.52	0.30	1.89	0.000	0.03	1.26	0.01		0.002
Albizia antunesiana	2	5	5.65	0.71	0.33	0.69	1.72	0.000	0.02	1.38	0.01		0.002
Albizia harvei	1	5	1.23	0.35	0.33	0.15	0.83	0.000	0.02	1.38	0.01		0.002
Albizia zetersiana	1	8	2.56	0.35	0.52	0.31	1.19	0.000	0.03	1.26	0.01		0.002
Azanza garckeana	2	9	3.45	0.71	0.59	0.42	1.72	0.000	0.03	1.23	0.01		0.002
Boscia angustifolia	1	10	2.87	0.35	0.66	0.35	1.36	0.000	0.03	1.21	0.01		0.002
Boscia salicifolia	3	5	2.35	1.06	0.33	0.29	1.67	0.000	0.02	1.38	0.01		0.002
Brachystegia microphylla	26	141	56.89	9.19	9.24	6.92	25.34	0.009	0.22	0.57	0.08		0.002
Brachystegia spiciformis	33	446	165.58	11.66	29.23	20.13	61.02	0.085	0.36	0.30	0.13		0.002
Bridelia duvigneaudii	1	3	1.09	0.35	0.20	0.13	0.68	0.000	0.01	1.50	0.00		0.002
Canthium burtii	2	11	7.69	0.71	0.72	0.93	2.36	0.000	0.04	1.19	0.01		0.002
Cassipourea mollis	7	17	23.77	2.47	1.11	2.89	6.48	0.000	0.05	1.08	0.02		0.002
Combretum molle	17	86	43.65	6.01	5.64	5.31	16.95	0.003	0.16	0.69	0.06		0.002
Combretum zeyheri	11	44	45.10	3.89	2.88	5.48	12.25	0.001	0.10	0.85	0.04		0.002
Commiphora africana	2	7	4.27	0.71	0.46	0.52	1.68	0.000	0.02	1.29	0.01		0.002
Commiphora mosambiensis	20	105	68.90	7.07	6.88	8.38	22.32	0.005	0.18	0.64	0.07		0.002
Commiphora ngogensis	6	9	4.50	2.12	0.59	0.55	3.26	0.000	0.03	1.23	0.01		0.002
Dalbergia melanoxylema	1	3	1.23	0.35	0.20	0.15	0.70	0.000	0.01	1.50	0.00		0.002
Dalbergia nitidula	1	3	1.28	0.35	0.20	0.16	0.71	0.000	0.01	1.50	0.00		0.002
Dalbergia stuhlmanii	2	6	5.45	0.71	0.39	0.66	1.76	0.000	0.02	1.33	0.01		0.002
Dichrostachys cinerea	2	3	5.86	0.71	0.20	0.71	1.62	0.000	0.01	1.50	0.00		0.002
Dolichos oliveri	4	20	12.80	1.41	1.31	1.56	4.28	0.000	0.06	1.04	0.02		0.002

Appendix 10: continued

Species	FR	N	G	RF	RD	RDo	IVI	C/SI	H'	SDI	E	SR	C
Erythrina abyssinica	1	1	0.79	0.35	0.07	0.10	0.51	0.000	0.00	1.76	0.00		0.002
Euphorbia candelabrum	1	2	1.29	0.35	0.13	0.16	0.64	0.000	0.01	1.60	0.00		0.002
Ficus stuhlmanii	2	4	1.42	0.71	0.26	0.17	1.14	0.000	0.02	1.43	0.01		0.002
Greela arborea	3	11	9.07	1.06	0.72	1.10	2.88	0.000	0.04	1.19	0.01		0.002
Grewia platyclada	4	27	10.49	1.41	1.77	1.28	4.46	0.000	0.07	0.97	0.03		0.002
Hymenodictyon parvifolium	2	3	1.92	0.71	0.20	0.23	1.14	0.000	0.01	1.50	0.00		0.002
Isoberlinia angolensis	2	7	1.18	0.71	0.46	0.14	1.31	0.000	0.02	1.29	0.01		0.002
Jubernadia globiflora	18	167	60.25	6.36	10.94	7.32	24.63	0.012	0.24	0.53	0.09		0.002
Jubernadia angolensis	3	6	4.37	0.71	0.39	0.53	1.63	0.000	0.02	1.33	0.01		0.002
Kigelia africana	2	12	2.68	0.71	0.79	0.33	1.82	0.000	0.04	1.17	0.01		0.002
Lannea humilis	2	7	3.46	0.71	0.46	0.42	1.59	0.000	0.02	1.29	0.01		0.002
Lannea schimperi	3	19	27.06	1.06	1.25	3.29	5.59	0.000	0.05	1.05	0.02		0.002
Lonchocarpus bussei	12	39	36.25	4.24	2.56	4.41	11.20	0.001	0.09	0.88	0.03		0.002
Margaritaria discoidea	2	17	7.80	0.71	1.11	0.95	2.77	0.000	0.05	1.08	0.02		0.002
Markamia lutea	2	1	2.01	0.71	0.07	0.24	1.02	0.000	0.00	1.76	0.00		0.002
Markamia obtsifolia	7	15	8.96	2.47	0.98	1.09	4.55	0.000	0.05	1.11	0.02		0.002
Mundulea sericea	1	7	4.99	0.35	0.46	0.61	1.42	0.000	0.02	1.29	0.01		0.002
Ormocarpum trichocarpum	2	6	4.37	0.71	0.46	0.21	1.38	0.000	0.02	1.29	0.01		0.002
Ozoroa insignis	2	7	1.76	1.41	0.39	0.52	2.33	0.000	0.02	1.33	0.01		0.002
Pleuurostylia africana	4	6	4.29	0.35	0.07	0.10	0.51	0.000	0.00	1.76	0.00		0.002
Pramna senensis	1	1	0.79	0.71	0.46	0.31	1.48	0.000	0.02	1.29	0.01		0.002
Pseudolachostylis maprouneifolia	2	7	2.56	0.71	0.79	1.43	2.92	0.000	0.04	1.17	0.01		0.002
Pterocarpus angolensis	2	12	11.76	1.06	0.72	1.91	3.70	0.000	0.04	1.19	0.01		0.002
Pterocarpus rotundifolius	3	11	15.75	0.35	0.13	0.24	0.72	0.000	0.01	1.60	0.00		0.002
Sclerocarya birrea	1	2	1.97	1.41	0.92	1.86	4.19	0.000	0.04	1.13	0.02		0.002
Solanum incanum	4	14	15.28	0.35	0.26	0.17	0.78	0.000	0.02	1.43	0.01		0.002
Strychnos cocculoides	1	4	1.36	0.35	0.20	0.14	0.69	0.000	0.01	1.50	0.00		0.002
Strychrios potaforum	1	3	1.15	1.41	1.38	2.06	4.85	0.000	0.06	1.03	0.02		0.002
Terminalia mollis	4	21	16.93	1.06	0.46	0.32	1.84	0.000	0.02	1.29	0.01		0.002

Appendix 10: continued

Species	FR	N	G	RF	RD	RDo	IVI	C/SI	H'	SDI	E	SR	C
Terminalia mollis	3	7	2.62	1.06	0.46	0.32	1.84	0.000	0.02	1.29	0.01		0.002
Terminalia sericea	7	35	31.30	2.47	2.29	3.80	8.57	0.001	0.09	0.91	0.03		0.002
Vangueria infausta	2	16	11.90	0.71	1.05	1.45	3.20	0.000	0.05	1.10	0.02		0.002
Vangueria madascaensis	2	9	3.56	0.71	0.59	0.43	1.73	0.000	0.03	1.23	0.01		0.002
Vitex mombassae	2	3	2.19	0.71	0.20	0.27	1.17	0.000	0.01	1.50	0.00		0.002
Xeroderris stunhlmannii	2	8	8.84	0.71	0.52	1.07	2.31	0.000	0.03	1.26	0.01		0.002
Ximenia caffra	3	7	3.21	1.06	0.46	0.39	1.91	0.000	0.02	1.29	0.01		0.002
Zanha africana	2	6	1.28	0.71	0.39	0.16	1.26	0.000	0.02	1.33	0.01		0.002
MEAN	**4**	**23**	**12.66**	**1.54**	**1.54**	**1.54**	**4.62**	**0.002**	**0.05**	**1.24**	**0.02**		**0.002**
STDEV	**6**	**61**	**24.52**	**2.13**	**4.01**	**2.98**	**8.90**	**0.011**	**0.06**	**0.28**	**0.02**		**0.000**
SUM	**283**	**1526**	**822.646**	**100**	**100**	**100.00**	**300.00**	**0.118**	**2.97**	**80.57**	**1.06**	**19.79**	**0.114**

Appendix 11: Species diversity indices at Mughuunga Forest Reserve in Mgori Forest in Singida District, Tanzania

Species	FR	N	G	RF	RD	RDo	IVI	C/SI	H'	SDI	E	SR	C
Acacia hockii	2	3	1.25	0.65	0.16	0.20	1.01	0.000	0.01	1.52	0.01		0.002
Acacia senegalsis	2	9	1.53	0.65	0.47	0.25	1.37	0.000	0.03	1.26	0.01		0.002
Acacia sieberana	3	3	0.40	0.97	0.16	0.06	1.20	0.000	0.01	1.52	0.01		0.002
Acacia tortilis	2	5	0.54	0.65	0.26	0.09	1.00	0.000	0.02	1.40	0.01		0.002
Acaia tanganyikensis	2	4	0.69	0.65	0.21	0.11	0.97	0.000	0.01	1.45	0.01		0.002
Accacia drepandobium	2	2	0.21	0.65	0.10	0.03	0.79	0.000	0.01	1.61	0.00		0.002
Adansonia digitata	1	2	0.68	0.32	0.10	0.11	0.54	0.000	0.01	1.61	0.00		0.002
Afzelia quanzensis	5	16	2.59	1.62	0.84	0.42	2.88	0.000	0.04	1.13	0.02		0.002
Albizia antunesiana	1	3	0.18	0.32	0.16	0.03	0.51	0.000	0.01	1.52	0.01		0.002
Albizia harvei	2	3	0.32	0.65	0.16	0.05	0.86	0.000	0.01	1.52	0.01		0.002
Azanza garckeana	1	3	0.11	0.32	0.16	0.02	0.50	0.000	0.01	1.52	0.01		0.002
Boscia angustifolia	1	5	0.93	0.32	0.26	0.15	0.74	0.000	0.02	1.40	0.01		0.002
Boscia salicifolia	6	11	0.97	1.95	0.58	0.16	2.68	0.000	0.03	1.21	0.02		0.002
Brachystegia microphylla	16	107	44.63	5.19	5.62	7.22	18.03	0.003	0.16	0.68	0.09		0.002
Brachystegia spiciformis	33	530	315.60	10.71	27.82	51.07	89.61	0.077	0.36	0.30	0.19		0.002
Bridelia duvigneaudii	1	3	0.45	0.32	0.16	0.07	0.55	0.000	0.01	1.52	0.01		0.002
Canthium burtii	6	21	2.91	1.95	1.10	0.47	3.52	0.000	0.05	1.06	0.03		0.002
Cassipourea mollis	9	43	4.74	2.92	2.26	0.77	5.95	0.001	0.09	0.89	0.05		0.002
Cissus rubiginosa	1	5	0.49	0.32	0.26	0.08	0.67	0.000	0.02	1.40	0.01		0.002
Combretum molle	11	62	6.88	3.57	3.25	1.11	7.94	0.001	0.11	0.81	0.06		0.002
Combretum obovatum	6	19	2.26	1.95	1.00	0.37	3.31	0.000	0.05	1.08	0.02		0.002
Combretum zeyheri	7	58	11.22	2.27	3.04	1.82	7.13	0.001	0.11	0.82	0.06		0.002
Commellina beghalensis	7	36	6.60	2.27	1.89	1.07	5.23	0.000	0.08	0.93	0.04		0.002
Commiphora africana	1	3	0.27	0.32	0.16	0.04	0.53	0.000	0.01	1.52	0.01		0.002
Commiphora mosambiensis	22	169	28.96	7.14	8.87	4.69	20.70	0.008	0.22	0.57	0.12		0.002
Commiphora ngogensis	4	4	0.33	1.30	0.21	0.05	1.56	0.000	0.01	1.45	0.01		0.002
Dalbergia melanoxylema	4	11	1.46	1.30	0.58	0.24	2.11	0.000	0.03	1.21	0.02		0.002
Dalbergia nitidula	10	60	9.18	3.25	3.15	1.49	7.88	0.001	0.11	0.81	0.06		0.002
Dalbergia stulhmanii	5	18	2.54	1.62	0.94	0.41	2.98	0.000	0.04	1.10	0.02		0.002

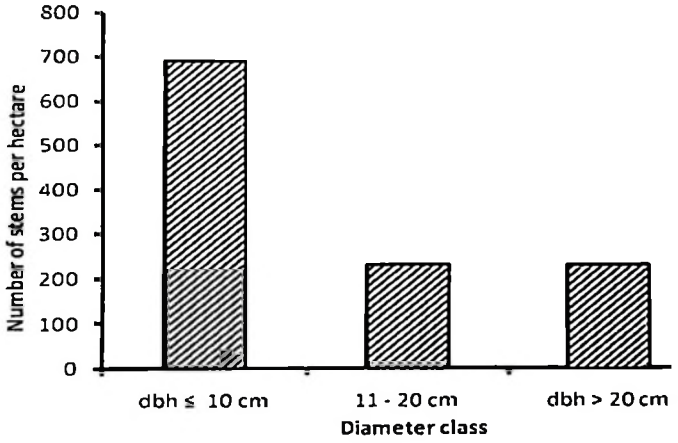
Appendix 11: continued

Species	FR	N	G	RF	RD	RDo	IVI	C/SI	H'	SDI	E	SR	C
Dichrostachys cinerea	2	6	1.38	0.65	0.31	0.22	1.19	0.000	0.02	1.36	0.01		0.002
Diospyros usambarensis	1	5	0.62	0.32	0.26	0.10	0.69	0.000	0.02	1.40	0.01		0.002
Dolichos oliveri	1	3	0.58	0.32	0.16	0.09	0.58	0.000	0.01	1.52	0.01		0.002
Erythrina abyssinica	3	4	0.19	0.97	0.21	0.03	1.21	0.000	0.01	1.45	0.01		0.002
Euphorbia candelabrum	1	3	0.31	0.32	0.16	0.05	0.53	0.000	0.01	1.52	0.01		0.002
Ficus stuhlmanii	1	4	0.43	0.32	0.21	0.07	0.60	0.000	0.01	1.45	0.01		0.002
Grewia platyclada	1	10	1.67	0.32	0.52	0.27	1.12	0.000	0.03	1.24	0.01		0.002
Hymenodictyon parvifolium	1	4	0.41	0.32	0.21	0.07	0.60	0.000	0.01	1.45	0.01		0.002
Jubernadia globiflora	23	291	107.46	7.47	15.28	17.39	40.13	0.023	0.29	0.44	0.16		0.002
Kigelia africana	2	3	0.62	0.65	0.16	0.10	0.91	0.000	0.01	1.52	0.01		0.002
Lannea humilis	4	19	2.18	1.30	1.00	0.35	2.65	0.000	0.05	1.08	0.02		0.002
Lannea schimperi	7	25	4.86	2.27	1.31	0.79	4.37	0.000	0.06	1.02	0.03		0.002
Lonchocarpus bussei	12	59	10.50	3.90	3.10	1.70	8.69	0.001	0.11	0.82	0.06		0.002
Margaritaria discoidea	2	7	0.33	0.65	0.37	0.05	1.07	0.000	0.02	1.32	0.01		0.002
Markamia lutea	1	10	0.32	0.32	0.52	0.05	0.90	0.000	0.03	1.24	0.01		0.002
Markamia obtsifolia	3	7	1.70	0.97	0.37	0.28	1.62	0.000	0.02	1.32	0.01		0.002
Multidentia crassa	2	6	0.83	0.65	0.31	0.13	1.10	0.000	0.02	1.36	0.01		0.002
Mundulea sericea	1	5	1.50	0.32	0.26	0.24	0.83	0.000	0.02	1.40	0.01		0.002
Ormmocarpum trichocarpum	1	2	0.50	0.32	0.10	0.08	0.51	0.000	0.01	1.61	0.00		0.002
Ozoroa insignis	1	4	1.12	0.32	0.21	0.18	0.72	0.000	0.01	1.45	0.01		0.002
Pavetta schumanniana	1	7	0.51	0.32	0.37	0.08	0.77	0.000	0.02	1.32	0.01		0.002
Phylanthus ingleri	2	2	0.57	0.65	0.10	0.09	0.85	0.000	0.01	1.61	0.00		0.002
Pleuurostylia africana	1	8	0.78	0.32	0.42	0.13	0.87	0.000	0.02	1.29	0.01		0.002
Pramna senensis	1	4	0.23	0.32	0.21	0.04	0.57	0.000	0.01	1.45	0.01		0.002
Pseudolachostylis maprouneifolia	1	4	1.25	0.32	0.21	0.20	0.74	0.000	0.01	1.45	0.01		0.002
Pterocarpus angolensis	12	30	4.54	3.90	1.57	0.73	6.21	0.000	0.07	0.98	0.04		0.002
Pterocarpus rotundifolius	3	6	1.38	0.97	0.37	0.22	1.56	0.000	0.02	1.32	0.01		0.002

Appendix 11: continued

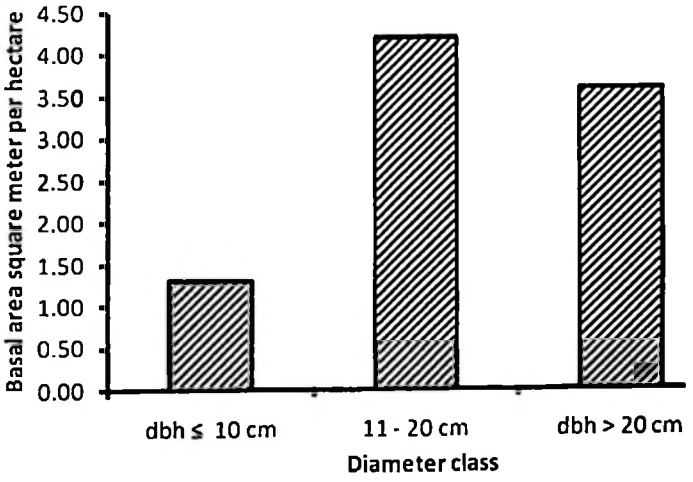
Species	FR	N	G	RF	RD	RDo	IVI	C/SI	H'	SDI	E	SR	C
Pyrenacantha kaurabassana	1	2	0.13	0.32	0.10	0.02	0.45	0.000	0.01	1.61	0.00		0.002
Schreberia tricoclada	1	2	0.33	0.32	0.10	0.05	0.48	0.000	0.01	1.61	0.00		0.002
Sclerocarya birrea	8	29	5.47	2.60	1.52	0.89	5.00	0.000	0.06	0.99	0.03		0.002
Solanum incanum	1	3	0.18	0.32	0.16	0.03	0.51	0.000	0.01	1.52	0.01		0.002
Strychnos cocculoides	1	8	0.94	0.32	0.42	0.15	0.90	0.000	0.02	1.29	0.01		0.002
Strychrios potaforum	8	34	4.95	2.60	1.78	0.80	5.18	0.000	0.07	0.95	0.04		0.002
Terminalia sericea	7	17	2.90	2.27	0.89	0.47	3.63	0.000	0.04	1.11	0.02		0.002
Tricalysia ruandensis	2	3	0.31	0.65	0.16	0.05	0.86	0.000	0.01	1.52	0.01		0.002
Vangueria infausta	1	2	0.36	0.32	0.10	0.06	0.49	0.000	0.01	1.61	0.00		0.002
Vangueria madascaensis	2	4	0.20	0.65	0.21	0.03	0.89	0.000	0.01	1.45	0.01		0.002
Vitex mombassae	4	2	0.30	1.30	0.10	0.05	1.45	0.000	0.01	1.61	0.00		0.002
Xeroderris stunhlmannii	4	32	4.75	1.30	1.68	0.77	3.75	0.000	0.07	0.96	0.04		0.002
Ximenia caffra	1	2	0.04	0.32	0.10	0.01	0.44	0.000	0.01	1.61	0.00		0.002
Zanha africana	3	8	1.41	0.97	0.42	0.23	1.62	0.000	0.02	1.29	0.01		0.002
MEAN	**6**	**27**	**617.96**	**1.43**	**1.43**	**1.43**	**4.29**	**0.002**	**0.04**	**1.28**	**0.02**		**0.002**
STDEV	**4**	**74**	**8.83**	**1.87**	**3.89**	**6.44**	**11.83**	**0.010**	**0.06**	**0.30**	**0.03**		**0.000**
SUM	**308**	**1905**	**39.77**	**100.00**	**100.00**	**100.00**	**300.00**	**0.119**	**2.92**	**89.36**	**1.58**	**21.04**	**0.106**

(a)

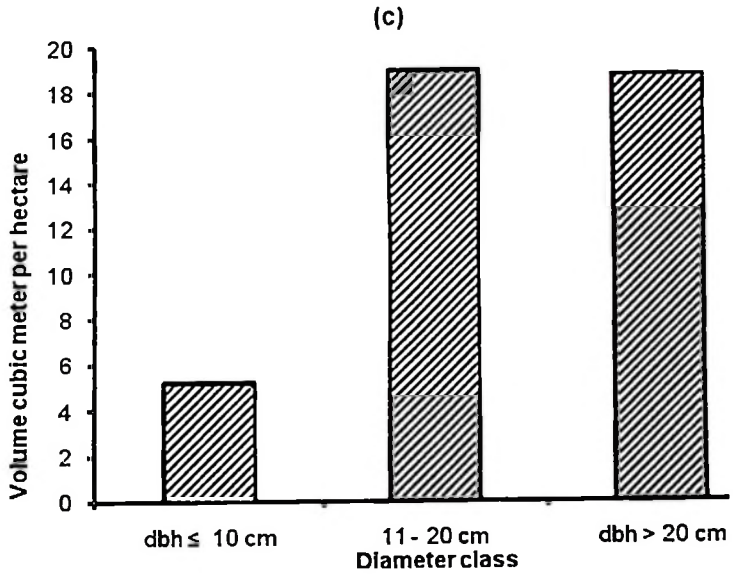


Appendix 12: Distribution of stems (N ha^{-1}) in Mgori Forest Reserve, Singida District, Tanzania

(b)



Appendix 13: Distribution of basal area (m^2 ha^{-1}) in Mgori Forest Reserve, Singida District, Tanzania



Appendix 14: Distribution of volume (m^3 ha^{-1}) in Mgori Forest Reserve, Singida District, Tanzania