WOODY SPECIES AND SOCIOECONOMICS CONTRIBUTION OF FOREST UNDER PARTICIPATORY FOREST MANAGEMENT: A CASE FROM BELETE FOREST SOUTHWEST ETHIOPIA

M.SC THESIS

BY

WONDIMAGEGN MENGIST KIBRET

JIMMA, ETHIOPIA

JUNE 2013

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M.SC THESIS

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APPROVAL SHEET

Jimma University College of Agriculture and Veterinary Medicine

Department of Natural Resource Management

Thesis Submission for External Defense Request Form (F-07)

Name of student: **Wondimagegn Mengist Kibret**, ID No. **00538/04**

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I have incorporated the suggestion and modifications given during the internal thesis defense and got the approval of my advisors. Hence, I hereby kindly request the Department to allow me to submit my thesis for external thesis defense.

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We, the Thesis advisors have verified that the student has incorporated the suggestions and modifications given during the internal thesis defense and the thesis is ready to be submitted. Hence, we recommend the thesis for external thesis defense.

Major Advisor: ______________________ ____________ ____________

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Decision/suggestion of Department of Graduate Council (DGC)

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Chair Person, DGC Signature Date

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Chair Person, CGC Signature Date

DEDICATION

Dedicated to my late father Mengist Kibret Belayneh

DECLARATION

I hereby declare that this thesis entitled **Woody Species and Socioeconomics Contribution of Forest under Participatory Forest Management a Case from Belete Forest Southwest Ethiopia** is my own work except wherever acknowledged. No part of this thesis has been submitted to any other university.

Name: Wondimagegn Mengist Kibret

Place__Jimma University__________

Date of submission___July 18/2013_

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BIOGRAPHICAL SKETCH

Wondimagegn Mengist Kibret was born on 19 December 1981 in Shewarobit town, North Shewa of Amhara Regional State, Ethiopia. He grew up in Shewarobit town and graduated from Shewarobit High School in 1999. In 2000, he joined the then Alemaya University presently Haramaya university and earned a Bachelor's Degree in Geography in 2003. He worked in SNNPR, Kefa zone for one year. From Kefa zone, he moved to Shashemene where he worked for nearly 7 years in Ethiopia Adventist college academy. While at Shashemene, he continued to attain weekend program in Hawassa University from 2007/8-2010/11 and earned another degree in Sociology. In 2011/12, he returned to Jimma University to earn a Master's degree in Natural Resource Management, specializing in Forest and Nature Conservation.

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ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
BA	Basal Area
CBD	Convention on Biological Diversity
CBNRM	Community Based Natural Resource Management
CF	Community Forestry
CV	Coefficient of Variation
DBH	Diameter at Breast Height
EC	Ethiopian Calendar
EFAP	Ethiopian Forestry Action Program
EPA	Environmental Protection Authority
ETB	Ethiopian Birr
FAO	Food and Agriculture Organization
FARM/SOS	FARM-Africa and SOS Sahel Ethiopia
FMA	Forest Management Agreement
FPA	Forest Priority Area
GFRA	Global Forest Resource Assessment
GPS	Global Positioning System
GTZ	German Technical Cooperation
ICDP	Integrated Conservation and Development Program
IUCN	International Union for the Conservation of Nature
IUFRO	International Union Forestry Research Organization
JFM	Joint Forest Management
JICA	Japanese International Cooperative Agency
IVI	Importance Value Index
MEA	Millennium Ecosystem Assessment
NGO	Non Governmental Organization
NTFPs	Non-Timber Forest Products
ODI	Overseas Development Institute
PFM	Participatory Forest Management
PFMA	Participatory Forest Management Agreement
RAFI	Relative Annual Forest Income
RNFE	Rural Non-Farm Economy
SNNPRs	Southern Nations Nationalities and Peoples Regional states
SPSS	Statistical Package for Social Sciences
TAFI	Total Annual Forest Income
TAHI	Total Annual Household Income
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
US	United States

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF TABLES IN THE APPENDIX

ABSTRACT

There has been a paradigm shift concerning forest management strategy from state centered approach to local people participation in Ethiopia. The study was designed to assess forest under participatory forest management system on their status and socioeconomics contribution to rural people. From both forest blocks, two forest fragments were randomly selected of which woody plant data were collected. The main plots of 20m x 20m and nested plots10m x 10m, 1m x 1m were laid systematically on parallel transect line. The nested subplots were established within the main quadrates. From each main plot and nested plot of 10mx10m woody plant species were counted, diameter at breast height (DBH) and height of trees and shrubs were measured. Seedlings of tree and shrub species were counted in 1mx1m-nested plots. Household survey and key informant interview was conducted to generate information on socioeconomics contribution of forest resource to rural people. Mean comparison using one sample as well as independent sample t-test and regression analysis were used to evaluate differences between the two forest blocks, and contribution of forest incomes. Fifty-five and 45 species were identified in forest without coffea and with coffea respectively. The density and basal area of woody vegetation per hectare were 17500 individuals' stems, 19.9 m^2 and 10791 individuals' stems, 18.7 m^2 in both forest blocks respectively. The overall Shannon diversity and evenness index of the forest without coffea was 2.98 and 0.74 while 2.13 and 0.56 for the forest managed for coffea. The result showed that the two forest blocks had variation in species composition, stem density, importance value index (IVI), diversity and evenness indexes. These diversity value revealed that forests managed for coffea were the most disturbed and the woody species composition has shown declining trend. There was difference between the two forests in stem density at sapling stage (t=19.134, p=0.035), and number of species at seedling stage (t=21.5, p=0.030). However, no statistical variation at seedling and mature tree level in stem density and at sapling and mature tree in species availability. Forest resource has a lot contribution to both forest users for home uses and as sources of cash income by selling produces of forest coffea, spices, and honey. The finding showed forest users had significant variation on income derived from forest coffea (p= 0.000). However, they had no significant variation in terms of income derived from honey (p=0.451) and spices (p=0.067). Similarly, the independent sample t-test revealed existence of very significant difference between the two forest users in total income from forests. Therefore, the forest with coffee needs some protective mechanism to improve woody species availability inside the forest, but the forest user without coffee should increased their forest income sources from the forest through maximizing outputs of non timber forest products.

Key words: Disturbance, diversity, livelihoods, natural forest, woody species

1. INTRODUCTION

1.1 Background and Justification of the Study

Forests are the most diverse terrestrial ecosystems and have important economic, social, and cultural roles for hundreds of millions of indigenous and local people worldwide. It provides livelihoods, through production of timber, pulpwood, firewood, fodder, meat, and medicinal plants (Gonzalez-Rivas, 2005). Tropical forest ecosystems host at least two-thirds of the earth's terrestrial biodiversity and provide significant local, regional, and global benefits for millions of people through the provision of economic goods and ecosystem services (Olander *et al*., 2008; Gardner *et al*., 2009). Tropical forests are also critical for the global climate as they sequester carbon from the atmosphere and therefore mitigate climate change (Millennium Ecosystem Assessment, 2005). However, tropical forest landscapes are changing rapidly as human populations and economies grow, and land-use pattern changes (Dirzo and Raven, 2003; Wright, 2005). It has to be noted that Ethiopia is one of the centers of plant genetic diversity and endowed with rich fauna and flora because of diverse ecological features, which make the country an important centre of diversity and endemism (EPA, 1998; Leul Kidane Woldemichael *et al.,* 2010). The Ethiopian rainforests are internationally renowned for their high biodiversity and their wild coffee (*Coffea arabica*) populations, but are severely threatened by deforestation (Schmitt and Grote, 2006). Similarly most of the natural forests in southwest Ethiopia, that is the moist evergreen montane forests as well as the largest forest reserves of the country, have been severely degraded and the remaining forests are highly fragmented which in turn affecting the associated biodiversity (Tadesse Woldemariam, 2003; Convention on Biological Diversity, 2009; Badege Bishaw, 2009). This continued exploitation of natural forests without giving due consideration to their propagation, domestication and cultivation has resulted in forest destruction that has led to increased scarcity and/or rarity of resources which in turn have resulted in increased demand and subsequent further destruction (Zewge Teklehaimanot and Healey, 2001).

The major reasons behind high degradation of forests are human interference through expansion of agricultural land, over grazing, firewood, and poverty. In addition, low agricultural productivity and standard of living, lack of alternatives and appropriate land use have all aggravated the situation (FAO, 2003). Forest resource depletion through such unlawful acts remained a common feature of developing countries like Ethiopia (Melaku Bekele and Tsegaye Bekele, 2005).

The situation was aggravated in Ethiopia due to centralized forest management administration over the last 50 years. In Ethiopia, the previous forest policy has negatively affected the forest resource by restricting local communities' access and user rights (Bedru Babulo, 2007). This centralized and exclusionary management system resulted in growing hostility between local communities and the forest resources. Also accordingly, the rules and regulations were directed towards exclusion of people from the forests. With such conventional forest management policies and strategies, Ethiopian governments usually fail to manage and promote the sector for the socioeconomic and environmental benefit of the people (Bekele Million, 2001). The reason was that such government approach appeared not compatible with communities' perception of access rights to forest products and their demands for forest ownership. The approach also undermined the roles of local communities, their traditional institutions and knowledge in forest management practices, and considered local communities as destroyers of the forests. In addition, successive governments also failed to allocate sufficient human and economic resources to manage nationalized forests in sustainable way (Tsegaye Gobeze *et al.,* 2009). For instance, hundred years ago, about 40-35 percent of land was covered by forest in Ethiopia (IUCN, 1990; EFAP, 1994; Bedru Babulo, 2007; Badege Bishaw, 2009). In the early 1950s the forests that remained covered 16 percent and in the 1980s the coverage was reported at 3.6 percent and further declined to 2.7 percent in the early 1990s (Bekele Million, 2001). The estimate of the remaining forest cover in Ethiopia is still contradictory among different sources (EFAP, 1994; FAO, 2005; Bediru Babulo, 2007; Badege Bishaw, 2009). Although, remaining forest cover is argumentative, all sources suggests that severe deforestation was taking place in Ethiopia during past time and the process of entire destruction and deforestation of natural forests was accomplished in less than a century time (Woien, 1995). In connection, the species composition and the tree density have been decreasing in almost all forested areas, which consist now mainly of deformed and over aged trees. Natural regeneration is scarce due to the high impact of domestic animals (FAO, 2003).

Therefore, the response to the problems of deforestation and forest degradation in many developing countries in the tropics has been the devolution of forest areas to local communities (Tassa *et al.,* 2010). With this, participatory forest management (PFM) is being adopted widely in many developing countries as an alternative method of managing forestry resources (Wily, 2002). The idea that community participation is central to effective natural resource management has been recognized in a number of international environmental conventions. It was given a prominent place in the 1992 Rio Earth Summit and the 1994 UN Convention to Combat Desertification (Amanor, 2003).

The involvement of local communities in forest management is currently a significant feature of national forest policy and practice and of internationally supported forestry programs through out the world (Poffenberger, 2000; Shackleton *et al*., 2002). Its growing popularity is reflected in the ratification of community forest related laws, the adoption of supportive policies, the expanding investments of bi-lateral and multi-lateral agencies in community forest programs, the broadening engagement of non-governmental organizations (NGOs) and academic institutions in community forestry activities and the emergence of community-based forestry networks and associations (Poffenberger, 2006).

In line with this, there has been a move in eastern, western, and southern African countries from centralized and state-driven management of natural resources towards decentralized and people-centered based regimes (Kajembe *et al*., 2003; Amanor, 2003). It is increasingly being used as an approach through which to achieve the sustainability of threatened forests and conservation of biodiversity. This is done through a process of inclusion, equity, and democratization of governance of the forest resources (Amanor, 2003). This new global trend in natural resources management is promoting local control and management of forests (Kobbail, 2010). Similarly, in Ethiopia PFM initiatives were started in the 1990s after conventional methods have proved to be inefficient (Girma Amente and Tsegaye Tadesse, 2004; Mulugeta Lemenih and Melaku Bekele, 2008). Such devolution and decentralization of governance of forest resources from state authorities to local communities through PFM are seen as cheap and efficient ways of forest conservation (Tassa *et al.,* 2010). In addition, most central governments realized that the active and willing participation of the communities is necessary for forest conservation as well as providing economic benefits to the local people. Hence, due to rapid rate of forest degradation in the area, the local people are allowed to involve in the management of natural forests through PFM program. The introduction of PFM was expected to achieve the dual goal of contributing to the sustainable management of the forest resources and the improvement of the socio-economic status of the local communities (Wily, 2002; Edwards, 2010).

As a result, the new approach allowed the local people to gain benefits side by side protecting the forest from degradation. However, a few comparative studies on the forest status and socioeconomic benefits for the forest user among different PFM managed forest were carried out in Ethiopia. For instance, a study made by Tsegaye Gobeze *et al.* (2009) in Bonga natural forest had investigated PFM and its impacts on livelihoods and forest status. The study considered comparing natural forest blocks found under PFM and outside PFM management system and socioeconomic benefit difference before PFM and during the time of PFM practice. However, the study did not address forest resource dependent people in PFM who were using natural forest in different income generation approaches. In addition, the study is site specific and there is no such research in Belete forest priority area. Another study conducted in Jimma zone by Kittessa Hundera (2007) explored the different traditional forest management practices. This study exclusively looks the traditional forest management types that had contribution for conservation of natural forests in the area. Nevertheless, it did not cover studying the status of forest community as well as socioeconomic benefits of forest resource to forest dependent people between different forest management systems. Moreover, Kittessa Hundera (2010) also made a study on the status of indigenous tree species regeneration under exotic plantations in Belete forest. However, this study did not cover the regeneration of indigenous trees under the natural forests in relation to PFM approach.

Therefore, under the present circumstances of increased anthropogenic disturbances, reliable and adequate information about woody species diversity and distributions patterns have become critical in order to protect and conserve the remaining plant species efficiently and effectively. Thus, the principal aim of this research work is to bridge these information gaps and the study focused on the management approach to maintain the natural forest species diversity, regeneration status and its implication for the betterment of the local people socio-economic condition and fulfillment of their need of forest products. With this research interest, the study did not cover the other dimension of the natural forests like human- natural forest resource conflict, other biodiversity inspection like herbs, wild animals, and medicinal plants.

1.2 Objective of the Study

The general objective was to study forest under participatory forest management system on their status and socioeconomics contribution to rural people.

The study has the following specific objectives:

1. To assess the regeneration status, forest community structure, species composition and diversity of woody species on natural forests without coffee and with coffee forests.
2. To assess the socioeconomic contribution of the forest resources from the forest managed with and without coffee to rural annual households’ income.

2. LITERATURE REVIEW

2.1 Participatory Forest Management (PFM)

Ever since the influential article by Hardin "The Tragedy of the Commons" there has been a growing debate on natural resources management approaches in the world (Hardin, 1968). In the context of forest resources management, because of its common nature of ownership and the subtractive nature of goods and services, people centered participatory approach has been raising interest in developing countries (Gibson *et al*., 2004; Dhakal and Masuda, 2008). Participatory or collaborative forest management is a concept that emerged sometime in the early 1980s (Worah, 2008). Today it broadly embraces a range of approaches that includes, among others, Joint Forest Management (JFM), Community Forestry (CF), Integrated Conservation and Development (ICDP), Community Based Natural Resource Management (CBNRM) and Participatory Forest Management (PFM). While these approaches might differ in their specific objectives, they have the common characteristic of some level of natural resource benefit sharing (Worah, 2008).

The main reasons for the world states to adopt this new paradigm include disappointing results of existing 'blueprint' strategies of natural resource management, emerging demands for empowerment of local communities, and fast dwindling resources necessary to impose top-down management strategies (Kumar and Kant, 2005). Moreover, devolution of authority from state to local community institutions providing communities living in and around forests to take direct control of the forests. They allowed the local people to use or co-manage forest resources with state authorities on some agreed benefit and cost sharing mechanisms (Lawrence and Green, 2000; Hobley, 2006; Schreckenberg *et al.,* 2006; Edwards, 2010). PFM also encompasses a wide range of different co-management arrangements with different levels of control from relatively conservative "benefit sharing" to genuine "community-based natural resource management" where local communities have full control over management of the resource and the allocation of costs and benefits (Schreckenberg *et al.,* 2006).

PFM is an arrangement where community (forest users) and the government services (forest service) enter into mutually enforceable arrangement and work together to define rights of forest use; develop ways of sharing management roles and responsibilities; and agree how to divide and share forest benefits (Iddi *et al*., 2006; FARM and SOS, 2011). PFM also refers to the legal empowerment of local communities to manage forest resources for, in the first instance, their sustained livelihoods, and in the second instance, economic return. All these are important aspects for sustainable management of defined forest resources (Iddi *et al*., 2006). Although the term covers a wide range of approaches, both of them share same concepts of promoting fair partnership between people living in and around the forests and forest administration bodies, who are the concerned stakeholders (Girma Amente and Tsegaye Tadesse, 2004). Therefore, the process of PFM involves the legal transfer of resources (use rights to, and/or, ownership rights) from the government to communities. This transfer is enabled by and dependent upon, a negotiated and documented forest management agreement (Wily, 2002). Another expression of PFM schemes essentially refer to a bundle of rights communities gained from the state through negotiated settlement and aims at avoiding or minimizing conflicts of interests between the two to use the resource in sustainable way. In brief, the PFM approach is targeting sustainable forest management and avoid open access situation, a non-property condition over forest. It essentially answers such questions as to who owns what, how, and even why (Mulugeta Lemenih and Melaku Bekele, 2008).

The whole idea of participatory approach in research and development is conceptualized within a framework of ecological emergency, i.e. resource depletion, growing poverty and food insecurity. World forests have been degraded by about 40 percent and three- fourth of this loss occurred in the last two centuries (UN, 2005). The world's total forest area in 2010 estimated to be just over 4 billion hectares, corresponding to an average of 0.6 ha of forest per capita (FAO, 2010). Moreover, 3 percent of the Earth's forest was lost between 1990 and 2005 and the rate of degradation is becoming more serious (UN, 2005). The major causes for fast world forest degradation were increase in population at an alarming rate and poverty (Fisher *et al*., 2007).

In Africa from 2000 to 2005 alone, the continent saw a net loss of 4 million hectares of forest, representing 55 percent of the global forest loss (FAO, 2007). The reason were inability of conventional forest management systems to address deforestation and forest degradation as a result of various anthropogenic interventions such as expansion of agricultural land, increased investments that require clearing of forests, population increase, and resettlement activities and soon (Tsegaye Tadesse *et al.,* 2007). Tanzania's forests however, face many challenges including deforestation. Deforestation was estimated at 412,000 hectare per annum between 1990 and 2005 (FAO, 2007). This is equivalent to 1.1 percent of the country's total forest area. The main direct causes of deforestation are clearing for agriculture, overgrazing, wildfires, charcoal making, persistent reliance on wood fuel for energy and lack of efficient production and marketing, over-exploitation of wood resources and lack of land use plans and non adherence to existing ones (Blomley and Iddi , 2009). In Ethiopia, there are rapid deforestation and degradation of land resources. Forest areas have been reduced from 40 percent a century ago to an estimated less than 3 percent today. The current rate of deforestation is estimated at 160,000 to 200,000 hectares per years. This was due to population pressure that have resulted in extensive forest clearing for agricultural use, overgrazing, and exploitation of existing forests for fuel wood, fodder, and construction materials (Badege Bishaw, 2001). This event has triggered the need to look for a sustainable forest management system (Tsegaye Tadesse *et al.,* 2007).

Consequently, it was initiated to organize and empower communities in order to rehabilitate degraded natural resources and to use them in sustainable way. It was a response to the failure of traditional top-down, paternalistic and state-initiated development practices, which ended in only alienating communities and put them in conflict with state forest management (Mulugeta Lemenih and Melaku Bekele, 2008). For instance, Nepal having failed to manage the forest through bureaucratic method and recognized the only practical way of ensuring protection and sustainable supply of forest products by giving the responsibility for management to the villagers (Gautam *et al*., 2004). As a result, countries of India and Nepal are implemented participatory forestry as a new paradigm for forest management since the old method failed to conserve forest resources from degradation. India gained successes by introducing Joint Forest Management (Roy and Alam, 2012). Sal forest experience in

Bangladesh proves PFM is useful to enhance interaction between livelihood of rural people and resource management (Safa, 2005). In Ethiopia, also PFM initiatives have achieved their objectives as expected (Tsegaye Gobeze *et al*., 2009). The whole claim is that villagers have a more concrete knowledge about and a stake in the resources than state bureaucrats. They also have a greater concern in managing forests in sustainable way, because their livelihoods depend on it. The objectives of PFM establishment, thus rests on the driving principles of accommodating conflicting interests over the forest resources, and the empowerment of communities by introducing congruency between the forest capacity and community's needs of forest products. The approach was to improve community livelihood and rehabilitate the forest resource by bringing villagers more closely to the resource with the sense of confidence and certainty, an effective policy tool to manage conflicts (Mulugeta Lemenih and Melaku Bekele, 2008).

2.2 Objectives of Participatory Forest Management

The specific objectives of PFM are different in each country. In Ethiopia PFM was introduced by NGOs to solve the problem of forest degradation (FARM-Africa and ODI, 2007). The two main objectives are social and environmental. The one emphasizes mitigation of biodiversity loss, forest degradation and deforestation; while the other views a concern for livelihoods in forest neighboring areas as well as the rights to utilize forest resources legally (Winberg, 2010). The motivation behind PFM program in Bale region was to conserve the unique biodiversity and ecological functions of the greater Bale mountains eco-region, whilst establishing and enhancing sustainable local community livelihoods (FARM and SOS, 2007). In Belete natural forest, the main objective of PFM introduction by the JICA was in order to mitigate deforestation (JICA, 2003). The Chilimo Project/programme has four main objectives that interlinked and form the strategy for the development of community based sustainable forest management. The objectives are; to contribute to the long-term conservation of forest ecosystems, through the development and establishment of new systems of forest management. Second to sustain and/or increase income opportunities from improved natural resource management and diversified livelihoods. Third to build the capacity of government staffs and rural community to manage natural resources in a sustainable and equitable way and fourth to catalyze the adoption of PFM within policy and practice (Zelalem Temesgen accessed on May, 2013).

In Tanzania, the objectives of PFM were two broad (but largely implicit) policy objectives drive the dissemination and scaling up of PFM. The primary goal of PFM is to restore or maintain forest quality and the environmental and ecological services they deliver to local and national stakeholders. Behind this lies the assumption that delegating management responsibility to the lowest possible level will lead to improvements in the quality of the forest resource in question. The next objective is improvements in livelihoods of forest dependent communities by capturing the benefits of forests and woodlands at the village, community and household level, it is assumed that rural livelihoods will become more secure and sustainable (Blomley and Ramadhani, 2005).

In India, Joint Forest Management was introduced as an innovative method to realize sustainable forest utilization to meet local needs equitably while ensuring environmental sustainability and conservation (Masuda *et al*., 2005). Nepal is one of the pioneer countries for participatory forest management in the world. The country has implemented community forestry program since the 1970s and it is recognized as one of the successful approaches of community based forest management in the world (World Bank, 2001). The main aims are conserve ecosystems and genetic resources, protect land against degradation and other effects of ecological imbalance and to contribute to local and national economic growth (Kanel, 2000). The major aim of JFM policy in Pakistan was the protection and improvement of the rural areas (particularly mountainous areas), and increasing the productivity of natural forests through active participation of stakeholders in the planning and implementation of project related activities (ADB, 1995). Various village level organizations such as, joint forest management committees, women organizations, and village development committees were created to govern the natural resources of the village and to monitor the affairs of the village land use plan (Shahbaz *et al*., 2012). Therefore, in most developing countries, community (participatory) forestry policies emerge as a response to 'institutional failure' regarding the sustainable management of the forest resources (Shaba and Ali, 2006).

2.3 Forest Management and Economic Role of Africa's Forests

According to FAO (2006), forest resources assessment report showed that the extent of forests in Africa as 635.4 million ha or about 16.1 percent of the world's forest covers. Other wooded lands account for 406 million ha or 29.5 percent of the total. Western and central Africa, eastern and southern Africa report a higher forest cover than that of northern Africa, with 277.8, 226.5, and 131.0 million ha of the total forest area, respectively. Gabon is the country in Africa with the highest forest cover of 84.5 percent of the total land area (FAO, 2006).

Deforestation has taken its toll of Africa. The calculated annual rate (1990-2005) was 4.4 million ha, i.e. -0.64 percent/year. Since 2000-2005, the rate decreased to -0.62 percent per year or 4.0 million ha. The improvement may be because by 2005, the extent of productive forest plantations in Africa was estimated at 10.8 million ha, or 2.5 percent of the total forest area (Castañeda, 2011). Action to involve forest-local communities in the management of forests is well underway in Africa. Most of these developments have or quickly acquire policy and legal support through National Forestry Policies, National Forest Management Plans, and particularly the new forestry legislation (Wily, 2002). PFM is under way in more than 30 countries, largely within more than 100 projects, involves about 5000 communities, affects more than 100 national forests and introduces more than 1000 new protected areas (community forests) (Wily, 2002).

In the new forest laws of Africa, the most common changes are the following:

1. Marked increase in national programming and individual forest planning requirements;
2. More rigor and control over the way in which governments themselves administer national forest properties;
3. Legal encouragement for private sector roles, particularly in the plantation sector;
4. Change in the character of central forestry administrations, with wider civil society input in decision-making, sometimes with relocation of forestry departments into semi-autonomous institutions, and varying degrees of decentralization to local governments;
5. The other change is policy commitment and new legal opportunity for forest-local populations to participate in forest management (Wily, 2002). The main drivers towards these

changes are well known, especially the continued loss of forest on the continent of up to 1 million ha each year and resultant added pressure for action being exerted through global environmentalism launched with the Rio Declaration of 1992 (FAO, 2001; Wily, 2002). A wave of change to forest management practice is under way. This is manifest in its most precise and binding terms in promulgation of new state forest laws. Since 1990, at least 35 countries of which Ethiopia is the one, have enacted such new codes, or have these in draft in early 2002 (Wily, 2002).

Although difficult to calculate systematically, forests play a significant economic role at the continental, regional, national, and local levels in Africa (Counsell, 2009). In 2006 African countries exported 7.6 million cubic meters of wood (round wood equivalent), worth $2 billion (excluding exports from South Africa) (FAO, 2006). In 2000, 870 000 Africans were employed in the formal forest sector (Counsell, 2009). One hundred and seventy thousand people are employed in South Africa's forest products industry (Edwards, 2006). In Eastern, Western and Southern Africa more than 90% of rural households are estimated to depend on fuel wood and charcoal for energy. More than 80% of sub-Saharan Africans rely on natural medicines, which are often derived from forest areas. Forests have been described by the World Bank as 'critical for the livelihoods' of around 40 million people, or three-quarters of the national population, in the Democratic Republic of Congo (Counsell, 2009). In most countries in Eastern and Southern Africa, non-timber forest values far exceed the recorded national income generated by formal forest industries. For example, the majority of Eastern and Southern Africa's population rely on wood-based energy (including over 85% in Namibia, 90% in Malawi, 70% in Zambia, 80% in Mozambique, 97% in Tanzania and 90% biomass fuels in Ethiopia) (Alemu Mekonnen, 1997: Mogaka *et al*., 2001). Other non-timber forest values are also demonstrably high. For example the use of forest-based traditional medicines is worth between US$ 77-155 million in South Africa, the potential recreational value of forests in Kenya is up to US$ 30 million, and the sum of non-timber values is US$ 180 million in Namibia (a figure that is nearly 450 times higher than income from commercial logging) (Mogaka *et al*., 2001). Forest services, such as watershed catchments protection, erosion control, nutrient cycling, maintenance of soil fertility and local and global climate control also have a high, and largely unrecorded, economic value. The few studies that have attempted to quantify these indirect benefits underline this high value. For example, soil erosion costs avoided by the presence of natural vegetation have been estimated to be worth up to US$ 42 million a year in Malawi, up to US$ 80 million in Zimbabwe, and US$ 1.5 million in Eritrea. Kenya's indigenous forests are thought to provide water catchments services with a value in excess of US$ 25 million a year, and the global value of carbon sequestration by Eritrea's forests and woodlands has been calculated at more than US$ 27 million (Mogaka *et al*., 2001).

2.4 History of Forestry Sector in Ethiopia

Ethiopia hosts the fifth largest flora diversity in tropical Africa, which is estimated to be between 6,500 and 7,000 species of higher plants (Mulugeta Limenih, 2004). Contrasting geo-climatic variations have induced rich floral and faunal diversity in Ethiopia. The highlands of Ethiopia alone contribute more than 50 percent of the tropical Afromontane vegetation in Africa of which tropical dry Afromontane forests cover the largest part. However, economic and demographic pressures are increasingly imposing non-sustainable development, which is driving greater proportions of tropical forests and their biodiversity either to be modified in to more open and species-poor secondary forests or to be lost completely (Mulugeta Limenih, 2004).

In Ethiopia, radical changes in forest ownership over recent decades have led to uncertainty about rights and contributing to practices that are causing destruction of forest resources. Forest and forestlands used to be controlled by local administrators under landlords claiming forest ownership. Various community-based organizations also had roles in forest management. Nevertheless, the rights of these individuals and institutions were removed by the Derg regime under the Land Reform Proclamation of 1975. Forests were divided for the purposes of control and management into state forests, under the control of the state forest department, and community forests, under the control of peasant associations (FARM-Africa and ODI, 2007). However, the proclamations in the Imperial and Derge regimes did not save the country forest resources from degradation and majority of the lost forests were destroyed in this period (Tadesse Getacher and Alemtsihay Jimma, 2012). People living in and around state claimed forests were removed without compensation. Control of these forest resources was placed in the hands of political officials who had little knowledge of former local resource management systems. Any benefit sharing from forests took place only through illegal encroachment, livestock trespass and extraction of products by evading the forest guards (FARM-Africa and ODI, 2007). Due to such pressures, unsustainable forest management and deforestation has been a feature in Ethiopia for many years. Forests continue to be over-exploited, jeopardizing both the forests and the livelihoods of those who depend on them. Though the government recognizes this, it has failed to establish effective long-term planning for sustainable forest. Forests continue to be over-exploited, jeopardizing both the forests and the livelihoods of those who depend on them (FARM Africa and ODI, 2007).

2.5 Participatory Forest Management in Ethiopia

Rural households in Ethiopia have different sources of forest products. These are community forests (PFM), state (de facto open access) forests, and private sources such as farm forestry and trees around homestead (Abebe Damte, 2011). Experiences from many countries show that the consequence of using open access resources is overexploitation and depletion. Due to this fact, Ethiopia has practiced the transfer of the management of forest to the local community over a decade, the decentralization of natural forest management and is considered as the best strategy to get a win-win situation between the government and the local people (Abebe Damte, 2011).

Community-based program in forest management (which is popularly known as PFM in Ethiopia) is fundamentally a decentralized grassroots/bottom up movement (Das, 2009). It led under localized natural resource management program initiated by forest fringe communities and government. Its objective is to strengthen communities' livelihood base and to protect natural forests from further degradation. Concerning to the decentralized planning and participatory program in PFM, forestry can play a significant role for the well-being of the people living in and around the forest areas (Das, 2009). As a result, numerous benefits are expected to accrue to individuals from participating in community forest associations through increased access to forest products such as fuel wood, herbal medicine, honey, tree seedlings, thatch grass, and fodder. Other activities allowed within the co-management framework include eco-tourism, bee-keeping, fish farming and growing of crops. With these benefits, such people can play a major part in making the forests around them more productive under local management partnership between the state and local communities and even it would be expected that communities would fast embrace the system and participate effectively (Das, 2009; Ogada, 2012).

In line with this, FARM-Africa has been promoting PFM in Ethiopia since the mid-1990s (FARM-Africa and ODI, 2007). At regional level, International Non-Governmental Organizations (NGOs) such as the German Technical Cooperation (GTZ), FARM Africa, and SOS Sahel Ethiopia are implementing the community based forest programs in collaboration with the national regional governments of Oromya and SNNPRs (Tadesse Getacher and Alemtsihay Jimma, 2012). A number of decentralization programs have been implemented in priority areas of Chilimo, Bonga, Borena, and Adaba Dodola. Although bilateral donors, such as the GTZ and JICA, as well as NGOs, including Farm Africa/SOS Sahel, have provided financial and mediation support for these initiatives (Alemu Mekonnen and Bluffstone, 2008; Neumann, 2008; Sisay Nune, 2008; Tadesse Getacher and Alemtsihay Jimma, 2012). This is considered as the best strategy to get a win-win situation between the government and the local people. It is believed that the new management style has brought a positive change in environmental outcomes as well as economic benefits to the local people. There are however, little quantitative empirical evidences on the effect of these institutional changes on the forest-poverty link in Africa in general and Ethiopia in particular (Abebe Damte, 2011).

In this approach, communities and government services work together to define rights of forest use, to share management responsibilities and to share forest benefits. It is believed that this approach has the potential to lead to sustainable management of forests in Ethiopia. Since 2003, 15 community groups have signed forest management agreements (FMA) with the Ethiopian government. Projects are expanding, and awareness of the value of participatory management is spreading, particularly in the Oromia and Southern Nations Regions where FARM-Africa's pilot projects are located. There has been increasing interest from local government in these two regions. In Oromia the government forest department working adjacent to FARM-Africa's Chilimo project has started developing PFM in the Jibat Priority Forest Area (FARM-Africa and ODI, 2007). Today in Ethiopia there are 58 designated Forest Priority Areas (FPA) and in eight of these, PFM is being trialed. Two of these are FARM-Africa projects, two are run by SOS Sahel Ethiopia, one by GTZ, one by the Japanese International Cooperative Agency, and two are under government management (FARM-Africa and ODI, 2007). The aim was to stop forest deforestation and deterioration, as well as its negative impact on the livelihood of people and to restore forest cover (Mohammed and Inoue, 2011). Here, much of the human-induced deforestation and forest degradation is, in varying degrees, economically wasteful and environmentally negative, as well as socially undesirable. Often, just a few individuals benefit (Hermosilla, 2000).

Therefore, underlying principle of this new program, called PFM, was to balance forest resource conservation and utilization by empowering communities in which forest responsibilities, use rights and management are legally shared between community and the government (Melaku Bekele and Tsegaye Bekele, 2005). The main objectives were phrased as a contribution briefly to long-term conservation of forest ecosystems; to sustain income opportunities from improved resource management and livelihood diversification, to build capacity of government staff and community to manage the forest sustainable and equitable. Lastly, it contributed to catalyze the adoption of PFM within forest policy and practice (Melaku Bekele and Tsegaye Bekele, 2005).

However, implementing PFM require huge financial and human resources although sufficient benefits can also be generated from forest resources. Benefits generable from forest ecosystems are diverse and not limited to monetary revenues only. These benefits can be categorized as tangible (quantifiable) and intangible such as social and environmental benefits (Mulugeta Lemenih *et al.*, 2010). Much more research is needed to fully understand the impacts that PFM has had and potentially could have. The impacts that were identified include ecological, economic, institutional and policy. Ecologically, participatory arrangements have stabilized use patterns and controlled overuse, improving the quality of the managed resources and in one case resulting in higher levels of productivity of tree species being harvested. In terms of economic impact, the livelihoods of a number of PFM partners who depend on forest resources are more secure because of better-managed forests, increased skills, and the exclusion of competitors. A few participatory arrangements have also generated local employment. According to Tsegaye Gobeze *et al*. (2009), PFM benefited the people as increased and more diversified income source led to better asset accumulation, and less dependence on the forest. However, the livelihoods of those excluded from access to forest resources have become less secure, with fewer economic opportunities. The other major impact of PFM has been on institution that is the culture and attitudes, and in some cases structures, of forest management agencies, which have become more focused on the role of forests in national and local development (Geoghegan, 2002). There has also been an increased use of management agreements between governments and other forest stakeholders, but difficulties in moving away from traditional structures and relationships has been a limitation in fostering co-management. The involvement of external assistance agencies has had both positive and negative impacts, on the one hand supporting capacity building, while on the other hand fostering dependency on outside financial and technical support (Geoghegan, 2002).

Generally, when PFM is introduced to a community it is accompanied by a management agreement and a plan that specifies restrictions and rights of forest utilization for the community. The utility is often strictly limited in regards to timber products from the forest, which in many cases had been the most important source of income generation before PFM (Winberg, 2010). The new management plan generally regulates extraction levels or periods in the cases where the extraction is not prohibited. Charcoal remains an important commodity for income generation in one case but it is other wise prohibited under PFM. Bush meat and wildlife is not allowed to be hunted for in any of the PFMs and was only reported to be exercised before PFM in one case. Timber of native species that was in all cases extracted before PFM is highly regulated under PFM. Timber of introduced species is allowed to extract in more cases than it was utilized before PFM implementation but it is as often prohibited in the new management. It seems that the utility is directed towards extraction of firewood of both native and introduced species rather than timber. Dead wood is in no cases prohibited to use (Winberg, 2010).

2.6 Rural Income Sources and Livelihoods Benefits of Forest

2.6.1 Rural income sources

Diversification is the norm. Very few people collect all their income from any one source, hold all their wealth in the form of any single asset, or use their assets in just one activity. As a result, income diversification is ubiquitous (Barrett and Reardon, 2000). Most rural poor people maintain diversified livelihood strategies both because they cannot obtain sufficient income from any single strategy to survive and to reduce risks. This is why most small farmers are not actually solely small agriculturalists, and many include forest products in their livelihood systems (Sunderlin *et al.,* 2005). There has been an increasing recognition recently that the rural economy is not confined to the agricultural sector, but embraces all the people, economic activities, infrastructure, and natural resources in rural areas (Reinert, 1998; World Bank, 2000; Barrett *et al.*, 2001; Davis, 2001). These livelihood strategies broadly include off-farm and land-based strategies (Paumgarten and Shackleton, 2011). Equally, rural livelihoods are not limited to income derived solely from agriculture but may be from diverse sources (Davis, 2001). Rural livelihoods thus include income from both farm and non-farm sources (Davis, 2001; Davis, 2006). The rural non-farm economy (RNFE) may be defined as being all those income-generating activities associated with waged work or self-employment in income generating activities (including income in-kind) that are not agricultural but located in rural areas (Lanjouw and Lanjouw, 1997; Davis, 2001). From this one can understand that, there are multiple sources of income in rural areas and that household often diversify and support themselves with different earnings. Income that is still frequently neglected is however, income from natural resources such as forests, fisheries, and wildlife (World Bank, 2007).

2.6.2 Forest benefits to rural livelihoods

Forests and woodlands are important source of wild foods, fuel wood, fodder and forbs for livestock, medicines and other materials (Bwalya, 2004). Thus, forest provide a wide variety of social and economic benefits, ranging from easily quantified economic values associated with forest products, to less tangible services and contributions to society (GFRA, 2010). Specially, forests play a crucial role in the lives of many poor people. Almost 70 million people of which many indigenous live in remote areas of closed tropical forests. In addition, another 735 million rural people live in or near tropical forests and savannas, relying on them for much of their fuel, food, and income or chopping them down for crops and pasture (Chomitz *et al.,* 2007). This means that a large percentage of the world's poorest people and global biodiversity are found in countries with significant areas of tropical forest, which are often under heavy pressure to deliver tangible economic benefits. The utilization of tropical forests for economic development and poverty alleviation, while maintaining long-term social and environmental sustainability, is paramount for many developing countries in the tropics and sub-tropics (Olson, 2007).

In Sub-Saharan Africa, forest goods and services are extremely important for rural livelihoods, providing food, medicine, shelter, and fuel and cash income (Kaimowitz, 2003). It is estimated that more than 15 million people in Sub-Saharan Africa earn their cash income from forest-related enterprises such as fuel wood and charcoal sales, small-scale saw-milling, commercial hunting and handicraft. In addition, between 200,000 and 300,000 people are directly employed in the commercial timber industry (Oksanen and Mersmann, 2003). It is now well appreciated in a number of disciplines, including the environmental, conservation, economics, and development fields that forests and forest products add to the well-being and, at times, the very survival of millions of rural poor throughout the world (Kaimowitz, 2003; Sunderlin *et al.,* 2005). Although, forest products play an important role in supporting rural livelihoods and food security in many developing countries, such benefits are not restricted to rural people since many forest products used and marketed within urban communities (Sunderlin *et al.,* 2005; Mulenga *et al*., 2012).

In general, there has been increasing realization that forests provide numerous benefits to humankind and improvement of forest condition in two main ways that is capital formation in rural communities and policy and governance reform of various organizations and agencies (Archana and Arvinder, 2003; Pokharel and Nurse, 2004). Further, forests are a source of natural habitat for biodiversity and repository of genetic wealth; provide means for recreation and opportunity for eco-tourism. In addition, forests help in watershed development, regulate water regime, conserve soil, and control floods. They contribute to process of carbon sequestration and act as carbon sink, which is important for reduction of green house gases and global warming. In ecologically sensitive areas like mountains, as well as river catchments, forests play an important role for prevention of floods (Archana and Arvinder, 2003). In addition, the collection of Non-timber Forest Products (NTFPs) provides a variety of forest products used for domestic consumption, as well as a source of complementary cash income and a safety net for people when agricultural yields are low (Angelsen and Wunder, 2003). However, degradation of forest resources has a detrimental effect on soil, water, and climate, which in turn affects human and animal life. This has created global concern for protection and preservation of forests (Archana and Arvinder, 2003). One of the field studies in Ambua and Keli villages in Rajasthan on livelihood impact has shown that JFM activities have produced only a marginal increase in physical, natural, and human capital, with substantial increases in financial and social capital (Pandey, 2005). In forest villages of Betul in Madhya Pradesh in India, collection and sale of NTFPs have not led to improved forest-based livelihood opportunities for traditional tribal stakeholders. This can be attributed to the over-exploitation of forest resources, as well as the low prices paid to the collectors in rural areas by intermediaries and traders (Vemuri, 2008).

The community forest in Nepal is found supportive for livelihood improvement of local people. According to the study of Dhakal and Masuda (2008), the Dhuseri community forest has supplied the basic needs of forest-products for example firewood, fodder/grass, and timber to local people on a regular basis. This study also revealed that the proper management of community fund is crucial for sustainable community forest management and livelihood improvement, where forest resources have higher economic potential in the Terai region. The study further revealed that PFM approach is not only effective to construct the local institution, but also effective to empower the local people and seize the forest management activities as the means of livelihood improvement. Sunderlin *et al.* (2005) found that household surveys and case study research demonstrated that the rural poor tend to be disproportionately dependent on forest resources in the sense that a higher proportion of their total income comes from forest resources. Forests and woodlands are important source of wild foods, fuel wood, fodder, and medicines. For instance, Ethiopians depend heavily on forest resources for various reasons. Forests supply biomass fuels, which are used to meet energy demands, since alternative modern energy sources are not widely developed. Recent estimates show that Ethiopia‘s biomass consumption is one of the highest in the world. Biomass consumption accounts for 96 percent of energy consumption. Wood is also used as pole and industrial wood whose demand is expanding with increased population. Other uses include incense, myrrh, and gums as forest products, grazing for livestock especially during the dry season, medicinal plants, sanctuary for wildlife, protection of soil from water and wind erosion, improvement in agricultural productivity through farm forestry, integration of ecosystems and water regimes, and foraging for honeybees. Given the lack of development in the modern energy sector, that dependency is likely to continue apace for many years (Alemu Mekonnen and Bluffstone, 2008).

3. MATERIALS AND METHODS

3.1 Study Area Description

The study site, Belete national forest priority area, is located in Shebe Sombo district of Jimma Zone in Oromia State, in the southwestern part of Ethiopia. It is found along the Jimma to Bonga road at 375 km far from Addis Ababa. It is geographically located at 7^0 30' N up to $7^0$45’ N, and 36^0 15'E up to $36^0$45’E (Figure 1).

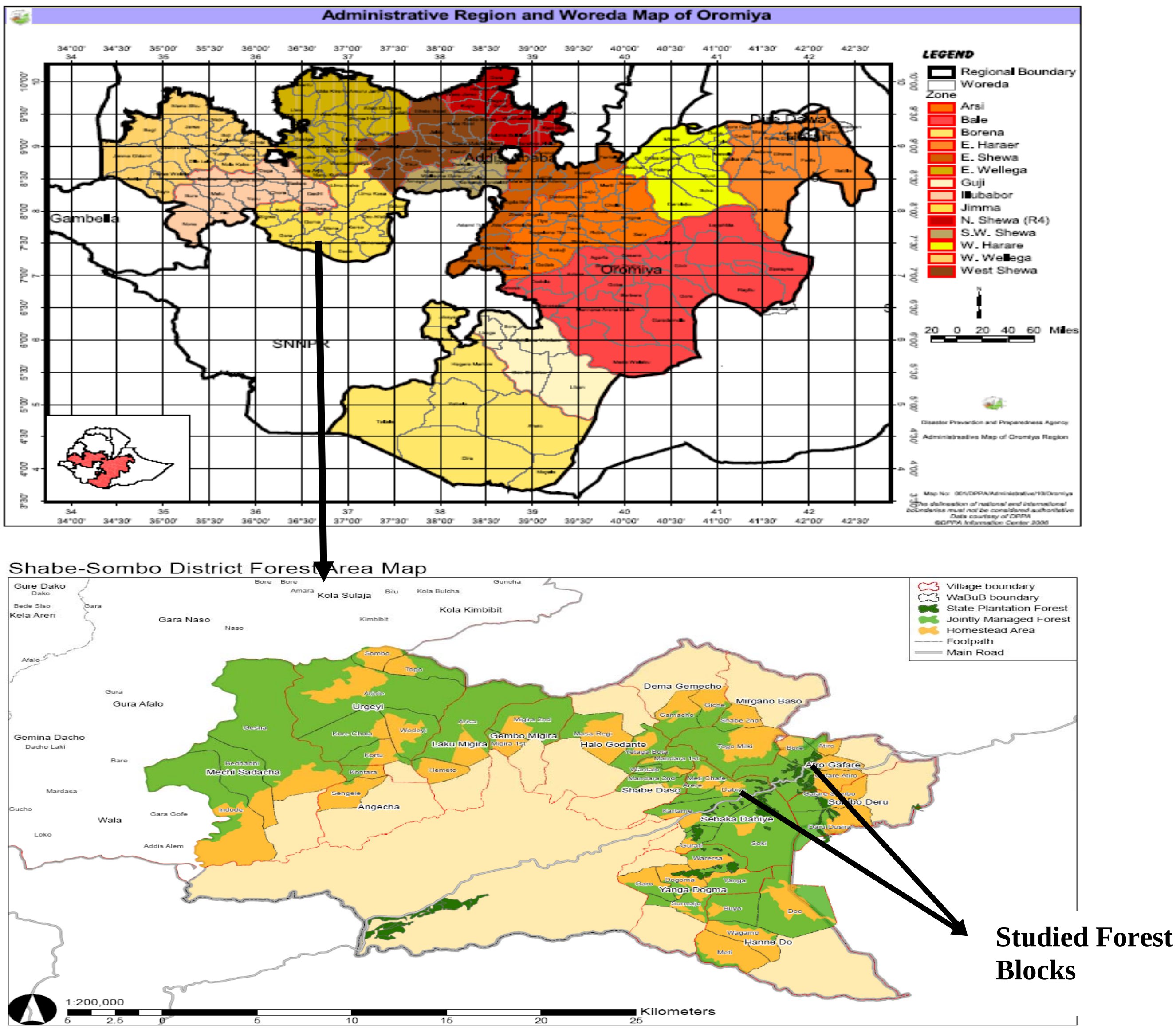

Figure 1 Map of study area

Source: JICA, 2011

Vegetation

The forest reserve is grouped in to Gera and Shebe district. Their sum of total area of forest cover is 166,709.69 in hectare of which 109,111.72 ha is the area of the forest. From the area of the forest, 83,513.78 ha are found in Gera and 25,597.94 ha in Shebe district (JICA, 2011). The Belete forest is unique in that it produces wild forest coffee as well as regular garden coffee. The forest area divided into two types: the coffee forest area, and the highland forest area without coffee. The natural forest managed by both the local people and the state. In the district there are 14 villages, seven of them are managed coffee forest area, and the rest seven villages managed the highland forest area without coffee. In both types of forest, the residents are mostly farmers, producing cereals, such as wheat, barley, and teff, vegetables, honey, and milk (JICA, 2011).

The natural forests are highland rainforests composed of broadleaved trees, which are resulted from the relatively ample precipitation throughout the year. In undisturbed closed high forests, dominant species are *Olea welwitschii, Scheflera abyssinica, Pygeum africana, Elaeodendoron buchananii, Diospyros abyssinica,* and *Albizia gummifera.* Those forests in close proximity of villages, farmlands, and grazing fields have received heavy human disturbance. In general, forest in the study area is relatively in a fair condition, compared to forest in other region. Felling of four important species is prohibited in the area. These are *Juniperus procera* (*Cupressaceae*), *Podocarpus gracilior* (*Podocarpacaea*), *Haygenia abyssinica* (*Rosaceae*), and *Cordia africana* (*Boraginacea*e) (JICA, 1998).

Geology and soils

The rocks in the study area consist of crystalline bedrocks from Precambrian era, which are in the lower complex granite basement, older than 2500 million years. Above that are volcanic rocks and lava of the Tertiary period. The subsurface geology above the volcanic rocks and lava is composed mostly to basalt and tuff (EMA, 1988; JICA, 1998). It has a drystic nitosols type, which is deep, clay red soils, with an argillic B-horizon. The color is red-brown clay soil and it is extensively dispersed. The weathering of its parent materials, basalt, and tuff generated this soil. In terms of the soil unit used in the FAO/UNESCO, soil classification, the soil consists of Haplic Nitosols, Nitosols, Humic Nitosols, and Dystric Cambisols. At some areas shallow soil with rock outcrops predominant, with the soil being mainly of Umbric Leptosols and Mollic Leptosols. At some depression, sites such as marshes, Gleyic Luvisols dominates (JICA, 1998). The soil is porous and has good potential for agriculture, good physical properties, stable structure, deep rooting volume, and high moisture storage volume. Chemically, these soils have low base saturation and pH of less than 5.5 (EMA, 1988).

Topography and drainage

The physical feature is characterized by a rugged topography, dominated by gentle slopes and a localized steep slopes ranging from four up to forty five percent. Although, undulating hills exist, steep mountains also exist in some parts (JICA, 1998). The area receives ample amount of rainfall throughout the year, and encompasses the headstreams of many small streams and these several small streams cross the area. Particularly, highland areas situated above the 2,000 meter above sea level are often shrouded in clouds. It is reasonable to assume that these areas receive more rain than the Jimma weather station where the elevation is 1,740 meter above sea level (JICA, 2004).

Climate

Analysis of the metrological data result showed that the mean annual temperature of the study area is about 19.3 ^{0}C, ranging from a mean minimum of 13.3^{0}C to mean maximum of 23.3 ^{0}C. The hottest months occur from September to November (maximum 27.8 ^{0}C). While coldness, occur from June to August (minimum 12.8 ^{0}C). The mean annual rainfall of the area is 1547 mm year –1, which varies greatly from year to year ranged from 787 mm year –1 (in the year, 2003) to 2212 mm year –1 (in the year, 1977). Generally, the study area has a unimodal type of rainfall pattern with the highest rain occurring between January and April. The rainfall increased linearly from September to December, while it drastically dropped down from May to August.

Land use

The land use and vegetation cover in the study area are classified as forest and non-forestland. Forestland is further divided in to plantations, closed high forest, disturbed forest, and bamboo thicket. The non-forestland includes marsh, logging road and other like farmlands, grazing field and villages. The share of these different land use patterns of the area are: Farmland, grazing field, villages (48%), closed high forest and heavily disturbed forest (each 19%), disturbed forest (7%), non-stocked forest, and forest plantation 4 and 3% respectively (JICA, 2004).

The area is known in coffee production and the cultivation way is grouped in to three manners. There is coffee beans collection from the wild forest, coffee planting in the natural forest and finally coffee planting on household land. The other forest land use practice of the site are timber production, which is illegally done, honey production, herbs, spices, nuts and medicinal plant collection (JICA, 2003).

3.2 Methods

3.2.1 Types and sources of data

For this study, both primary and secondary methods of data collection were used based on their applicability and usefulness towards achieving the research objectives. The primary data source was include data of the forest status indicators such as forest disturbance conditions, regeneration and diversity of woody species from forest managed with coffee and the highland forest area without coffee. Whereas, secondary data were gathered from internet source, books, and used to support the primary data sources.

3.2.2 Forest inventory techniques

3.2.2.1 Sampling design

In the area there were 14 villages practicing PFM and seven of them were forests managed for coffee and the other seven village using forests without planting coffee. The total number of PFM established with in 14 villages was 44. For this study, two villages were selected in stratified simple random sampling technique: one from forests managed for coffee and another one village from forest area without coffee. However, both selected villages have more than two forest user association (PFM). Among the total number of PFM found in the selected villages, two-forest user associations was drawn from each village in simple random sampling technique via lottery method. Therefore, the study totally covered four PFM associations. Field survey was carried out using systematic line transect sampling design in the selected forest blocks that are subjected to PFM forest managemnt approaches (Scariot, 1999; Tadesse,2003; Feyera, 2006). From each forest pactches vegetation data was collected from main and nested plot. The shape and size of main quadrate was 20 m x 20 m that distributed along transects using a compass and tape measure. Many researchers have used similar sample plot size and shape in the different Afromontane forests in Ethiopia (Tadesse Woldemariam, 2003; Feyera Senbeta, 2006; Feyera Senbeta and Denich, 2006; Tsegaye Gobeze *et al.*, 2009).

However, precision of the results depend in part on the variation in the stand characteristics between the inventory plots, and partly on the number of sample plots if the population of interest is so heterogeneous. Thus, it is useful to know how many plots of a certain size are needed for a certain precision. Then the number of sampling units (n) required to attain a desired precision at sampling error (E) of 10% was given by the formula:

$$N = \frac{CV^2 * t^2}{E^2}$$ ……………………..……………………...(Shrivastava, 1997; Zahabu, 2008).

Where: N = number of sample plot needed,

CV= coefficient of variation (%) which is standard deviation/mean,

t= the value of t obtained from the student's distribution table at n-1 degree of freedom of the pilot study plots at 10% probability and,

E= desired sampling error expressed as percent of mean.

Other experience has shown that under certain circumstances, a 10 percent sampling error can be used to reduce costs while maintaining estimates within the precision of ±10 percent of the mean with a 95 percent confidence level (Zahabu, 2008). Therefore, bearing in mind the cost element and ease of handling the plots, it was decided to adopt the 10 percent sampling error of the mean with a 90 percent confidence level. Having decided on the use of 10% sampling error, total plot number was done based on the result of eight plots. The result of the eight plots helped to calculate standard deviation and mean value, which again help to calculate the CV and e-values. Then the number of plots, *n*, needed for each forest was obtained and distributed systematically. Once the use of 10% sampling error has decided, the calculation of the number of plots was done accordingly and the research had 58 plots (29 plots from forest without coffee and another 29 from forest with coffee forest). This total plot number was grouped according to the area coverage of the natural forest.

Latter, in all sample forest patches, the plot was spaced at every 300 m along linear and parallel transects at 500 m because the precision and accuracy of results are usually best if the plots are as far from each other as possible (Tadesse Woldemariam, 2003). Moreover, all sample plots was located at least 50 m from forest edges or roads to avoid edge effect on the species diversity and regeneration rate (Feyera Senbeta and Demel Teketay, 2001; Kittessa Hundera, 2010).

3.2.2.2 Methods of data collection

Data was collected from main plots of 20 m x 20 m and, nested plots of 10m x 10m and 1m x 1m positioned in each sampled forest patch. From the main plots of 20 m x 20m was recorded all mature trees of their diameter at breast height (DBH), their species level, tree height, number of individuals and indicators of human disturbances. Tree saplings / shrubs were identified and recorded with in 10m x 10m sub plots. Regeneration (tree seedlings) of less than 1.5 m height were identified and counted with in sub-plots of five with 1m x 1m size nested in the main plots. They were located at each corner and one at the center within the main quadrate of 20 m x 20 m. Here, sapling as those with height 1.5 m up to 6 m and DBH < 10 cm and seedlings defined as woody plants with height ≤ 1.5 m (Ensermu Kelbessa and Teshome Soromessa, 2004; Feyera Senbeta and Denich, 2006).

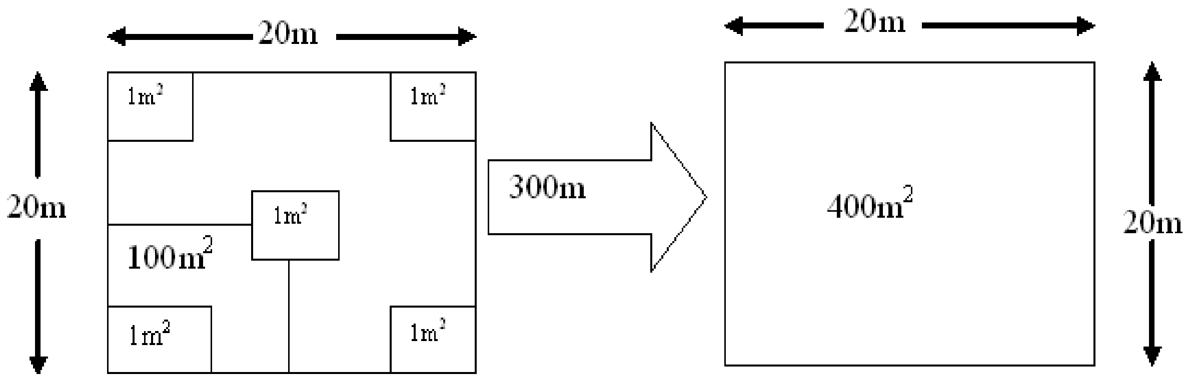

Figure 2 Layout of main and nested plots used

Tree DBH was obtained from measured circumference using common tapes. The great girth of trees in tropical forests renders common tapes preferable to calipers, as they provide measurements that are more consistent. While measuring tree diameter, the common tape was around the trunk in the horizontal plane and pulled tight with no bend, wrinkle, kink, or buckle anywhere along the tape. Moss, lichens, and loose bark were removed prior to measurement. While taking DBH, several cases exist to the point where the fork divides the stem. If the fork begins, the point where the core is divided, below 1.3 m height, each stems having the diameter required was considered as a tree and measured separately. When the fork begins at 1.3 m or a little higher, the tree was counted as a single tree. The diameter measurement is thus, carried out below the fork intersection point, just below the bulge that could influence the DBH (Saket *et al.,* 2004).

The height of these plant species was taken by using Hypsometer and sometimes with visual estimation where the tree located at difficult place to take hypsometer readings. The magnitude of human disturbance was recorded. As a certain level of anthropogenic disturbance exists in the forests, the type and extent of disturbance was recorded for each plot on words. Disturbance was based on visible signs such as coffee production, honey production, trees cut, poles cut; charcoal making, burnt areas and grazing.

Tree species names were identified in the field with the help of knowledgeable local individuals from the community. Moreover, species identification attempted by using published field guides of the Flora of Ethiopia (Azene Bekele *et al.,* 1993), and honeybee flora of Ethiopia (Fichtl and Admasu Addi, 1994). In addition, Botanist was consulted for species that were difficult to identify in the field through the above techniques and to assured the species identified by the local knowledgeable people. Finally, all the species types identified in the plots were collected, mounted, labeled, and have been deposited in Jimma University Herbarium. The identification was done using the Flora of Ethiopia and Eritrea and by comparing the specimens with the authentic specimens in the Jimma University Herbarium. The nomenclature of plant species follows the Flora of Ethiopia and Eritrea (Edwards *et al.*, 1995; 1997; 2000).

3.2.2.3 Methods of data analysis

All individuals of species registered in all the sample quadrates were used in the analysis of vegetation structure. The Diameter at Breast Height (DBH), basal area, tree density, frequency and important value index were used for description of vegetation structure.

1. Diameter at Breast Height (DBH)

DBH measurement was taken at about 1.3 m from the ground using common tape. Like caliper, the common tape does not measure diameter directly, but instead measures the circumference of the tree. The circumference was converted to diameter by solving for DBH in the equation: $C = \Pi * DBH.$

Where: C =circumference of tree,

Π =3.14,

DBH =diameter at breast height of tree.

Therefore, $DBH = C/\Pi$ ……………………………...........…………... (FFA Forestry, 2010).

2. Basal Area (BA)

Basal area refers to a measure of tree density that defines the area of a given section of land occupied by the cross-section of tree. It expressed in meter square per hectare. Basal area was also used to calculate the dominance of species.

$$BA = \Pi\left(\frac{DBH}{2}\right)^2$$ …………... (Suratman, 2012).

Where: BA- Basal Area (meter square)

DBH -is diameter at breast height (cm)

Π= 3.14

3. The Importance Value Index (IVI)

The Importance value index was calculated for each species to know the distribution of tree species in the natural forest with coffee and without coffee. Density of a species reflects the numerical strength of species in a given community (Kohli *et al.,* 2012). The IVI of a species is defined as the sum of its relative dominance, its relative density, and its relative frequency. Relative dominance is the total basal area of a species/total basal area of all species ×100, relative density is the number of individuals of a species/total number of individuals' ×100, and the relative frequency is the frequency of species/sum frequencies of all species ×100 (Dangol and Shivakoti, 2001; Feyera Senbeta, 2006; Savadogo *et al.*, 2007).

4. Species diversity, richness, and evenness indices

Diversity indices provide important information about rarity and commonness of species in a community. The indices used to compare diversity between habitat types (Suratman, 2012). Species richness is simply the number of species present in an area and species evenness refers to the proportion that each species comprises of the whole (Nolan and Callahan, 2006).

Thus, different diversity, species richness, species evenness indices were calculated for each for both forest patch categories.

The Shannon-Weiner species diversity index is calculated by taking the number of each species, the proportion each species from the total number of individuals, and sums the proportion times the natural log of the proportion for each species. Since this is a negative number, we then take the negative of the negative of this sum. The higher the number, the higher is the species diversity (Nolan and Callahan, 2006).

$$H' = -\sum_{i=1}^{s} pi \ln(pi)$$ ………………..…..……………………………………… (Shannon, 1948).

Where: H'= Shannon's diversity index

S = total number of species in the quadrate

Pi = ni/N, the number of individuals found in the i^{th} species as a proportion of the total number of individuals found in all species

In = natural logarithm to base e

The values of Shannon diversity index is usually found to fall between 1.5 and 3.5 and only rarely surpasses 4.5, where high values indicate high diversity (Magurran, 1988 and Scariot, 1999). Species richness (S) is defined by: $S = \sum n$ where, n is number of species in a forest lock. Evenness (E) was calculated using the Shannon evenness index following the equation

and it was calculated as Evenness (E) = $$\frac{H'}{H'_{max}} = -\frac{\sum_{i=1}^{s} pi(\ln pi)}{\ln S}$$ ………………(Alatalo, 1981).

Where: H'- is the Shannon-Wiener diversity index and,

H'max is the maximum possible value of diversity and it is equivalent to *InS*

S- The total number of species at a site

Evenness is normal between zero and one, and with one representing a situation in which all species are equally abundant, (the higher the value of E, the more even the species is in their distribution within the quadrates). Similarly, the higher the value of H', the more diverse are the quadrate.

Simpson index measures the probability that two individuals selected at random from a sample will belong to the same species. The Simpson index helps to calculate species richness for finite population. The formula are: $D = \frac{\sum ni(ni-1)}{N(N-1)}$ .... (Simpson, 1949).

Where: D= Simpson index

ni= no of individuals or amount of each species (no of individuals of the i^{th} species)

N= total number of individuals for the site

Simpson's index as originally formulated varies inversely with heterogeneity. To avoid this difficult it is statistically more correct to use a formulation adjusted for finite sample size: $D = 1 - \frac{\sum ni(ni-1)}{N(N-1)}$ (Peet, 1974). Generally, as D increases, species diversity decreases (Magurran, 1988).

5. Similarity indices

Measure similarity between communities based on species composition and it is useful in comparing communities under different management. Moreover, to measure similarities between the two forests categories, Sørensen's similarity coefficients were calculated using the following formula.

$S = \frac{2a}{(2a+b+c)}$ …………………………….....………………….………….. (Balmer, 2002).

Where: S= Sørensen's similarity index

a = number of species common to both habitats.

b = number of species present in the first habitat and absent from the second.

c = number of species present in the second habitat and absent from the first.

The similarity index value ranges from zero to one with the higher value suggesting greater similarity. Moreover, to give percentage similarity index multiply mostly the coefficient by 100. In addition, the value of dissimilarity can be calculated by index of dissimilarity = 1-S, where S- is the Sorensen's similarity coefficient.

3.2.3 Socio-economic data collection methods

3.2.3.1 Sampling procedure and sample size

The socio-economic primary data was collected from the selected four-forest user of PFM members. The required sample size was determined based on the formula below.

$$n = \frac{\frac{z^2 pq}{d^2}}{1 + \frac{1}{N}\left(\frac{z^2 pq}{d^2}\right) - 1} \quad \text{…………………………..…………….. (Cochran, 1977).}$$

Where: n= is the desired sample size

N =the number of sample size when the population is less than 1000

Z=95 percent confidence limit i.e. 1.96

P =0.1(proportion of the population to be included in the sample i.e., 10 percent)

q=1-0.1 =0.9

N= total number of population

D =margin of error or degree of accuracy desired (0.05).

Following the formula, the total sample size of the study was 137 households and the sample size was proportional to the total member household size of each forest user association. The total samples were the sum of 70 from forest without coffee users and 67 from forest with coffee users. To select the required sample size from the target group, first the lists of the forest user group were collected from the JICA office found in Shebe town and required sample households was selected in simple random method using a table of random numbers without replacement. Latter, the sample household head were responding to the questionnaire.

3.2.3.2 Methods of data collection

Data for this study was obtained from secondary and primary sources. The primary data source was including demographic and forest benefit data from both forests block users found under PFM through household survey and key informant interview. Secondary data was gathered to support the primary data sources.

Household Survey

The household survey was conducted to collect information from members of PFM users' using questionnaires. The questionnaires were composed of a mixture of open-ended and closed ended questions based on the objectives of the research to generate both qualitative and quantitative data. The questionnaire was designed prior to the actual fieldwork and was translated into local language (Afan Oromo). The questionnaire has two parts. The first part was about socioeconomic background information of the respondents like age, sex, and marital status, number of children, educational level, and religious affiliation. Whereas, the second part has detail question about the benefit they were earning during the year 2004 EC from all livelihood strategies and specifically from forest (including cost of production) and forest disturbance condition. The questions presented directly to each sampled respondents by the interviewer and administered on a face-to-face interview bases. The interviewers read each of the questions as instructed on the survey form and record the interviewee's responses.

Income from forest is the value of forest products, collected from natural forest managed by participatory forest management approach. The forest product includes forest coffee, spices, honey, controlled poles harvesting, firewoods, traditional medicines, and grasses. The economic benefits of natural forest calculated directly as the quantity of outputs produced from the natural forests by the local users, and each multiplied by an appropriate value then added together. For many outputs, local market prices were used as an estimate of value. However, instead of mentioning if nothing is there that goes to the household even if it is possible to attach monetary value. Therefore, in this study forest product like forest coffee, controlled poles harvesting, spices and honey from the forest have a monetary value.

Therefore, Total annual forest income (TAFI) is summation of different cash returns from forest products.

Key informant interview

For this study, key informants were people having in-depth knowledge of the forest status between different forest management system and its contribution for the society as well as possessing awareness of the different socio-economic status of the rural people. Hence, eight key informants were selected which was four key informants from the forest dependent rural population; two from the forest guards formally employed by the Oromia forest and wild life enterprise, and two from the site office worker of JICA. The four key informants from the forest dependent rural population groups were distribute to both village equally: two per one village. The four key informants were interviewed about the forest disturbance condition before and during PFM time, the management system that they were practicing on the forest, and the benefit from the forest, the nature of forest disturbance, and the forest enrichment practices that they were applying. The guards were asked about the situation of human influence on the natural forest during and before the PFM approach, and which management approach was sustainable for the forest condition. Lastly, the two office workers of the JICA were asked about their office role to maintain the natural forest species diversity. The interviews were semi-structured and involved asking open-ended questions. Prior to each interview, certain questions were determined to be key questions that needed to be asked of that interviewee.

3.2.3.3 Methods of data analysis

Data was analyzed using both descriptive and inferential statistics to draw meaningful result about the problem under investigation. The data collected from household questionnaires was analyzed using Microsoft Excel and the Statistical Package for Social Sciences (SPSS version 16). In this study, descriptive statistics was used to describe the demographic characteristics of the respondents and to find out the socioeconomic benefit differences of respondents in the two-forest user category. Finally, selected variables were tested by using regression and mean comparison. In all statistical tests, the value of $p = 0.05$ as level of significance was used. The regression equation of the model used in the tests can be presented as:

$$\gamma i = \beta_0 + \beta_1 \chi_1 + \beta_2 \chi_2 + \ldots + \beta_\kappa \chi_\kappa + \varepsilon i$$

Where: β_0 =Constant/intercept

γi =Total forest income

$\chi_{1-}\chi_k =$ Different forest income sources like forest coffee, spices, honey and controlled timber (which are independent variables explaining variance in Y).

εi is standard error of coefficient………………….………………(Simon, 2003).

4. RESULTS AND DISCUSSION

This chapter presents the findings of the study. The findings presented in a structured manner beginning with forest inventory data and followed by a socio-economic profile and benefits of natural forest for the studied villages.

4.1 Forest Community Structure

4.1.1 Family and species composition

Only live standing trees were measured and 32817 individual representing 60 species of vascular plants belonging to 37 families were identified from 58 quadrates (total area of 2.32 hectares) examined from the study area. The collected species were composed of 36.9% trees, 33.5% shrubs/trees, 29.5% shrubs, and 0.01% climbers.

When the two forest blocks described separately, forest without coffee had 55 species belongs to 33 families. Among these, the major families were Fabaceae and Rubiaceae represented by six and five species and they shared 5.7 and 16.6% from the total stem density of the block respectively. The next four families had 3 species each and Celastraceae (24.2%), Euphorbiaceae (2.2%), Oleaceae (9.2%) and Rutaceae (8.9%) of stem density. From the rest families, five of them had two species and 22 families each had only one species. On same point, forest with coffee had 45 woody species which were belongs to 26 families. Out of the total stem density of woody species in the forest with coffee, Rubiaceae family constituted five species (53.7%) followed by Oleaceae (9.4%), Celastraceae (9.2%), Fabaceae (5.8%), Rutaceae (4.8%) and Euphorbiaceae (1.13%) each with three woody species. The rest families had small number of species of which five families had two species and 15 families had only one species. This pronounced family hierarchy is one of the most important characteristics of the evergreen montane forests. Generally, forest without coffee had more number of woody species belongs to 33 families, but the forest with coffee was less diverse in terms of families of woody species. This was resulted by the existence of selective cutting of woody species in the forest with coffee by the users. Therefore, a complete list of scientific name, family, habit, and local name of the species were given in Appendix Table 1.

Ethiopia is situated in the Horn of Africa; possess one of the richest assemblages of plants in the African continent. According to Zewge Teklehaimanot and Healey (2001) and Zerihun Woldu *et al.* (2002), Ethiopia is endowed with rich fauna and flora because of its diverse ecological features, which make the country an important centre of diversity and endemism. Out of the endemic rich areas, Belete forest area is the one and among the total woody species identified in the study area, three of them were endemic species, which are included in the preliminarily assessed list for International Union for the Conservation of Nature and Natural Resources (IUCN) Red Data List. These were *Erythrina brucei* Schweinf, *Milletia ferruginea* (Hochst.) and *Vepris dainellii* (Pichi-Serm.) Kokwaro (Tesfaye Awas, 2009). These three woody species are least concern endemic species (Vivero *et al*., 2005).

4.1.2 Density of woody species

The density of tree and shrub species of the sampled area was analyzed. The density per hectare value of trees were (274 and 187), saplings and shrubs (1337 and 1493) and seedlings (16000 and 9103) of forest without and with coffee respectively. From the total number of individual, *Maytenus arbutifolia*, *Bersama abyssinica*, *Olea capensis, Rothmanniaur celliformis, Maytenus undata, Rytigynia neglecta,* and *Vepris dainellii* were the seven woody plant species contributed to the largest proportion of tree individuals in the forest without coffee. They shared 10771 out of 17500 individual trees and shrubs per hectare (which were 61.6%). Whereas, *Coffea arabica* was the first largest species that shared 4972 (46.1%) out of 10791 total woody individual per hectare in coffee managed forest. The next largest species were *Olea capensis, Maytenus arbutifolia, Bersama abyssinica*, *Rothmanniaur celliformis, Vernonia auriculifera,* and *Milletia ferruginea.* They together shared lower amount than *Coffea arabica* species, which was 3788 per hectare (35.1%) of trees and shrubs from forest with coffee. This signifies that coffee trees dominated the forest.

The finding was statistically tested for seedlings, sapling and shrubs, and trees of both forests. The one sample t-test demonstrate that significant differences was found in stem density at sapling and shrubs stage of the forest patches (t=19.134, p=0.033). However, the two forest categories had no significant difference in seedling (3.640, p=0.171) and mature trees (t=5.299, p=0.119) although in terms of count, the forest with coffee had a lot seedlings. Furthermore, no significant difference observed between the forests in stem density per hectare of seedlings, saplings, and trees when excluding the coffee species from the analysis (Table 1).

Table 1 Comparison of stem counts across different growth forms of both forest

Growth level	T	df	Significance level (2-tailed)
Seedling	3.640	1	0.171
Sapling	19.134	1	0.033
Trees	5.299	1	0.119

4.1.3 Diameter class distributions

The distribution of trees across different DBH classes was analyzed. The patterns of diameter class distribution indicate the general trends of population dynamics and recruitment processes of a given species (Feyera Senbeta, 2006). The total density of woody species was 17500 and 10791 individual per hectare in forest without and with coffee respectively. From DBH greater than 0.5 cm, more density was contributed by *Maytenus arbutifolia* (17%), *Bersama abyssinica* (8.9%), and *Olea capensis* (8.4%) in forest without coffee. However, from forest with coffee, *Coffea arabica* contributed 46% followed by *Olea capensis* (9.2%) and *Maytenus arbutifolia* (6.2%). Those with DBH greater than 10, 20 and 40 cm of forest without and with coffee had individual per hectare value of 273 and 191, 120 and 74, and 45 and 18 respectively.

The DBH analysis revealed that more number of woody stems was distributed in the lower DBH classes, which were followed by a decrease in the number of stems per hectare when the DBH increased. The density per hectare value in DBH 0.5-5 cm implied that there were more individual stems in the forest with coffee area than forest without coffee (Figure 3 & 4). However, when the DBH value increased, the stem density per hectare became relatively higher in the forest without coffee than forest with coffee. Therefore, the DBH distribution of both forest blocks showed an inverted J-shape which typically observed in natural undisturbed montane forests with many small stems compared to few large sized trees. This pattern implied that the forest has good reproduction and recruitment potential. Though the DBH distribution showed an inverted J-shape in the forest with coffee area, it did not refer the forest potential of reproduction and recruitment. This was due to the domination of single species (*Coffea arabica*). This single species shared 46.1 percent from the total stems per hectare. Feyera Senbeta and Demel Teketay (2003) also concluded that the dominance of shrubs and small trees in a forest suggests that bigger tree species are selectively removed. Mastewal Yami *et al.* (2006) also stated that the selective removal of bigger woody species for fuel wood and construction in Tembien, Tigray affects the diameter distribution. As a result, the number of individuals in the next higher diameter classes declined due to high interference by local people and the same was true in forest with coffee. The finding was consistence with Alemnew Alelign *et al.* (2007) in peninsula of Zegie, north Gonder, Deka *et al.* (2012), Majumdar *et al.* (2012), Khumbongmayum *et al.* (2005), Bhuyan *et al.*(2003) and, Chittibabu and Parthasarathy (2000) in India.

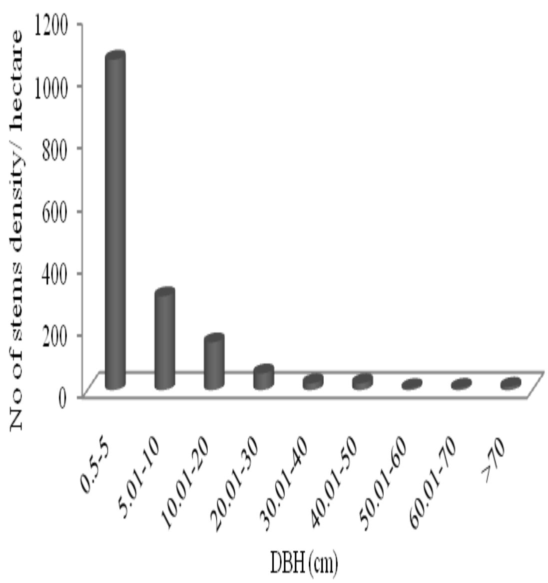

Figure 3 DBH classes of forest without cofea

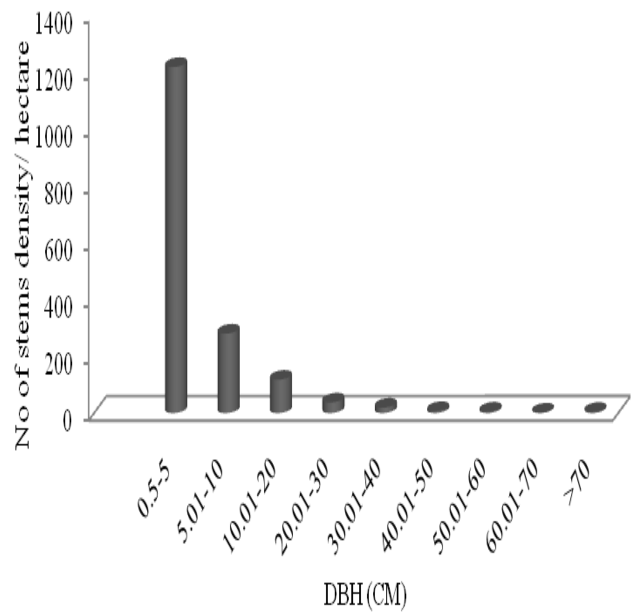

Figure 4 DBH classes of forest with cofea

According to Fekadu Gurmessa *et al.* (2012), the ratio of density at DBH class from 10-20 cm to density greater than 20 cm is taken as the measure of size class distribution. Accordingly, the ratio of individuals with DBH between 10 up to 20 cm to DBH greater than 20 cm was 1.4 and 1.58 for forest without and with coffee respectively. These results indicated that their proportion of medium-sized plants, DBH between 10 and 20 cm, was greater than from large sized trees (DBH > 20 cm). However, the ratio of density value implied the forest with coffee had more number of stems per hectare with DBH value range from 10-20 cm than the forest without coffee and this proved that the forest with coffee are in a stage of secondary regeneration forest.

Although the two forest categories were found in the same agro ecological zone with local people participation in the management, natural forest with coffee showed lower density of individual trees with DBH greater than 20 cm. This variation was due to the different way of using the natural forest by the local users and the existence of selective clearing of species in forest with coffee.

When this ratio was compared with other forests in the country (Table 2), forest without coffee was greater than Menagesha-amba mariam, but lower than all others listed. This was largely because of high density of big size trees of *Syzygium guineense, Croton macrostachys,* and *Sapium ellipticum* in the forest. However, forest with coffee was greater than forest without coffee, Menagesha amba mariam, Komto forest, and Angada. This indicates there was relatively more abundance of individuals of DBH 10-20 cm compared to DBH greater than 20 cm. This was resulted by the domination of *Coffea arabica* and clearing of other woody species.

Table 2 Reported stem density value of other montane forests in Ethiopia

Name of Forests	DBH between 10-20 cm (a)	DBH >20 cm (b)	Ratio of a/b	References
Masha Andaracha	385.7	160.5	2.40	Kumilachew Yeshitela and Taye Bekele (2003)
Donkoro	526	285	1.85	Abate Ayalew *et al.* (2006)
Gura Ferda	500	263	1.90	Dereje Denu (2007)
Menna Angetu	292	139	2.10	Lulekal (2008)
Alata-Bolale	365	219	1.67	Woldeyohannes Enkossa (2008)
Menagesha Amba Mariam	155.5	197	0.80	Abiyou Tilahun (2009)
Gedo	832	464	1.79	Birhanu Kebede (2010)
Chato	333	194	1.79	Feyera Abdena (2010)
Angada	372.8	252	1.47	Shambel Alemu (2011)
Komto	330	215	1.53	Fekadu Gurmessa *et al.* (2012)
Belete forest with coffee	136	86	1.58	Current study (2013)
Belete forest without coffee	178	127	1.40	Current study (2013)

4.1.4. Vertical structure

The vertical structure of the woody species occurring in studied forest were described following the International Union Forestry Research Organization (IUFRO) classification scheme as used by Lamprecht (1989). Therefore, in this study the tallest tree recorded were *Celtis africana,* and *Sapium ellipticum* with 30 m height each. Accordingly, the upper storey (tree height greater than 2/3 of the top height) was greater than 20 m, middle storey (tree height between $1/3^{rd}$ and $2/3^{rd}$ of the top height) was 10-20 m and lower storey (<$1/3^{rd}$ of the top height) <10 m (Table 3). Table 2 indicated that 87.4 percent of the woody species in the forest without coffee were concentrated in the lower storey where the middle and upper storey had 9.6 and 3 percent respectively. While the coffee forest area had woody species of 89.9% in the lower storey, but declined more to the middle and upper storey as compared to forest without coffee. In addition, the forest without coffee had more species number in lower and upper storey than the forest with coffee. However, they had nearly equal species in the middle storey. Small number of woody species occupied the upper storey of the forest with coffee. This condition again confirmed the existence of selective cutting of woody species in the forest with coffee. Based on species analysis across height classes, there were species in both forest block that had no representative in the middle and lower storey. Among the species listed in forest without coffee, *Polyscias fulva* that had no representative from the lower and middle storey. Similarly, the forest with coffee had two woody species (*Apodytes dimidiata* and *Schefflera abyssinica*) that had no representative in the lower and middle storey. Therefore, absence of representative in the lower and middle storey indicates that the species are in the verge of extinction in the forests.

Table 3 No of stems per hectare and number of species in each vertical layer of both blocks

Storey	Height (m)	No of stems/ha		No of species	
		Without coffee	With coffee	without coffee	with coffee
Lower	<10	1437.9 (87.4%)	1516.4(89.9%)	47	41
Middle	10-20	157.8(9.6%)	147.4(8.7%)	29	30
Upper	>20	49.1(3%)	23.3(1.4%)	13	7

Statistical analysis of one sample t-test was done separately for their stem density per hectare of the three strata of the forests. Statistically significant difference was observed between lower (t=37.634, p=0.017) and middle storey (t=29.346, p=0.022). However, the upper storey did not show significant difference (t=2.806, p=0.218). Similarly, based on the species available in each stratum of the two forest patches, significant differences were observed at the middle (t=59, p=0.011) and though not strong, at lower storey (t=14.667, p=0.043). However, there was no significant variation between the two forests at the upper strata (t=3.333, p=0.186) (Appendix Table 4).

Tree height reflects about the different growth phase of tree species. In addition, it is a good indicator of the role of a species as each of them occupies a different layer and practically determines the vertical structure of the stand (Pascal *et al.,* 1996). Variation in tree height is an important ecological phenomenon that affects the microclimate and distribution of epiphytes and climbers (Tamrat, 1993 cited in Feyera, 2010). Height can be used as an indicator of forests age and the woody species in the study area could be conveniently divided into 6 height classes. The density of trees decreased with increasing height classes (Figure 5 and 6). This means, there were higher number of woody species in the lower size and a gradual decrease towards the middle and upper height class that indicates absence of continuous representation of individuals in all height classes. Such patterns commonly referred to as inverted J-shape distribution showing stable woody population structures.

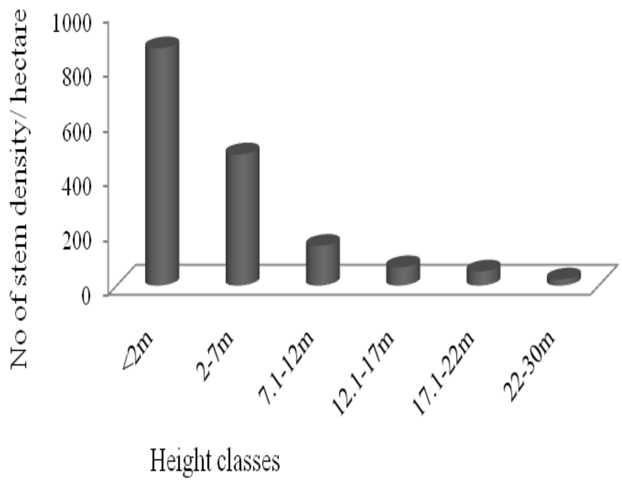

Figure 5 Height classes of forest without cofea

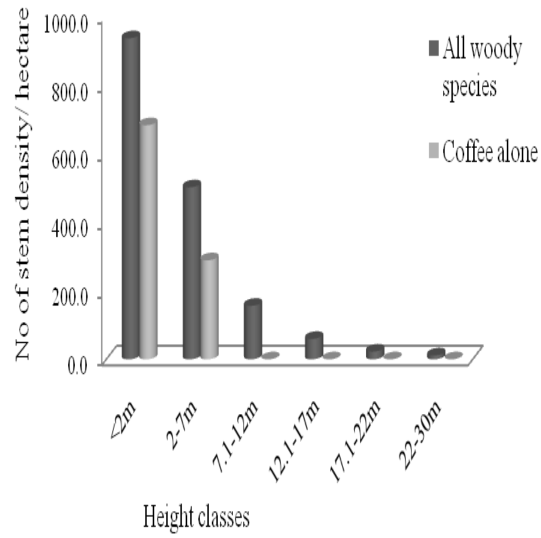

Figure 6 Height classes of forest with cofea

From the total stems density, 83.2% found in the height class of less than 2 meter in forest with coffee and 44% (747 coffee trees from 1687 individual per hectare) were covered by coffee plant. This implied the rest woody species shares were smaller as compared to woody species share in forest without coffee. From trees in height class 2-7 meters, the forest with coffee (502 individuals/ hectare) was greater than forest without coffee (481 individuals/ hectare). However, in the rest height classes, the forest without coffee showed greater stem density than the forest with coffee. Fekadu Gurmessa *et al.* (2012) in Komto Afromontane moist forest in east Wellega zone found a similar result. Moreover, the current study agreed with Feyera Senbeta (2006) a study conducted in five Afromontane rainforests in Ethiopia (except Harenna forest). Although the two forests showed an inverted J- shape graph, the forest with coffee had no good recruitment potential since the forest had domination of *Coffea arabica*. The reason was, although the participatory forest management agreement (PFMA) does not allow the forest user to cut alive trees, illegally the member were practicing selective cutting of woody species in the forest to enhance their coffee productivity. According to Getachew Tesfaye and Abiyot Berhanu (2006), existence of higher number of large-sized individuals in the upper height class in the natural forest implies the presence of a good number of adult tree species for reproduction. This argument holds true for forest without coffee than the forest managed with coffee due to relatively the lower rate of cutting of a standing and a live trees.

4.2 Forest Regeneration Status

Trees density and their regeneration in the forest are largely dependent on the response of the seedling and saplings to the forest microenvironment and interactive influence of an array of biotic and abiotic factors (Shankar, 2001; Mishra *et al.,* 2003). The population (age) structure of a species in a forest can convey its regeneration behavior. Regeneration status of species was based on population size of seedlings and saplings (Dhaulkhandi *et al*., 2008). Therefore, the total density of seedlings, saplings and shrubs, and mature trees in forest without coffee were 16000, 1337 and 274, and in forest with coffee were 9103, 1493 and 187 per hectare respectively (Table 4). Based on these values, forest without coffee has larger density of seedling and mature trees, but lower stems density at sapling stage, and this variation was largely due to differences in level of anthropogenic disturbance. Concerning the number of species, the forest without coffee had larger amount in each stage than forest managed with coffee. However, relatively from seedling and sapling, the forest with coffee constitutes more species at the mature tree level (41 species) due to the preservation of trees for coffee shade (Table 4).

Table 4 Stem per hectare and species number of seedlings, saplings, and mature trees

No	Types	Forest without coffee		Forest with coffee	
		Stem density/ha	Species number	Stem density/ha	Species number
1	Seedlings	16000	31	9103 (4483 coffee)	17
2	Saplings and shrubs	1337	33	1493 (972 coffee)	19
3	Mature trees	274	45	187	41

Output from one sample T-test shows that there was significant difference between the two forest blocks in species at the seedling stage ($t=21.5$, $p=0.030$). This might be due to the great disturbance of the lower storey of forest with coffee through removing of under storey vegetation. However, the difference is insignificant in species available at sapling and shrubs ($t=3.714$, $p=0.167$) and mature tree ($t=3.429$, $p=0.181$) (Appendix Table 4).

Both forest categories had mature tree lower than the seedling and saplings, which indicates the existence of good regeneration status. However, among the total number of seedlings identified in the forest with coffee, majority of them were coppicing-regeneration from vegetative sprouts because they have strong ability to reproduce vegetative (Schmitt *et al*., 2009). On top of that, in the forest with coffee, *Coffea arabica* alone constituted 49.2% of individual seedling per hectare that marked other woody species regeneration status was endangering. The same domination was extended to the sapling and it constituted 65% coffee trees per hectare. Regeneration of a particular species is poor if seedlings and saplings are lower in number than the mature trees. If a species is present only in an adult form, it considered as not regenerating (Saxena and Singh, 1984; Dhaulkhandi *et al*., 2008). With this concept, forest without coffee had five woody species that had no representative from the sapling and seedling stages. These were *Dombeya torrida, Hagenia abyssinica, Macaranga capensis, Polyscias fulva,* and *Schefflera abyssinica*. Similarly, in the forest with coffee, the species with no representation in the seedling and sapling stages were more in number*:* *Pouteria adolfi-friedericki, Apodytes dimidiata, Ekebergia capensis, Ficus thonningii, Polyscias fulva,* and *Schefflera abyssinica*.

The results revealed that, mean total density of regenerates per plot was 640 and 364 stems in forest without and with coffee respectively. Moreover, woody species recruitment from seeds already present in soil layer was lower in forest with coffee than forest without coffee and most of the seedlings in forest with coffee were coppicing. Bhuyan *et al.* (2003) reported that stump coppicing shoots are abundant in highly disturbed forest stand with the extraction of trees in eastern Himalayas in India. Tadesse Woldemariam (2003) in Yayu forest in Ethiopia and, Eilu and Obua (2005) in Uganda found similar results. Pawar *et al.* (2012) have also reported a similar trend of results where least disturbed site was good regenerating but highly disturbed site did not show good regeneration. In sum, the disturbance condition was serious in the forest managed with coffee and resulted declining of woody species. For the healthy natural forest ecosystems, forests managed without coffee was good since it constituted higher woody species and more mother trees.

4.3 Basal area and Importance Value Index

In the case of natural forests, basal area is a good measure of site potential (Kusaga, 2010).The total basal area of forest without coffee calculated was 19.9 m^2 per hectare for woody species of DBH greater than 0.5 cm. There was a considerable decrease in number of individuals with increasing DBH size in the first three DBH classes, which was followed by slight falling and finally higher basal area in the last DBH >70 cm. The reason for irregularities might be illegal tree cutting. The total basal area of woody species in the forest with coffee was 18.7 m^2 per hectare. There was a considerable decrease in basal area as increasing DBH size up to DBH 70 cm, but the last DBH class possesses 46.7 percent from the total basal area per hectare which was much larger than the forest without coffee (Figure 7 and 8). This was the result of few but, larger sized tree existence.

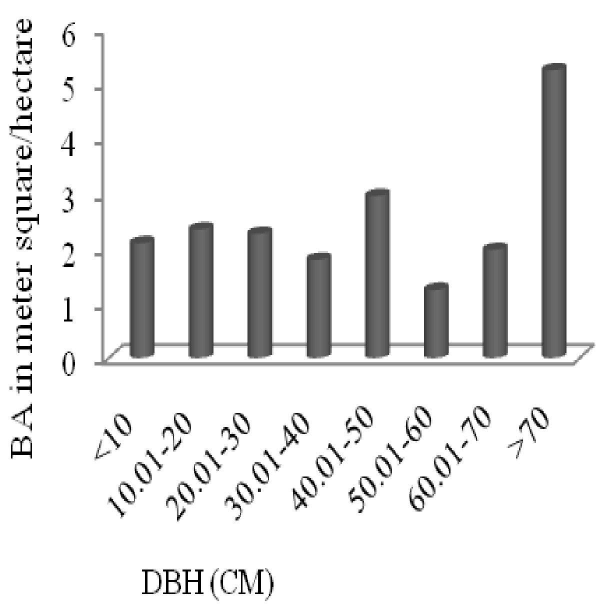

Figure 7 Basal area verses DBH classes in forest without cofea

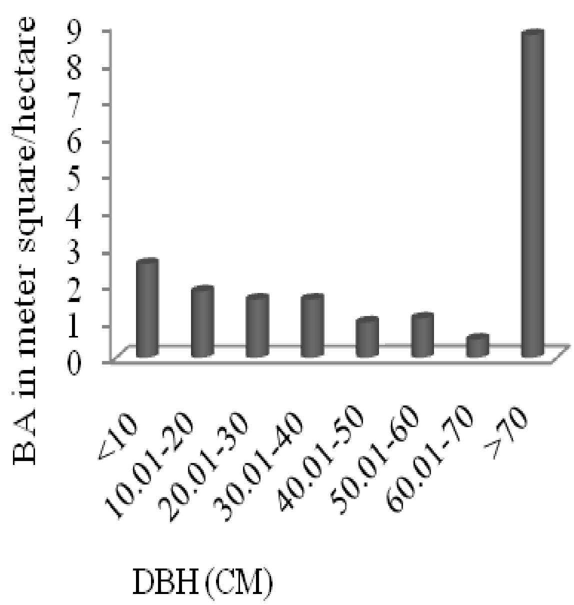

Figure 8 Basal area verses DBH classes in forest with cofea

Similar results were found out in the contribution of larger DBH classes to total basal area in other forests of Ethiopia such as in Komto (Fekadu Gurmessa *et al.,* 2012), Masha Anderacha forest (Kumilachew Yeshitela and Taye Bekele, 2003), and Dodola forest (Kittessa Hundera *et al.*, 2007). Generally, the findings of the present study indicated that forest with coffee is under tremendous pressure from human disturbance. This is in conformity with the findings of Yadav and Gupta (2006) who reported that the species richness, density, and basal cover of most of the species were relatively higher in the undisturbed forest as compared to the disturbed forest areas in India.

From the entire basal area, four species in forest without coffee share relatively higher basal area. These *Syzygium guineense, Sapium ellipticum, Croton macrostachys* and *Prunus africana* together constituted 12.05 m^2 per hectare (60.3%). Similarly, in the forest with coffee five woody species of *Celtis africana, Olea welwitschii, Polyscias fulva, Sapium ellipticum,* and *Schefflera abyssinica* shared 10.32 m^2 (55.4%). However, only one species (*Sapium ellipticum*) had high basal area per hectare in both forest categories. Nevertheless, the rest woody species were different. The relative importance of woody species in a forest understands well from measurements of basal area than stem counts. Therefore, species with the largest contribution in basal area considered the most important woody species in the forest (Fekadu Gurmessa *et al.*, 2012). Species like *Bersama abyssinica, Coffea arabica*, *Maytenus arbutifolia*, *Maytenus undata, Olea capensis, Rytigynia neglecta,* and *Vepris dainellii* although they had higher density per hectare; their basal area is not as high as their density. This is because such woody species have small size.

According to the relative dominance of woody species, both forest is characterized by a few dominant species and many in less dominancy. The ranked species curve had a steeper slope for forest without coffee. *Syzygium guineense* (31.3%), *Croton macrostachys* (13%) and *Milletia ferruginea* (8.39%) were the first three species in forest without coffee whereas; the forest with coffee had nearly equal relative dominancy between *Olea welwitschii* (13.4%), *Sapium ellipticum* (11.1%), *Celtis africana* (10.7%), and *Schefflera abyssinica* (10.7%) (Figure 9, Appendix Table 2 and 3).

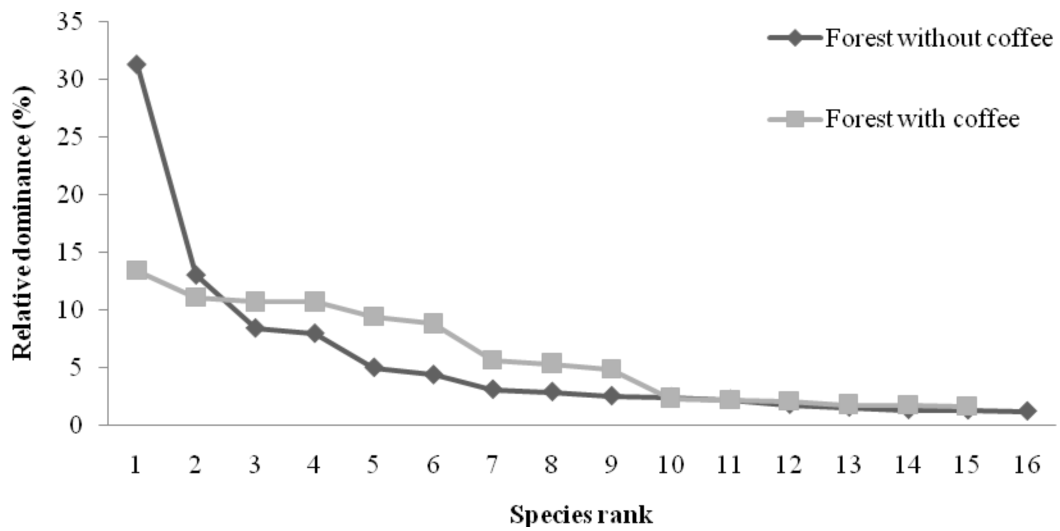

Figure 9 Relative dominance of woody species greater than one percent

From both forest blocks, the 12 most dominant woody species with the higher importance value index are listed in Table 3 and 4. Among the listed species, the first five dominant and ecologically most significant tree species were used. From the forest without coffee, *Syzygium guineense* (IVI = 41.4), was the dominant species in the forest. It had the highest relative dominance - an extrapolation of basal area- of all woody species, at 31.3 %, a relative frequency of 5.63 %, and relative density of 4.51%, but it was lower than other species in the site. The second ranked species was *Maytenus arbutifolia* (IVI = 26.2), which had a relative density of 17%, relative frequency of 6.81% and relative dominance of 2.4 %. This species took the first rank in terms of relative density and relative frequency; however, in terms of relative dominance, it ranked tenth. The third ranked species was the *Croton macrostachys* (IVI= 19) which had a relative density of 1.38 %, relative frequency of 4.69 % and relative dominance of 13%. Note that at 13%, this species' relative dominance was second to that of *Syzygium guineense*. The fourth species in the importance value index was *Bersama abyssinica*, (IVI = 16.8). This woody species ranked second in terms of relative density and third in relative frequency value. *Olea capensis* (IVI= 15.7), ranked fifth in its importance value index; however it ranked third in relative density (8.41 %), seventh and ninth in terms of its relative dominance and relative frequency respectively (Table 5).

Table 5 Importance Value Index (IVI) of the 12 most species in forest without coffee

Species name	Abundance/ha	Frequency	RD	RF	RDO	IVI
Syzygium guineense	915	24	4.51	5.63	31.3	41.4
Maytenus arbutifolia	3455	29	17	6.81	2.4	26.2
Croton macrostachys	281	20	1.38	4.69	13	19.0
Bersama abyssinica	1799	23	8.86	5.4	2.5	16.8
Olea capensis	1707	18	8.41	4.23	3.07	15.7
Maytenus undata	1449	23	7.14	5.4	1.53	14.1
Rytigynia neglecta	1293	22	6.37	5.16	1.76	13.3
Prunus africana	591	10	2.91	2.35	7.93	13.2
Allophyllus abyssinicus	923	18	4.55	4.23	4.34	13.1
Milletia ferruginea	266	13	1.31	3.05	8.39	12.8
Vepris dainellii	1236	19	6.09	4.46	1.18	11.7
Rothmanniaur celliformis	1552	12	7.65	2.82	0.21	10.7
Total	15467		76.18	54.23	77.61	

From forest with coffee, *Coffea arabica, Olea capensis, Olea welwitschii, Milletia ferruginea, and Sapium ellipticum* were the first five species based on their IVI values relative to other species. *Coffea arabica* (IVI= 64) took the first rank in terms of relative density and relative frequency; however in terms of relative dominance, it ranked sixth. *Olea capensis* (16.6) had second in terms of relative density, but fourth and thirteenth in relative dominance. Although *Olea welwitschii* (15.7) had the third position in terms of IVI value, it took the first position in relative dominance that was followed by *Sapium ellipticum* (14.4). Concerning *Milletia ferruginea* (ranked fourth in IVI=15.6) had second position in terms of relative frequency next to *Coffea arabica*, but seventh and eighth rank based on the relative density and dominance respectively (Table 6).

Table 6 Importance Value Index (IVI) of the 12 most species in forest with coffee

Species name	Abundance/ha	Frequency	RD	RF	RDO	IVI
Coffea arabica	5767	29	46.07	9.12	8.8	64
Olea capensis	1153	18	9.211	5.66	1.76	16.6
Olea welwitschii	17	7	0.136	2.2	13.4	15.7
Milletia ferruginea	463	21	3.699	6.6	5.3	15.6
Sapium ellipticum	18	10	0.144	3.14	11.1	14.4
Celtis africana	17	9	0.136	2.83	10.7	13.7
Vepris dainellii	328	21	2.62	6.6	2.31	11.5
Schefflera abyssinica	2	2	0.016	0.63	10.7	11.3
Croton macrostachys	120	15	0.959	4.72	5.62	11.3
Maytenus arbutifolia	772	14	6.168	4.4	0.59	11.2
Bersama abyssinica,	747	12	5.968	3.77	0.84	10.6
Polyscias fulva	2	2	0.016	0.63	9.42	10.1
Total	9406		75.143%	50.3%	80.54%	

Therefore, the two forest blocks had different woody species list both in the most and least dominant species. From the most dominant species list only one species (*Olea capensis)* with different rank common in both forest categories, but the remaining species were different. For instance, *Syzygium guineense* was first species in the forest without coffee, but the *Coffea arabica* with IVI value of 64 took the leading position in the forest with coffee.

Among the total species recorded in the site, the least woody species based on their IVI value from forest without coffee were *Podocarpus falcatus* (IVI=0.25), *Paveta abyssinica* (IVI=0.25), *Justicia schimperiana, Jasminum abyssinicum* and *Acacia brevispica,* each with 0.28 IVI value. Similarly, the species types from forest with coffee were *Premna schimperi* (0.33), *Calpurnia aurea* (0.35), and *Jasminum abyssinicum* (0.38) (Table 5).

Table 7 Woody species that needs more conservation priority of both forest categories

	From forest without coffee	From forest with coffee
1	*Dombeya torrida*	*Ehretia cymosa*
2	*Dracaena fragrans*	*Landolphia buchananii*
3	*Dracaena steudneri*	*Rhus ruspolii*
4	*Premna schimperi*	*Ficus thonningii*
5	*Acacia brevispica*	*Jasminum abyssinicum*
6	*Jasminum abyssinicum*	*Calpurnia aurea*
7	*Justicia schimperiana*	*Premna schimperi*
8	*Paveta abyssinica*	*Dracaena steudneri*
9	*Podocarpus falcatus*	*Dracaena fragrans*

Therefore, such woody species were the least dominant and ecologically less significant species in the site. Although, the listed species had less economic value to the local people, since they are not timber trees, they may need most conservation priority from ecological point of view.

4.4 Woody Species Diversity and Composition

Plant species diversity is mostly influenced by human impacts and natural disturbances and when the disturbance level is less, it promotes species diversity (Rasingam & Parathasarathy, 2009; Sapkota, 2009). This is probably because forests subjected to low levels of disturbance were also often subjected to low level of species exploitation, which ensures higher resource availability (Sapkota, 2009). The differences in number of species to number of individual ratio between forest types indicate that the disturbance affects the species richness and abundance in both forests differentially and hence influenced the woody species diversity (Magurran, 2004).

4.4.1 Woody species diversity

Shannon-Wiener and Simpson diversity index were computed for the two forest categories. The result showed that the diversity (2.98) and evenness (0.74) in forest without coffee were much higher than the forest with coffee (2.13 of Shannon diversity and 0.56 of evenness).

Hence, Shannon's species diversity index shows that the forest stands without coffee have higher diversity as compared to that of the stand with coffee. This variation was an indicative of high anthropogenic disturbance that led to the high abundance of one or a few species in forest with coffee. This demonstrates the reduction in woody species diversity in human impacted sites and it is similar with the studies of Lalfakawma *et al.* (2009); Yadav and Gupta (2006); Sagar *et al.* (2003) and Chittibabu and Parthasarathy (2000) in India. Hence, low diversity of the forest with coffee attributed to a large number of *Coffea arabica* individuals. This is consistent with study by Feyera Senbeta and Denich (2006) and Feyera Senbeta (2006) that most plots that were affected by human influence were found to contain a high number of coffee plants, which has significant negative relationship with species richness. Moreover, the forest without coffee not only has a greater number of species abundance, but the individuals in the community were relatively distributed more equitably than forest managed with coffee (Table 8).

Table 8 Diversity index comparisons of both forest categories

No	Index	Forest without coffee	Forest with coffee
1	Shannon Wiener diversity index (H`)	2.98	2.13
2	Species richness (S)	55	45
3	Evenness (E)	0.74	0.56
4	H'max	4.0	3.8
5	Simpson index	13.9±0.93	4.2±0.70
6	Beta diversity	80%	

In forest with coffee, forest management activities like coffee plantation, weeding under storey and cutting of trees were common. Once the coffee trees were planted, the users keep on removing the under storey species because; coffee is highly sensitive to competition from shrubs and small trees (Demel Teketay 1999 cited in Feyera Senbeta, 2006). Schmitt *et al.* (2005) has also stated that in forest the cutting of trees leads to an opening of the vegetation and to the development of a dense shrub and herb layer. In line with this, the forest users have continuously removed the under storey vegetation. Therefore, such kinds of forest management acts reduce woody species composition and vegetation structure of the forests which latter resulted to the missing of forest woody species. This agrees with Tadesse

Woldemariam (2003) who have argued that such continued removal of the under storey vegetation in forest leads to a decline in species diversity in Yayu forest. This is because such continued clearing of the under storey limits the capabilities of species regeneration from seedling and soil seed banks, and the coppicing ability of stumps.

4.4.2 Beta-diversity

The Sorensen's similarity coefficient was used to calculate beta-diversity to detect similarities/dissimilarities among woody species in the two forest blocks. As a result, 80 percent of their woody species were similar in composition. Although, the two forest blocks were found in same agro ecological zone, they showed 20 percent dissimilarity index. These variations were due to disturbance level variation. Relatively, the forest with coffee exposed to more anthropogenic activities like clearing of under storey vegetation, cutting of bigger trees, pit-sawing, animal grazing, fire, hanging beehives, and more than these all the local people were planting coffee and they let mostly trees that had no major impact on the produce of coffee. On the contrary, the forest without coffee protected better than forest with coffee and the level of human disturbance was limited. The local people were using the natural forest for animal grazing, collection of dead woods, hanging beehives, but no acts like cutting alive trees, coffee plantation, burning of trees, ring cutting, and pit sawing. Therefore, the dissimilarity level of the two-forest block was not mainly due to environmental variability, but the variation in level of anthropogenic disturbances.

4.5 Types and Extent of Forest Disturbances

Various types of forest disturbances were found throughout the study area. Both forests had shown evidence of some form of human disturbance. This included cutting of poles, trees, firewood and bark, the presence of charcoal pits, pit sawing structures, animal traps, burnt areas, coffee plantation, clearing of under storey and honey production. Livestock grazing was particularly widespread in both forest areas. Concerning anthropogenic disturbances within same forest block, their intensity was varying across different areas. However, forest with coffee had disturbances mostly related to cultivation of coffee, cutting of trees, charcoal making, hanging of beehives, burnt areas, livestock grazing, removing of some species bark for local beehives making and firewood harvesting (Figure 10). The intensity of tree harvesting varied across the different sites with in coffee managed forest. Especially in Metti Chafe forest patch, tree harvesting was extremely intensive than the Debiye forest.

Figure 10 Tendency of human disturbance inside natural forests with coffee

Forest without coffee had no incidences of coffee plantation, charcoal making, burnet areas and clearing the under storey. In this forest category, the human activities with the highest disturbance factors were trees cut followed by livestock grazing. There were nearly balance incidences of honey production in both forest blocks. The forests with coffee had more production of coffee compared to forest without coffee. There were also burnt areas and charcoal making, although they were not common. Generally, human disturbance in forest with coffee were higher and put negative impact on the diversity of woody species as well as the forest moved to a few species domination.

4.6 Socioeconomics Contribution of Natural Forest

4.6.1 Households' demographic characteristics

Demographic features such as sex, age structure, family size, ethnic composition, literacy, and landholding size of the respondents presented and analyzed in this sub-heading. Brief description of these features can be helpful to understand the socioeconomic status of the area under study. Of the sampled household heads' in forest with coffee users, the majority (95.5%) were male headed where as only 4.5% were female headed. Similarly, in the forest without coffee users, 92.9% were male and 7.1% female. The respondents were mainly from male sex who mostly involve in forestry, farming, labor work, selling of animals and other income activities assuming that usual participant can provide more information than those who do not involve in such income earning activities.

The mean age of respondents of forest without coffee users was 44.34 years with a standard deviation of 9.13 and it ranges from 30 up to 66 years. In the forest with coffee user villages, respondents mean age was 42.12 years with a standard deviation of 11.52 that ranges from 23 up to 69 years. The overall mean of family size was 5.93 and 5.10 persons in forest without coffee and forest with coffee villages respectively. A large proportion of respondents, 48(68.6%) of the village of forest without coffee had a family size range from 4 up to 6 persons and similarly, village of forest with coffee had 41 (61.2%) from 4 up to 6 persons (Table 9).

Table 9 Demographic characteristics of the respondents

Variables	Age		Family Size	
	Forest without coffee	Forest with coffee	Forest without coffee	Forest with coffee
Minimum	30	23	3	1
Maximum	66	69	11	9
Mean	44.34	42.12	5.93	5.10
Std. Deviation	9.13	11.52	1.71	1.76

The education level of respondents was broadly classified into four categories such as illiterate, primary level, secondary level and college level. According to the household survey result, most of the respondents (52.2%) were illiterate, 37.3% had completed the primary level, and 10.4% had completed the secondary level in respondents from forest with coffee users. Whereas, respondents from forest without coffee users, 54.3% illiterate, 32.9% primary education level, 10% had secondary education and 2.9% had technical and vocational education training.

The land holding size of the respondents' ranges from 0.25 ha to 2.75 ha with a mean of 1.1 ha and standard deviation of 0.64 in forest with coffee users. It ranged from 0.25 up to three ha with a mean of 1.37 ha and standard deviation of 0.64 in forest without coffee users. Moreover, the respondents involved in the survey were belonging to different ethnic groups. Oromo ethnic shared 90 and 85%, Amhara 3 and 6%, Kefa 3 and 6 %, and remaining 4 and 3% from other ethnic categories without coffee and with coffee users respectively.

4.6.2 Income from natural forest reserves

Forest was one of the income sources and the present study indicated that forest plays a great role in contributing to rural people incomes. Most of the communities in the study areas are used forest and its products as sources of sustenance and income.

The study applied t-statistic to compare whether there was a significant difference between the income levels of PFM participants with coffee and without coffee forests. Based on simple comparisons of means of household incomes co-varieties between the two groups, the differences were quite very significant in forest (p=0.000). This implied that the forest with coffee users had more income sources from their forest block. This was due to the cultivation of coffee from the forests. However, their forest income source was not including the premium price from the sale of organic coffee in Japan. The exported organic coffees of 2012 to Japan market were not completely sold and some were remaining in the warehouses until April 2013 (Teferi and Tesfaye, Personal communication). Therefore, the research was not able to include that as part of forest income sources. One could imagine that the forest contribution to the rural people might be more than that if the premium value were included.

Further, the forest income sources were statistically tested and the result revealed that the two forest users had significant variation on income derived from forest coffee (p= 0.000). However, they had no significant variation in terms of income derived from honey (p=0.451) and spices (p=0.067) (Appendix Table 6). It is obvious that the forest with coffee users are keep on planting coffee seedlings to boost up their cash return from forest whereas, the forest without coffee users had no right to planting coffee inside of their PFM forest blocks except collecting wild coffee beans.

Generally, the qualitative data indicated that, local communities derive a number of benefits from their forest blocks. They were using the forest for fuelwood collection for cooking and heating, legal timber production, wild coffee collection, collection of medicinal plants for household needs, collecting spices for both home use and market to earn some money. From the two villages, villag with coffee forest have also more income source from coffee production under the natural forets. Fuel wood is the most important forest product in Ethiopia. For example, annual demand for fuel wood (45 million m^3) is close to twenty times the demand for other forest products combined (Bekele Million and Berhanu Leykun, 2001). Similarly, the local people in both forest categories harvested a lot amount of firewood from their forest patches. The by-law granted the member to collect firewood twice a week and once per week for the non-members living around the forest patches. Firewood is used for cooking and heating. This was due to unavailability of kerosene oil, electricity, and gas cylinder. Hence, the local people option was using of firewood for cooking and heating. On top of that, the forest was being extensively used for pasture in both villages, and probably this was another obstacle in natural regeneration of the woody species in the forests. Moreover, timber and poles are used for house construction and manufacturing farming tools. Grass and other herbs from the forest are fed to their animals particularly during the winter months when ground forage is in short supply.

4.7 Results of Key-informant Interviews

According to the interview result, almost all people from Sebeka-Debiye responds that PFM as very important both for the forest and for their livelihoods. On same expression, the key informants' people in the Atro-Gafare village respondents considered that PFM was extremely important for the forest and important for improving the benefit for the user group. However, they noted the PFM had less benefit for them as compared to the villagers producing coffee from the forest. Thus, most respondents generally viewed PFM as an important mechanism for both the people and forests. Nonetheless, some respondent look their PFM implementation as unfair and limited them from planting coffee seedlings inside the forest like the people in Sebeka-Debiye villages. Moreover, respondents from both forest user categories reported an overall improvement in forest cover now than past period. However, a minority reported that there is decline in recent years since the forest started jointly governed by regional state and local people. The reason was that, since the forest guards were from the local community, people had less fear to exploit commercially valuable species.

Despite the illegality of taking cut wood from the forest reserves, the by-law granted them to harvest poles for building from the forest reserves. According to the by-law, special permits required to harvest poles for own private use within the village such as for house construction purposes. Under such circumstances, the member selects old trees and grants them to villagers upon approval of requests by the members of the forest association. The decision to cut old trees for timber has to be authorized by the group of forest users' leaders and the bylaw decided that the person should plant another five seedlings after harvest. Although, it was not common in all villages surrounding the forest, rural people in the forest with coffee categories can also harvested organic coffee from the forest.

The important lessons learned from key informant interviews in forest with coffee user suggest that the participatory forest management had given chance to the local people to enlarge the number of coffee trees inside the forest, and even they removed the benchmark point between the forest and the private holdings. This was done deliberately to expand their private land holdings. Some of them feared that the forest may be eliminated since the continued removal of the under storey continued and if the forest use agreement is not put in to practices. Moreover, the responses of the former forest guards were not supporting the PFM since the local people did not obey the by-law. They degraded the forest instead of using in a sustainable fashion. The people themselves harvesting timber, and producing poles from endangered species like *Pouteria adolfi-friedericki, Milletia feruginia, Cordia africana,* and also from plantation trees like *Juniperous procerea, Pinus pachula* and soon. This list was based on the responses of former forest guards interviewed.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the results obtained from the sample size used, 60 woody species of 37 families were recorded. The total number of species collected from forest without coffee was 55, which belongs to 33 families and forest with coffee had 45 woody plant species that belongs to 26 families. The two-forest blocks had 40 (80%) species in common. However, twenty woody plant species that is fifteen species exclusively found in forest without coffee and five observed in managed coffee forest. A very small number of woody plant species represented most of the families, i.e. 15 in forest with coffee and 22 in forest without coffee. The two forest categories had showed differences in the species number and total stem count per hectare. Moreover, the study has concluded that although the forest is characterized by the presence of more woody species in common, it lacks natural balance between different DBH and height classes. Such variation was associated with the degree level of antropogenic disturbances in the natural forest.

Description of population structure of woody species revealed inverted J-shaped graph, which referred existence of more population from the lower age group. Such different patterns of population structure indicating high variation among woody species population composition and the existence of good recruitment potentials. Though the graph of forest with coffee was an inverted J-shape, population of lower DBH class was possessed by *Coffea arabica* and thus the forest was not in a good recruitment potential due to few species domination. Therefore, high density of coffee plants in the lower diameter class implied the other woody species were continuously declined from the forest and gradually the coffee plant may dominate the natural forest. For instance, *Pouteria adolfi-friedericki, Apodytes dimidiata, Ekebergia capensis, Ficus thonningii, Polyscias fulva,* and *Schefflera abyssinica* had no representative from sapling and seedling stage that might be associated with disturbances.

There was variation in diversity and evenness of woody species and, the Shannon-Wiener and Simpson diversity index value confirmed that the diversity and evenness in forest without coffee were much higher than the forest with coffee. The lower values of Shannon and Simpson index in the forest with coffee were an indicative of the high abundance of one woody species. Such one species domination implied the existence of loss of woody species diversity and it is more likely to have negative effects on forest biodiversity. This ecological variation between the two forests was caused by differences in level of anthropogenic disturbances. With this, the present study reveals that the anthropogenic disturbance causes disruption of forest structure and changes in species composition which latter leads to reduction of woody species density and frequency. Therefore, the major disturbing factors in the forest without coffee were found to be tree cutting and animal grazing. Whereas, inside the forest with coffee, coffee plantation and clearing under storey was being serious and changing the forest structure, leading to species diversity loss and creation of a homogeneous, mono-specific *Coffea arabica* under storey in the forest.

The results also indicate that a considerable difference was found in the sources of income and livelihood strategies of the respondents of community forest participants'. The major cash oriented livelihood strategies of respondents from forest with coffee users was coffee from the natural forests. Moreover, forest resources contributed significantly towards the subsistence (non-cash) oriented livelihoods of all respondents (for example fire wood for cooking and heating, poles for construction purposes, pastures for livestock, medicine, etc). Therefore, the improvement of the forest cover might ensure and strengthen livelihood security of the local people in the future. Result of mean comparision between the two forest users, the difference was great in forest income (p=0.000). They had significant variation on income derived from forest coffee (p= 0.000) but, they had no significant variation in income from honey (p=0.451) and spices (p=0.067). Despite the potential and obvious importance of beekeeping as a sustainable income generating activity, only few people in both areas generates income from wild honey.

5.2 Recommendations

The composition, distribution, and diversity of woody plant species in montane forests are becoming management issues because of the concern over their vulnerability to human-induced changes. Therefore, based on the analysis of the forest community structure and socio-economic situation in Belete natural forest between the two forest blocks of under PFM, action recommendations have been forwarded for sustainable utilization of the natural forest.

1. The participatory forest management activities is one alternative for sustainable utilization of the forest. However, there should be strict follow up from outside bodies, especially on the village where they are using the forest for organic coffee production.

2. Species of listed in the first and second priority classes for conservation should be given enough attention and should be conserved in-situ by creating collaboration with local people and the district as well as with Oromia forest and wild life enterprise. The species under great threat of extinction need further scientific investigation concerning their regeneration capability. These were *Paveta abyssinica, Podocarpus falcatus, Premna schimperi, Landolphia buchananii, Hagenia abyssinica, Rhus ruspolii, Ehretia cymosa, Prunus africana, Ekebergia capensis, Pittosporum viridiflorum, Pouteria adolfi-friedericki Fagaropsis angolensis, Flacourtia indica* and so on.

3. Although the PFM forest management agreement supports the planting of indigenous tree species, the actual work was low. Therefore, reforestation is crucial to enhance the natural regeneration of poorly represented and totally absent woody species in the lower and upper storey such as *Polyscias fulva, Schefflera abyssinica* and *Apodytes dimidiata* by planting of ample number of seedlings.

4. Open grazing system should be reduced since the grazing process can affect the natural regeneration capacity of different woody species in both forest blocks.

5. The concerned bodies (district agriculture office) should motivate the farmers to expand non-timber forest product harvesting systems. Specially expand modern apiculture for local people using the natural forest outside of coffee cultivation in order to improve their total household income.

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7. APPENDIX

Appendix 1: Household Questionnaire

Dear Sir or Madam:

Hello, my name is Wondimagegn Mengist. I am a graduate student from Jimma University, Ethiopia from Natural Resource Management department. I am conducting research on woody species and socioeconomic variations of participatory forest management blocks with and without coffea: a case from Belete forest, Southwest Ethiopia. My research is being carried out under the support by Jimma University. Therefore, the information will be used for academic work and all individual information will be kept confidential.

I thank you very much for your cooperation!

Questionnaire no.___________ Date _______________

Interviewee name_________________________ Village__________________

1. Background information of household characteristics

1. Your age ________

2. Sex_________

3. Marital status A. Married B. Single C. Divorced D. Widow

4. Level of education A. University degree and above B. Diploma C. Illiterate
D. Secondary (grade 9-12) E. Primary (grade 1-8)

5. Number of family size______________________

6. Size of your farm lands_________________ (in hectare).

7. Occupation type A. Farmer B. Village council leader C. Self employed
D. Employed either in NGO or government institutions E. Others (Specify) __________

8. Ethnic group A) Oromo B) Amhara C) Keffa D) others, specify________

9. What is your primary livelihood means? a) Agriculture b) daily labor work c) Trading
d) off-farming activities like selling of fire wood, collecting of wild honey, e) other ____

II. Information on the PFM program, its benefit and challenges

10. Are you members of the WABuB? A. Yes B. No

11. Are people generally supporting the WaBuB initiative?
A. Yes: in what way (examples)? __________________________
B. No: why not (examples)? ___________________________________

12. Do you have access to the natural resources within the forest patches found in your village? A. Yes B. No

12.1 How far the forest resource from:

A. your home_________km B. the market______________km

13. What are the types and quantities of forest products you can collect for both home use and market sale in the year 2004 E.C?

Forest products	unit	Amount collected	Home use	For market	Net income per month
1. Fuel wood					
2. Charcoal					
3. Pole					
4. Grasses					
5. Timber					
6. Coffea					
7. Honey					
8. Spices					

Key: the unit can be in kilogram, for product listed from 6-8, quintal for number 4, bundle for the rest.

14. The spice amount you could collected from the forest in the last year

No	Types of spices	Amount collected	Home use	For market	Net income
1	Ginger(Zingiber officinale)				
2	Ethiopian Cardamom (Korerima)				
3	Ethiopian Coriander (Coriandrum sativum)				
4	Piper capense (Timiz)				
5	Cinnamon				
6	Gesho				
7	Ensosela				
8	Medicinal plants				

15. Compared to the time when no PFM practice in your village, what is the benefit amount you have got now?

A) Less than B) equal amount C) greater amount D) undefined

16. Compared to the village where PFM practice is absent, what is your benefits level?

A) Less than B) equal amount C) greater amount D) undefined

17. Forest benefit distribution in your village is equal to all members of WaBuB?

A. Yes B. No

17.1 If your choice is no for question #17, what is the reason?

____

18. During the year 2004 E.C, what amount of your income source was derived from each means of livelihoods?

	Types of means of livelihoods	Total amount
1	Farming (crop sale)	
2	Small business	
3	Livestock(sale in number)	
	Livestock (in income: butter, egg, cheese…)	
4	Income from forests	
5	Fishing and hunting	
6	Labour/daily wage	
7	Remittance	

19. Which part of tree can be collected from the forest found in your village?

a) Deadwood b) Living branches c) Both deadwood and living branches

d) The whole stems

20. How do you asses community based forest management (WABuB or PFM)?

	WaBuB benefits	For the forest	For the user livelihood
1	It is very important		
2	It is important		
3	It is not important		
4	Indifferent		

21. If your answer is either No 1 or No 2 for question #20, what are your reasons from the listed point in the table below? Make a mark in the table below based on your preferences to forest access.

	List of benefit due to WaBuB	Rank
1	More access to forest products	
2	More access to non forest products	
3	Gained training ,which leads to improving forest harvest quality	
4	Improvement on forest products and marketing opportunities	
5	Participation in forest tree management	
6	Alternative income sources e.g. tree nurseries management	
7	PFM designing extraction rules and enforcement rules in decision making process	
8	If is there other, please specify and rank it	

22. If your answer is "not important" for question #20, what are your reasons from the listed point in the table below? Make a mark in the table below based on your preferences.

	List of disadvantage due to WaBuB	Rank
1	Less access to forest products	
2	Less access to non forest products	
3	No improvement on forest products and marketing opportunities	

4	No participation in forest tree management	
5	Absence of alternative income sources like tree nurseries management	
6	Local chief designing extraction rules and enforcement rules in decision making process	
7	If is there other, please specify and rank it	

23. If your answer is "indifferent", why? ______________________________

24. What kinds of forest management activities have done in your forest patch? ________

25. What kinds of forest management activities are prohibited? ____________________

26. Who should manage the forest reserves?

A. Federal government B) Regional government C) Local people through PFM program d) other, please specify________________________

27. When you compare the forest benefit before and during PFM, in which time do you have more forest products for personal uses?________________

28. Do you say that the PFM practice in your area reduced rate of forest degradation?

A) Yes B) No

29. Do you plant seedling to improve the status of forest in your village?

A. Yes B. No

30. If your answer for question #29 is yes, who selected the species type? _________

31. At the time of planting seedlings in which part of the forest you planted the seedlings? (Possible to give more than one answers)

Responses type	Mark X on your choice
A) Open areas B) after clearing of shrubs and herbaceous plants C) by clearing of old trees D) by clearing of economically less important trees E) After harvesting of all mature trees	

32. Did you see change in the forest condition after the forest given to WaBuB members?

A. yes B. No

33. If your response is yes, answer the two questions below.

A. What are the positive changes you observe in the forest? ____________________

B. What are the negative changes you observe in the forest? ____________________

34. How do you regard the status of the forest as compared to the past period?

(A) Very good (B) Good (C) Satisfactory (D) Poor (E) Do not know

Appendix 2: Key Informant Interview Guide Lines

Background Information on Participants

Residency: In which community do you live and how long have you lived there?

Occupation: What is your principal occupation and how many years have you worked in this occupation?

Education: What is your highest level of education?

Age: What is your date of birth? (Or approximate age)

Sex: ________________

Forest condition, benefit and challenge related questions: Overview

1. What are the benefits of natural forests?

2. What are the benefit differences between members of WaBuB?

3. What did you do for the protection of the natural forest in your village? Who initiated you to do that?

4. What are the great challenges of natural forests degradation in your village?

5. Which plant species have highand less market demand?

6. If the current governing system continued in the future, what will be the chance of the natural forest in your perspective village?

7. Is there big difference between members WaBuB in terms of poverty?

8. Based on your opinion, who should govern the natural forests?

9. How do you control conflicts between/among the member of the WaBuB/ forest user outside of PFM?

Is there anything else you believe I should know?

Appendix 3: Forest inventory form

Date____________________ Forest block___________ Plot No______________ Transect No________________ Plot size____________m²

GPS coordinate (x/y) ___________, ___________

No	Tree species		DBH (cm)	Height (m)	Forest layer	Scale of human disturbance
	Local name	Scientific name				
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						

Appendix Table 1 List of plant species collected in Belete natural forest, Southwest of Ethiopia

C=Climbers, S= Shrubs, T= Trees, T/S= Tree/Shrubs, *Amharic name, ** name in Kafinnono, and Ver. name = Vernacular name in Afan Oromo

Botanical name	Family	Habit	Ver.name	Coll.no
Acacia brevispica Harns	Fabaceae	S	Kontir *	WM017
Albizia gummifera (J.F. Gmel) C.A.Sm.	Fabaceae	T	Ambabessa, Catto,	WM020
Allophyllus abyssinicus (Hochst.) Radlkofer	Sapindaceae	T	Seo	WM034
Apodytes dimidiata E. Mey. ex Arn.	Icacinaceae	T	Qumbela	WM049
Bersama abyssinica Fresen.	Melianthaceae	T	Lolchiisaa	WM025
Brucea antidysenterica J.F. Mill.	Simaroubaceae	T	Komengaw	WM056
Calpurnia aurea (Ait). Benth.	Fabaceae	S	Cheekaa	WM015
Celtis africana Burm .f.	Ulmaceae	T	Kayyii	WM022
Clausena anisata (Wild.) Benth.	Rutaceae	S/T	Ulumay	WM008
Coffea arabica L.	Rubiaceae	S/T	Bunaa	WM048
Cordia africana Lam.	Boraginaceae	T	Wadessa, Mokoto	WM047
Croton macrostachys Hochst. exDel.	Euphorbiaceae	T	Bakanissa	WM001
Diospyros abyssinica (Hiern) F. White	Ebenaceae	T	Loko	WM050
Dombeya torrida (J.f Gmel.) P.Bamps	Sterculaceae	T	Daannisa	WM044
Dracaena fragrans (L.) Ker-Gawl.	Dracaenaceae	T/S	Jedo	WM030
Dracaena steudneri Engl.	Dracaenaceae	T/S	Emoo **	WM052
Ehretia cymosa Thonn.	Boraginaceae	T/S	Ulaga	WM042
Ekebergia capensis Sparrm.	Meliaceae	T	Sombo	WM054
Elaeodendron buchananii (Loes.)	Celastraceae	T	Loko guracha	WM029
Erythrina brucei Schweinf	Fabaceae	T	Afrartu, Korch	WM004
Fagaropsis angolensis(Engl.) Dale	Rutaceae	T	Siglu	WM046
Ficus sycomorus L.	Moraceae	T	Harbu	WM024
Ficus thonningii Blume	Moraceae	T	Dambii	WM058
Flacourtia indica Brn.f.Merr	Flacourtaceae	T	Akukkuu	WM021
Galiniera saxifragea (Hochst.) Bridson	Rubiaceae	S/T	Simerero	WM010
Glinus lotoides L.	Aizoaceae	S	Mitre	WM038
Hagenia abyssinica (Bruce) J.F. Gmel.	Rosaceae	T	Heexoo	WM059
Hypericum quartinianum A. Rich.	Guttiferae	S/T	Mito Keleme,	WM018
Jasminum abyssinicum Hochst. ex. DC.	Oleaceae	C	Nech Hareg *	WM039
Justicia schimperiana (Hochst. ex Nees) T. Anders	Acanthaceae	S	Dhumugga/ Tumuga	WM040
Macaranga capensis (Baill.) Sim	Euphorbiaceae	T	Halelle	WM009

Continued...

Maesa lanceolata Forssk.	Myrsinaceae	T	Abayyii	WM014
Maytenus arbutifolia (Hochst. Ex A. Rich.) Wilczek	Celastraceae	S	Kombolcha (1)	WM002
Osyris wightiana Wall. ex Wight	Santalaceae	T/S	Wentafulasa	WM060
Maytenus undata (Thunb.) Blake lock	Celastraceae	S	Kombolcha (2)	WM005
Milletia ferruginea (Hochst.) Bak.	Fabaceae	T	Birbirraa	WM019
Olea capensis(C.H.Wright)Verdc	Oleaceae	T	Geja	WM006
Olea welwitschii (Knobl.) Gilg & Schellenb.	Oleaceae	T	Bayaa	WM051
Paveta abyssinica Fresen.	Rubiaceae	S	Mukabuna/Bunorebii	WM032
Landolphia buchananii (Hallier f.) Stapf	Apocynaceae	C	Yeibbo **	WM007
Piper capense L.f.	Piperaceae	S	Timiz *	WM031
Pittosporum viridiflorum Sims.	Pittosporaceae	T	Soolee	WM041
Podocarpus falcatus(P.gracilior)	Podocarpaceae	T	Birbirsa	WM057
Polyscias fulva (Hiern.)	Araliaceae	T	Aberra	WM023
Premna schimperi Engl.	Vewenaceae	T/S	korasuma	WM055
Pouteria adolfi-friedericki(A.Chev.)Aubrev. &pellegr.	Sapotaceae	T	Kararo, Guduba	WM028
Prunus africana (Hook.f.) Kalkm.	Rosaceae	T	Gurayo, Homii	WM035
Psychotria orophila Petit	Rubiaceae	S/T	Aeimato **	WM043
Pterolobium stellatum (Forssk.)	Fabaceae	S	Qoonxirii, Kajima	WM027
Rhamnus prinoides L'Herit	Rhamnaceae	S/T	Raha, Geeshoo	WM016
Rhus ruspolii Engl.	Anacardiaceae	T	K'ammo **	WM045
Rothmanniaur celliformis (Hiern) Robyns	Rubiaceae	T/S	Diibo **	WM033
Rytigynia neglecta (Hiern) Robyns	Rubiaceae	S/T	Mixxoo	WM013
Sapium ellipticum (Hochst.) Pax	Euphorbiaceae	T	Bosoka	WM011
Schefflera abyssinica (Hochst.ex.A.Rich.)	Araliaceae	T	Gatamee	WM036
Syzygium guineense F.white	Myrtaceae	T	Badessa	WM003
Tiliacora troupinii cufod.	Menispermaceae	C	Leketi Hareg	WM026
Vepris dainellii (Pichi-Serm.) Kokwaro	Rutaceae	S	Hadhessa	WM037
Vernonia amygdalina Del.in Caill	Asteraceae	T/S	Ebicha	WM053
Vernonia auriculifera Hiern.	Asteraceae	S	Reejjii	WM012

Appendix Table 2 Frequency, importance value index (IVI) and priority for conservation of woody plant species in forest without coffea

Scientific name	Frequency	RD	RF	RDO	IVI	Priority class
Syzygium guineense	24	4.51	5.63	31.3	41.4	5
Maytenus arbutifolia	29	17	6.81	2.4	26.2	5
Croton macrostachys	20	1.38	4.69	13	19	5
Bersama abyssinica	23	8.86	5.4	2.5	16.8	5
Olea capensis	18	8.41	4.23	3.07	15.7	5
Maytenus undata	23	7.14	5.4	1.53	14.1	5
Rytigynia neglecta	22	6.37	5.16	1.76	13.3	5
Prunus africana	10	2.91	2.35	7.93	13.2	5
Allophyllus abyssinicus	18	4.55	4.23	4.34	13.1	5
Milletia ferruginea	13	1.31	3.05	8.39	12.8	5
Vepris dainellii	19	6.09	4.46	1.18	11.7	5
Rothmanniaur celliformis	12	7.65	2.82	0.21	10.7	5
Hypericum quartinianum	16	2.58	3.76	0.7	7.03	4
Clausena anisata	16	2.69	3.76	0.44	6.89	4
Albizia gummifera	10	3.29	2.35	0.89	6.53	4
Macaranga capensis.	6	0.07	1.41	4.97	6.45	4
Sapium ellipticum	20	0.75	4.69	0.7	6.15	4
Ficus sycomorus	10	0.11	2.35	2.86	5.32	4
Piper capense	5	2.92	1.17	0.21	4.3	3
Glinus lotoides	9	1.28	2.11	0.37	3.76	3
Celtis africana	8	0.84	1.88	0.78	3.5	3
Polyscias fulva	2	0.79	0.47	2.19	3.46	3
Pouteria adolfi-friedericki	7	0.47	1.64	1.28	3.39	3
Vernonia auriculifera	9	0.96	2.11	0.22	3.29	3
Flacourtia indica	7	0.85	1.64	0.02	2.51	2
Olea welwitschii	2	0.81	0.47	0.97	2.26	2
Brucea antidysenterica	4	1.23	0.94	0.07	2.24	2
Landolphia buchananii	6	0.53	1.41	0.19	2.13	2
Calpurnia aurea	7	0.13	1.64	0.23	2	2
Maesa lanceolata	5	0.1	1.17	0.55	1.82	2
Pterolobium stellatum	6	0.12	1.41	0.16	1.69	2
Rhamnus prinoides	1	0.02	0.23	1.3	1.56	2
Ehretia cymosa	2	0.8	0.47	0.13	1.4	2
Apodytes dimidiata	3	0.4	0.7	0.25	1.36	2
Erythrina brucei	2	0.79	0.47	0.07	1.33	2
Fagaropsis angolensis	3	0.09	0.7	0.47	1.27	2

Continued...

Cordia africana	2	0.43	0.47	0.22	1.12	2
Osyris wightiana	1	0.41	0.47	0.13	1.02	2
Psychotria orophila	1	0.02	0.23	0.61	0.87	2
Galineria saxifrage	3	0.06	0.7	0.08	0.84	2
Tiliacora troupinii	3	0.06	0.7	0.08	0.84	2
Hagenia abyssinica	1	0	0.23	0.59	0.83	2
Elacodendron buchananii	2	0.02	0.47	0.09	0.59	2
Pittosporum viridiflorum	2	0.02	0.47	0.09	0.59	2
Vernonia amygdalina	2	0.01	0.47	0.07	0.55	2
Schefflera abyssinica	2	0.01	0.47	0.03	0.51	2
Dombeya torrida	1	0.01	0.23	0.13	0.38	1
Dracaena fragrans	1	0	0.23	0.07	0.31	1
Dracaena steudneri	1	0	0.23	0.07	0.31	1
Premna schimperi	1	0.04	0.23	0.05	0.33	1
Acacia brevispica	1	0.02	0.23	0.03	0.28	1
Jasminum abyssinicum	1	0.02	0.23	0.03	0.28	1
Justicia schimperiana	1	0.02	0.23	0.03	0.28	1
Paveta abyssinica	1	0	0.23	0.01	0.25	1
Podocarpus falcatus	1	0	0.23	0.01	0.25	1
Total		100	100	100	300	

Appendix Table 3 Frequency, importance value index (IVI) and priority for conservation of woody species in forest with coffea

Scientific name	Frequency	RD	RF	RDO	IVI	Priority class
Coffea arabica	29	46.07	9.12	8.8	64	5
Olea capensis	18	9.211	5.66	1.76	16.6	5
Continued...	7	0.136	2.2	13.4	15.7	5
Milletia ferruginea	21	3.699	6.6	5.3	15.6	5
Sapium ellipticum	10	0.144	3.14	11.1	14.4	5
Celtis africana	9	0.136	2.83	10.7	13.7	5
Vepris dainellii	21	2.62	6.6	2.31	11.5	5
Schefflera abyssinica	2	0.016	0.63	10.7	11.3	5
Croton macrostachys	15	0.959	4.72	5.62	11.3	5
Maytenus arbutifolia	14	6.168	4.4	0.59	11.2	5
Bersama abyssinica,	12	5.968	3.77	0.84	10.6	5
Polyscias fulva	2	0.016	0.63	9.42	10.1	5
Cordia africana	12	0.184	3.77	4.8	8.76	4
Vernonia auriculifera	9	4.889	2.83	0.53	8.25	4
Rothmanniaur celliformis	5	5.169	1.57	0.24	6.98	4

Diospyros abyssinica	9	2.788	2.83	0.98	6.59	4
Maytenus undata	9	2.756	2.83	0.44	6.03	4
Clausena anisata	9	2.101	2.83	0.18	5.11	4
Paveta abyssinica	8	1.534	2.52	0.25	4.3	3
Albizia gummifera	6	2.069	1.89	0.27	4.23	3
Elacodendron buchananii	10	0.232	3.14	0.6	3.98	3
Galiniera saxifraga	11	0.128	3.46	0.25	3.84	3
Ficus sycomorus	5	0.08	1.57	2.14	3.79	3
Allophyllus abyssinicus	9	0.104	2.83	0.35	3.29	3
Apodytes dimidiata	3	0.024	0.94	2.02	2.99	2
Maesa lanceolata	2	0.687	0.63	1.61	2.92	2
Glinus lotoides	6	0.743	1.89	0.16	2.79	2
Flacourtia indica	3	0.032	0.94	1.72	2.69	2
Rytigynia neglecta	5	0.775	1.57	0.13	2.48	2
Syzygium guineense	5	0.048	1.57	0.61	2.23	2
Fagaropsis angolensis	6	0.072	1.89	0.2	2.15	2
Vernonia amygdalina	4	0.112	1.26	0.36	1.73	2
Pouteria adolfi-friedericki	3	0.032	0.94	0.41	1.38	2
Macaranga capensis	3	0.024	0.94	0.15	1.12	2
Prunus africana	2	0.016	0.63	0.39	1.04	2
Ekebergia capensis	2	0.064	0.63	0.31	1.01	2
Ehretia cymosa	2	0.032	0.63	0.16	0.82	1
Landolphia buchananii	2	0.064	0.63	0.06	0.76	1
Rhus ruspolii	2	0.016	0.63	0.02	0.66	1
Ficus thonningii	1	0.008	0.31	0.07	0.39	1
Jasminum abyssinicum	1	0.032	0.31	0.03	0.38	1
Calpurnia aurea	1	0.016	0.31	0.02	0.35	1
Premna schimperi	1	0.008	0.31	0.01	0.33	1
Dracaena steudneri	1	0.008	0.31	0.01	0.33	1
Dracaena fragrans	1	0.008	0.31	0.01	0.33	1
Total		100	100	100	300	

Appendix Table 4 Statistical out put on forest data using one sample test

1. Comparison of stem counts across different growth forms of both forest

Growth level	T	df	Significance level(2-tailed)
Seedling	3.640	1	0.171
Sapling	19.134	1	0.033
Trees	5.299	1	0.119

2. Based on stem density of seedling, sapling, & shrubs, and trees of the two forests.

One-Sample Test

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Seedling	3.640	1	.171	12551.500	-31265.85	56368.85
Sapling &shrubs	19.134	1	.035	1414.75	420.489	2409.011
Trees	5.299	1	.119	230.500	-322.22	783.22

3. Based on the stem density per hectare in both forest across the three storeys.

One-Sample Test

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Lower	37.634	1	.017	1477.1500	978.431	1975.869
Middle	29.346	1	.022	152.6000	86.528	218.672
Upper	2.806	1	.218	36.2000	-127.710	200.110

4. Based on the species availability in both forest across the three storeys.

One-Sample Test

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Lower	14.667	1	.043	44.000	5.88	82.12
Middle	59.000	1	.011	29.500	23.15	35.85
Upper	3.333	1	.186	10.000	-28.12	48.12

5. Based on species available in seedling, sapling and trees of the two forests

One-Sample Test

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Seedling sp	21.500	1	.030	43.000	17.59	68.41
Sapling &shrubs sp	3.714	1	.167	26.000	-62.94	114.94
tree sp	3.429	1	.181	24.000	-64.94	112.94

Appendix Table 5 Regression analysis outputs

1. Multiple Regression output in forest users' village without coffea

Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.4454(a)	.206	.144	665.006

a. Predictors: (Constant), Total annual income, Forest distance from home, Forest distance from market, Family size, Farmland

b. Dependent Variable: Forest

ANOVA (b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7356219.907	5	1471243.981	3.327	.01(a)
	Residual	2.8300000	64	442232.926		
	Total	3.5660000	69			

a. Predictors: (Constant), Total annual income, Forest distance from home, Forest distance from market, Family size, Farmland

b. Dependent Variable: Forest

Coefficients (b)

Model		Un standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1090.236	543.431		2.006	.049
	Family Size	103.711	65.072	.247	1.594	.116
	Farm land size	-657.965	179.570	-.585	-3.664	.001

	Forest distance from home	159.724	96.307	.220	1.658	.102
	Forest distance from market	-390.399	165.325	-.329	-2.361	.021
	Total annual income	.041	.019	.373	2.180	.033

a. Dependent Variable: Forest

Appendix Table 6 Independent sample t-test out puts

Independent Samples Test for forest income comparison

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
coffea	Equal variances assumed	95.530	.000	10.607	135	.000	8196.378	772.728	6668.161	9724.596
	Equal variances not assumed			10.376	66.005	.000	8196.378	789.968	6619.159	9773.598
honey	Equal variances assumed	.571	.451	-.265	135	.791	-21.709	81.917	-183.715	140.297
	Equal variances not assumed			-.264	124.706	.793	-21.709	82.360	-184.713	141.295
spices	Equal variances assumed	3.411	.067	-.918	135	.360	-47.194	51.421	-148.888	54.501
	Equal variances not assumed			-.937	72.100	.352	-47.194	50.346	-147.554	53.166