THEROLES OF PARTICIPATORY FOREST MANAGEMENT(PFM)IN IMPROVING COMMUNITY LIVELIHOODS AND FOREST CONDITIONS: A CASE STUSY OF HADIYA ZONE, SOUTHERN ETHIOPIA

MSc. THESIS

BY

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The Roles of Community Participation in Forest Management (PFM) inImproving Forest Conditionsand People's Livelihood: A case study of Hadiya Zone, Southern Ethiopia

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DEDICATION

I dedicate this piece of work to my Family: Father, mother and my uncle Mekoro Mechato, his wife TadelechGebure and their daughters because without them this work wouldn't possible to do next the Son of the GOD.

STATEMENT OF THE AUTHOR

First, I declare that this is my own work and that all sources of materials used for writing this study was source based (reference concerned) as much as possible).This thesis has been submitted to Jimma University, College of Agriculture and Veterinary Medicine in partial fulfillment of the requirements for the Degree of Master of Science in Natural Resources Management(specialization in Forest and Nature Conservation) and deposited at the Library of the University to be made available to borrowers under the rules and regulations of the library. I declare that I havenot submitted this to any other institutions anywhere for the award of any academic degrees, diploma or certificates.

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BIOGRAPHICAL SKETCH

The author, Tarekegn Mechato Ergicho, was born in Gibe District, Hadiya Zone, and Southern Ethiopia in September 18, 1987.He attended his elementary education at Bettara elementary school. He also attended secondary and preparatory school at Morsito Senior Secondary School.

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LIST OF ABBREVIATIONS AND ACRONOMY

CBNRMCommunity Based Natural Resources Management
CBO Community Based Organization
CIFOR Center for International Forestry Research
CPR Common Pool Resources
CSA Central Statistical Authority
DBH Diameter at Breast Height
FAO Food and Agricultural Organization
FARM-Africa Food and Agricultural Research Management, Africa
FGD Focus Group Discussion
FRA Forest Resource Assessment
FUG Forest User Group
GWAO Gibe Worada Agricultural Office
GWFEPO Gibe Worada Forest and Environment Protection Office
HDA Hadiya Development Association
JFM Joint Forest Management
KFS Kenya Forest Assessment
LFA Licha Farmers Association
MDG Millennium Development Goal
MEA Millennium Environmental Assessment
MoFED Ministry of Finance and Economic Development
NFUG Non Forest User Group
NFUG Non Forest User Groups
NGO Non-Governmental Organization
NJFM Non Joint Forest Management
NPFM Non Participatory Forest Management
NR Natural Resource
NRM Natural Resources Management
NRU Natural Resource Us
NPFM Non Participatory Forest Management
NTFP Non Timber Forest Product
PFM Participatory Forest Management
PFMI Participatory Forest Management Institution
SNNPR Southern Nation Nationalities and Peoples Region
SPSS Package for Social Science
TFP TimberForest Products
UNIDO UnitedNations International Development Organization
WBISPP Woody Biomass Inventory and Strategic Planning Project
WWF World Wide Fund for Nature

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ABSTRACT

Ethiopia is gifted with immense wealth of biological resources due to its diverse topography, soil and climate; however, Forest resources in Ethiopia have suffered decades of mismanagement due mainly to loosely defined property relations over it. As one of the solutions, Participatory Forest Management (PFM) system was introduced during the early 1990s by some NGOs.This study tried to investigate the role ofcommunity participation on forest management and its role for improving forest condition and the livelihoods of the participant household.Socio-economic data from households and NGOs, GOs in PFM forest and forest inventory data was collected from both PFM and non-PFM forest sites. The study examined the change of PFM application on forest resources conditions and livelihood of participant local communities on PFM program at least the PFM project life time comparing household incomes of PFM and NPFM. With regard to forests in PFM and NPFM; the density and frequency of woody plant species found in the sampled plots have shown differences not only between forests but also within the plots. The density of the species at different DBH and height classes also showed difference in both PFM and NPFM forests. DBH and height classes in both forests shown inverted "J" shape of normal distribution pattern but the density, frequency, dominance and IVI shown quite difference between them. The DBH and Height-class distribution analyses have shown that there are similar trends in both diameter and height classes. The result also revealed that varied dependency of the household has been shown in both PFM and non-PFM forest sites. Although both PFM and NPFM households are dependent on forest resources to get livelihood incomes from it, PFM households are benefited and got more incomes from forest resources than NPFM households. The study concluded that when accompanied with complementary non-forest based livelihood activities, PFM helped to diversify income sources, increase household income,and build household income improvement conditions. This reduces dependence of communities on forests for livelihoods. The study recommend that PFM system is a crucial management of forest resources by the local community in collaboration with NGOs and GOs and its progress should be assessed in a short periods of time before PFM project terminates.

Keywords: Forest Management;Livelihood;PFM;LocalCommunity

1. INTRODUCTION

1.1. Background of the Study

Ethiopia is endowed with immense wealth of biological resources due to its diverse topography, soil and climate, which have resulted in ecosystem diversity (Zerihun W et al., 2002).Vegetation types in Ethiopia are highly diverse, varying from Afro alpine to desert vegetation. However, the vegetation resources, including forests, are being destroyed at an alarming rate because of a numbers of factors. The major factors for the destruction of natural forests in Ethiopia are agricultural expansion and overexploitation for various purposes such as fuelwood, charcoal, construction material and timber, all spurred by rapid human population growth. Deforestation is one of the biggest challenges for the country. Deforestation and land degradation led to ecological and socio-economic crises in Ethiopia (Tegegne, S., 2016).

Statistical figures regarding Ethiopian forests indicate a continuous decline from the original 35% forest cover in 1950 to 2.4% in 1992 (Sayer *et al.* 1992). During 1990 – 2010, 2.65% (2.91 million ha) of the forest cover of the country was deforested (FAO, 2010). In the many parts of Ethiopia, forest loss is more intensified, and, as a result, patches of natural forests are almost found only around churches and in areas which are not accessible for use by humans and livestock (EFAP, 1994; Wassie*et al.* 2009). High population growth and the associated ever-increasing demand on natural forests for various forest products and agricultural land has put the remnant forest patches on the threshold of disappearance (Bekele*et.al.* 2005).

Patches of natural forests in the highlands of Ethiopia can serve as seed sources for restoration of degraded areas, as points of reference for restoration activities, and for biodiversity conservation (Wassie *et al*. 2005; Wassie and Teketay, 2006). However, the persistence of the remnant forest patches and their indigenous species in many areas are threatened. Fragmentation and habitat loss could influence the structure and regeneration of these forests (Cabin *et al.* 2002). Human-induced disturbances strongly influence the regeneration success of woody species and, in turn, determine the vegetation structure and composition of forests (Ortega Larrocea, 2006).Tesfaye *et al*. (2002), noted significant pressure from disturbances such as intensive tree removal and grazing on forest regeneration in the Ethiopian highlands. Thus, the potential use of remnant

forest patches in restoration and conservation activities is absolutely dependent on their sustainability (Wassie andTeketay, 2006).

According to FAO (2010), the livelihood of most rural people of developing countries is strongly linked to natural resources like forests. Currently problems related to environment and climate changes like land degradation,deforestation, over extraction of both renewable and nonrenewable natural resources are controversial issues throughout the globe particularly in least developing countries(LDCs); since the lives of the people directly and indirectly depend on the existence of these resources (Bedru, 2007; FAO, 2010).Terefe (2003), pointed out that the major problems to aggravate such severe problems are high rate of population growth with low rate of economic growth and low level of technological improvement in forest sector, and increased consumption of nonrenewable natural resources. Moreover, the rural poor who have not accumulated wealth are unable to build reserve asset from the utilization of these resources in order to tackle problems in hard times (Tola, 2005).

At local level forests and trees provide food, medicine, energy, fodder, farm implement and construction materials. Upon conversion, forestlands have been offering fertile croplands to sustain crop production. When protected forests are used as rangelands, act as biological measures to conserve soil and water and provide watershed protection. Studies show that 90% of the energy used in Ethiopia originates from biomass, and nearly 80% of human and 90% of livestock populations in Ethiopia depend on traditional herbal medicine for primary health care (WHO, 2002; Yinger *et al*., 2007).FAO (2002) estimated that Ethiopia's fuel wood consumption amounts to 84 million m^3 per year. Despite their wide reaching significance, forest resources of the country have been declining both in size (deforestation) and quality (degradation) (WBISPP, 2004).

Human beings interact with their environment more often so as to make ends meet; such human interactions with the environment can build or destroy it(Chitonge, 2014). However, since resources are dynamic and keep changing with time and as humans continue to interact with their environment, it is very essential that in the management of such environmental resources, and forest in particular, the community involvement is not left out so as to ensure its sustainable use of the forest management and conservation activities (FAO, 2013).Therefore, participation gives the community full control over decisions regarding natural resources like forest, water, pastures,

communal land and protected areas. Natural resource managers have found that increasing the role of the local people in managing natural resources is the most appropriate solution in the management of natural resources and improving the livelihoods of the participant communities (FAO, 2013).

In Ethiopia, since the mid-1970s; the management of forest resources was mainly carried out as state forestry and managed by government. These non-participatory approaches failed to reduce tree felling and clearing, especially in protected national forest priority areas (FARM Africa, 2000b). Further this problem was beyond the control of the state therefore, the ultimate solution for this severe problem will be encouraging of local people to manage and conserve their resources since they live with forests and they are primary users of forest products(FAO, 2010).According to Yemiru (2011), in Ethiopia, there is a growing understanding that deforestation and land degradation will further exacerbate poverty, which brings natural resource conservation to the front position of natural resources' management initiatives. Teketay (2003) on his side stated that community participation is decisive and very crucial, to overcome the rate of deforestation.

According to FARM Africa (2000) and UNDP (2012), the government created spaces for NGOs engagement in the forest resources management, through participatory forest management (PFM) practices with a number of NGOs and bilateral programs launched PFM in the mid-1990s. PFM was first introduced to Ethiopia few years ago but the approach is expanding to cover more and more hectares of forest across the country (UNDP, 2012). Participatory forest management (PFM) in Ethiopia was introduced as one of the solutions to solve the problem of open access to forest resources and promote sustainable forest management in the country through community participation. Participatory forest management approach is created as a result of unfair distribution and/or unregulated access of natural resources and top-down rural development policy programs in Ethiopia (Mulugeta and Melaku, 2003).Participatory Forest Management (PFM) is a new paradigm system of forest management which is adopted and implemented in order to fulfill the interest, respecting of traditional users, and bottom-up approach which encourage a sense of belongingness to the rural people in general and landless rural youth in particular (FAO, 2010).

Southern Nation Nationalities and Peoples Region is one of the most forest coverage regions in Ethiopia next to Oromia Regional State; however, less attention was given to the management and conservation of forest resources integrated with non-forest based livelihood improvement conditions of the local communities living adjacent to the forest resources. Studies conducted on Bonga forest by (Teketay *et al.*, 2009), indicated that; forest management appears to have achieved the dual purposes positively affecting the forest, improving forest conservation and management on one hand and improving the livelihoods of the participant local communities on the other hand. Starting from the last decade, local communities through various customary usufruct and entitlement rights together with the government bodies have become the main actors of forest management and conservation integrated with livelihood improvement conditions in Kaffa zone (Teketay, 2009).

Participatory forest management in Gibe district was formerly planned to be carried out through involving the communities in the selected twokebeles within which about 568.7ha of forest areas was set for participatory forest management. However, from the above total hectares; 308 ha were for Amboro kebele (Hunase forest).But 260.7ha to Hadaye kebele (Hadaye forest) by awareness creation of FARM Africa in collaboration with Hadiya development association (HDA) with Licha Farmers Associations (LFA) towards local communities and giving training about forest resources to Gibe worada forest and environmental protectionoffice (GWFEPO).FARM Africa is the European non-governmental organization (NGO) specializing in growing agriculture, protecting the environment and developing businesses in rural Africa. Investing in smallholder farming is the number one way to combat poverty in rural Africa. Prosperity depends on making agriculture work better, using natural resources well, and creating stronger markets for what farmers produce.

FARM Africa in the study area has therefore three main objectives:

i) Agricultural product improvement: Developing innovative solutions to finding the right balance between producing foods and conserving the environment is at the heart of Farm Africa's work. Now, more than ever, as food production is threatened by rising populations, a declining resource base and a changing climate, their top priority is to find an effective balance between farming and nature (FARM Africa, 2008) and providing productive livestock to the local communities.

ii) Business development: Saving account and provision of money and provision of training on how local communities use and save the resources they have; modern saving habit to be adapted and continued with the local communities.

iii) Environmental conservation: Reducing deforestation by helping community development forest-friendly businesses, such as beekeeping and forest off-farm activity promotion and provision. These businesses have provided economic incentives to reduce the land degradation that was previously occurring. Tree planting and the introduction of improved cook stoves have also helped to reduce the unsustainable harvest of fuelwood. In generally; the PFM program in the study area was basically designed to few approaches to sustainable forest management. That is establishing community level forest management systems and promoting forest-based livelihoods and; introducing and supporting other nonforest-based alternative livelihoods.

The key assumption behind the alternative livelihood approach is that the alternative livelihood activities and associated incomes replace forest-dependent livelihoods and thus reduce the pressure on the forest resources. Non-forest based livelihood activities focus on the promotion of crop variety improvement, horticulture promotion; poultry breed improvement, sheep fattening, and soil and water conservation. Forest-based livelihood activities focus on NTFPs products such as honey and off-farm activity users. The overall changes that the PFM project wanted to achieve was the establishment of a sustainable forest management system for environmental conservation linked to sustainable rural livelihood (FARM Africa, 2002b).

1.2. Statement of the Problem

Globally, 52% of the total forests are in tropical regions and they are known to be the most important areas in terms of biodiversity (Agrawal, 2005). Local communities living nearby depend on these forests for their livelihoods. For instance, forest trees provide resources like food, traditional medicine, energy, timber, shade, and habitats for other organisms. The rapid increase in human population near forest ecosystems has increased threats of degradation and fragmentation to these ecosystems.Many scholars forwarded that it is important to conduct studies on the participation of the local communities on forest management integrated with livelihood and forest condition improvements (Agrawal and Ostrom, 2008).Among the studies conducted in Ethiopia (Teketay,2009), studies concluded that nothing could be done without

local community's participation and involvement. Hence, participating and motivating the community in any natural resources management activities in general and forest resources management particularly in participatory forest management(PFM) while improving forest condition and livelihoods of participant communities should be taken as the backbone and indispensable asset or input to forest management and conservation.

In rural areas of Gibe district, the fact no research was conducted on the activities of community participation in conservation and management of natural resources in general and forest resources management in particular; this study contributes how their participation improved forest condition with their livelihood improvement. Gibe district specially where forests are vulnerable to mixed agricultural and subsistence farming practices like livestock keeping, sheep rearing, fuelwood, timber forest products (TFPs) extraction, charcoal burning and the pressure of urbanization on forests were inevitable.

However, there are communally and/or jointly managed forests over which the surrounding communities rely on for different purposes specially using forest resources for livelihood improvement. In this case, the society use their own indigenous ways of forest conservation and management ruled by local laws, regulations and commendation as well as punishments over those who misuse forests. In contrary with this; there is another forest on which less management and conservation was applied rather than exploitation to get consumption for livelihood. Therefore, this study deal with the local community's participation with contemporary forest management mechanisms (PFM) in comparison with state managed forest (NPFM) in the comparative study areas.

Since no studies have been taken in both participatory forest management(PFM) and non-participatory (NPFM) areas aboutthe generalforest improvement conditions and composition, detailed study of specifically woody species is very essential. The base line data of woody species should be useful for the management and sustainable utilization of the forest resources of the study areas. Therefore; participation and inclusion of the local communities in all forest management activities inorder to improve forest status and livelihoods of the participant local communities have to be a continuous exercise.

1.3 Objectives of the study

1.3.1 General objective

- General objective of this study is to examinecommunity participation in forest management and its role for improving forest conditions and people's livelihood.

1.3.2 Specific objectives

- To assess changes in forest conditions as a result of PFM application in the study areas
- To assessand quantify PFM and NPFM HHs in livelihood conditions

1.4. Research questions

- How did participatory forest management did improved forest conditions in the study areas?
- How PFM and NPFM HHs didimprove the livelihood of the local participant communities in the study areas?

1.5. Significance of the study

This study seeks to fill the gap in knowledge on the community participation in forest management and its benefits from forest in Gibe district. Few studies have attempted to evaluate its effectiveness in forest management; in fact, evidence on monitoring, planning, management, conservation and evaluation of natural resources without community participation is difficult and very inadequate; this study provided the current literature better insight and attitude to the local communities by recommendation.

1.6. Scope and study limitations

The study focused on community participation in natural forest management and its role for improving forest conditions and participant people's livelihood for enhancing participatory based natural resources' management. This study encountered some limitations in the study area; some respondents hesitated to respond to the interviews as their activities are a threat to the sustainability and consumption of natural forests in Hadaye kebele; for examples charcoal makers due to the fear of legal measures against them. This made the researcher spare more time to be friend with them as a customer in order to collect data from this group. Some respondents asked for money in order to participate in the study, the researcher had to explain that the study

is meant for academic purposes therefore he asked for their cooperation in order to accomplish the purposes.

Time constraints is another limitations, the researcher study leave elapsed before the completion of the work and logistical constraints to provide research supporters of the study area and to collect more data; so the respondents are limited. Transportation constraints with poor road infrastructure to consult respondents consecutively and attentively while data collection and awareness of the respondents to identify the difference between PFM with its objective and NPFM were the major problems in the study.

2. LITERATURE REVIEW

2.1. The concept of community based natural resources management

According to CBNRM Net (2008); community based natural resources management refers to the management of natural resources under a detailed plan developed and agreed to by all concerned stakeholders where by the communities managing the resources have the legal rights, institutions and economic incentives to take substantial responsibility for sustained use of these resources and become the primary implementers assisted and monitored by technical services. Community based natural resources management is a term that describe the management of resources such as land, forests, wild life and water by collective, local institutions for local benefits (Roe and Nelson, 2009). CBNRM takes many different forms in different locations and different socio-political and bio-physical contexts; it may be based on commercial uses of natural resources, such as managing wildlife for local tourism or hunting enterprises, or may be based on primarily subsistence uses of resources such as non-timber forest products.

Based on the above definitions, it can therefore be concluded that there has been a shift from highly centralized natural resources management towards more devolved models known very broadly as community based natural resources management; these CBNRM models focuses on strengthening locally accountable institutions for natural resources use and management, enabling local groups of people to make better decisions about the use of natural resources (Farm Africa, 2007). Participatory forest management is the process and mechanism which enables people with a direct stake in forest resources to be part of decision-making in all aspects of forest management including policy formulation and implementing processes (Blomley and Said, 2009).

2.2. Community Participation on Community Forest Management (PFM)

PFM is the system of management whereby a community forest is managed by the members of the local community, and not by some external, remote governing body (Gobeze *et al.*, 2009). According to FARM-Africa and SOS Sahel Ethiopia (2002), Participatory Forest Management (PFM) is used as a broad term to describe systems in which communities (forest users) and government services, work together to: define rights of forest use; develop ways of sharing management responsibilities; and agree how to divide forest benefits.

The involvement of the local community in the management forest resources has several purposes such purposes include Wood (2008), reducing the degradation of marine and terrestrial biodiversity; address resource use conflicts; improve the community's quality of life and provide opportunities for economic activities; seeks to improve governance through building stronger community institutions and increased community capacity; Ensures empowerment and voice to the communities which in turn provide a vehicle for strengthening local governance in other spheres of social and economic development(CBNRM Net, 2008).

According to FAO (2003), the role of active community participation in ensuring forest resources management in sustainable manner is obviously known and undeniable. Currently, people are considered as the most important factors and agents of management and their participations are highly required as it is the central focus (Gebremedhin, 2004). According to him management and development is unthinkable without the participation of the native (local) people and people should be placed first in management development projects if their development is what the activity plan aims to promote and the real aim of development should be to improve and change the livelihood of local people. Directly and indirectly a given development project particularly forest management program affects the life of indigenous people; since they live with forests and they are primary users of forest products (FAO, 2010).

PFM study stated that living near or within forestland, local communities are recognized to have greater knowledge and understanding of the resources and easily identify their constraints and opportunities. Then "Who can manage forests better than those living within or beside them (Agrawal, 2009). Generally Isager *et al.,* (2004) contended that forest conservation without genuine local community participation has not only become a subject of failure but also results in conflict, violence and the participation itself provides no guarantee of success. That is why Agrawal and Angelsen (2009), justified excluding local communities is likely to work against community interests, and may aggravate illegal harvesting, fire and fire-raising in forests or other illegal activities that reduce forest management. From this point of view community participation is imperative at every stage to be effective and sustained PFM (Agrawal and Gibson, 1999).

Another study from Nepal community forestry showed over the last 25 years gain a large positive impact in terms of enrichment of greenery and growing stock. Forests under government management systems unlike CFM is not only depleting but also degrading the resources lead

tragedy of the commons. Currently there are some basic facts which indicate that community forest user groups are also generating financial resources, which are used mainly in better forest management and community development activities (Kanel and Dahal, 2008). Generally community forest is highly susceptible but provides numerous services like balancing the environment; serve as human consumption and habitat for animal species. According to Agrawal and Angelsen (2009), Community forest management (CFM) encompasses two essential things: the forests resource management and livelihood improvement of the participant local communities.

Though participatory forest management known in various forms, it has two clear key essential goals that are conserve bio diversity and improve rural livelihood. According to Wily (2002), Community in the context of PFM refers to people living within or next to forests. According to him Participatory Forest Management (PFM) is broken old concepts and open new thinking in the forestry sector; in order to involve local community in the management of forests through community forestry, participatory forestry and joint forestry based on the contexts and policy of the country. Osumba (2011) advocated that the main objective of PFM was to devolve forest governance to the local levels. For instance the act proposed the following measures to enhance community participation in forest conservation: encouraging sustainable use of forest resources; supporting the establishment of community forests associations through which communities can be able to participate in the conservation and management of forests. Protecting and encouraging the traditional interests of local communities customarily resident within and around forests Purity (Osumba, 2011)

2.2.1 The Concept of Participatory Forest Management(PFM)

The idea of participatory forest management came into practice in the world following the high rate of forest degradation and deforestation in the early 1990s (FAO, 2011).This approach anticipated to ensure sustainable forest management by involving a large number of stakeholders with different interests, knowledge, expectations and rights (Sumbi, 2004). Before the 1990s, the majority of countries in the world had relied on the centralization approach whereby, the central government managed forests without the involvement of the local communities. As a result, forests were under high pressure of deforestation and forest degradation (Terefe, 2003).

In response to this challenge, the Rio de Janeiro summit was held in 1992. At the summit, a number of agreements were reached, including the adoption of a comprehensive statement of forest principles on sustainable forest management worldwide; Agenda 21, which entails a comprehensive programme of global action in all areas regarding sustainable forest management and development; and the Rio Declaration on environmental development that define roles and responsibilities of every state (Himberg *et al*., 2009). The Rio de Janeiro summit, which is also known as the UN Conference on Environment and Development (UNCED), was held with the goal of addressing various environmental issues such as the protection of forests, and other natural resources, conservation of biological diversity; management of wastes and technology. Subsequently, after Rio de Janeiro agreements, countries started to change the forest management approach by introducing participatory forest management that directly involves local communities in forest management (Himberg *et al*., 2009).

Local communities play a crucial role in influencing forest management because of their needs for land, wood for energy, construction and other non-timber forest products NTFPs (Ribot, 2003).Several scholars and practitioners (Larsen *et al*., 2007and Blomley, 2013), therefore, argue that engaging local actors is a crucial step toward enhancing contribution of resources to community development and at the same time improving resource management through the participation of local communities. This stance tends to contrast with the centralized (government-led) schemes that are largely rated as having failed to ensure proper management of natural resources through the protectionist model. For instance, Enters and Anderson (2008) argued that, contrary to the objective of enhancing conservation, some protected areas experienced loss of biodiversity mainly because there lacked genuine engagement of local communities.

The involvement of local communities in the management of forest resources can take several forms, depending upon the environment and the degree of involvement. Effective involvement in forest management requires one to be informed and to be informed one has to first get information, be able to use resources, be knowledgeable and ultimately increase the participation of stakeholders in forest management activities (Maestre *et al.,* 2012); thereby improving the ability of individuals to make informed decisions. Understanding the roles and responsibilities of stakeholders in forest management activities create self-motivation and willingness of the community to participate in any activities related to forest management. The assumption here is

that informed decision would impact on one positively as an individual and as a community member as a whole for the betterment of the community.

Participatory forest management includes many forms of partnership. The first one is collaborative forest management in which the communities cooperate with the government. The second one is joint forest management in which the community lead agency and the community take over the duty of conservation of forest (Lawrence and Green, 2008).FARM/SOS(2008:34) defines participatory forest management as a system in which the communities (forest users and managers) and government services (forest department) work together to define rights of forest resource use, identify and develop forest resource responsibilities, and agree on how forest benefits will be shared. For the purpose of this study, PFM is operationalized to mean the definition given by FARM/SOS.

PFM is a multi-stakeholder approach where the private sector, institutions and communities are involved in management of forests and sharing of benefits that accrue from such management processes. While PFM can be considered in a wider perspective of CBNRM, community forest management is the most emphasized approach for implementing PFM in many developing countries (Koech *et al*, 2009). PFM is a mechanism to protect forests and enhance the livelihoods of communities who use and benefit from them in the process (Ellen Weinberg, 2010).

PFM is shown to have positive impacts both on the state of the forest and living condition of participant households. Forest conditions such as seedling and sapling densities improved (Wondimagegn Mengistu *et al.,* 2016). PFM also (i) promote awareness about forest,

(ii) Capacitated locals to form new institutional arrangement that increased their participation in forest management, helped to reduce open access and assisted a regulated forest use, and (iii) contributed towards social equity in terms of gender and minority ethnic groups. When accompanied with complementary non forest based livelihood activities, PFM helps to diversify income sources, increase household income level and build household assets.

There are many reasons for introducing PFM in selected location. The main two 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. These two are closely interlinked under PFM. However, the proportion of balance can be more prominent in one of the other, sometimes

comprising one another(Ellen Winberg, 2010).PFM has conceptuallythree main objectives; conservation, development and equitable benefit sharing; but it differs according to the countries priority (Akililu Ameha *et al.*, 2014).

2.2.2 Participatory Forest Management in Africa.

Natural forests of moist, coastal and especially dry types represent a massive resource of more than 500 million ha, found in all 56 states of Africa, ranging from 135 million ha in the Democratic Republic of the Congo to 2000 ha in St Helena (FAO, 2001b). Thirty seven states have more than 1 million ha and 17 states have more than 10 million ha of forests. Plantations constitute less than 9 million ha. This is manifest in its most precise and binding terms in promulgation of new state forest laws. Since 1990, at least 35 countries have enacted such new codes, or have these in draft in early 2002. In new forest laws, the most common changes are the following:-Marked increase in national programming and individual forest planning requirement; more rigors and control over the way in which governments themselves administer national forest properties; legal encouragement for private sector roles, particularly in the plantation sector ; 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 (Anstey, 2000).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 (FAO, 2001a; 2001b; resultant added pressure for action being exerted through global environmentalism launched with the Rio Declaration of 1992.

Less acknowledged are the effects of the changing sociopolitical climate, as African states adopt more devolved and inclusive ways of managing society and its resources (Wily, 2000). This is a trend broadly encompassed by the term democratization and having legal expression not only in new environmental, forestry and wildlife laws but also in founding constitutional, as is the case in South Africa, Lesotho, Namibia, Swaziland, Mozambique, Malawi, Zambia, Uganda, the United Republic of Tanzania, Kenya, Ethiopia, the Gambia, Burkina Faso, Mali, Senegal and Benin, among others. Sometimes these reforms proceed hand-in-hand with forest reform village land management approach of countries such as Mali and the Niger).Even where this is not the case, land and governance have a direct impact on the handling of local forest rights.

According to Alden and Wily (2002), based on what is actually agreed in terms of management agreements or contracts between the government and the community, with over-simplification participatory forest management in Africa. The word PFM may be different as the context of the countries and management objectives. For example in Kenya, PFM refers to a forest management approach that deliberately involves the forest adjacent communities and other stakeholders in forest management within a framework that contributes to community's livelihoods (KFS, 2015).

2.2.3. Participatory Forest Management in Ethiopia

Ethiopia has been subject to extensive deforestation; estimates show that the country is losing up to 140,000 hectares of forest each year (FRA, 2005). Humans benefit from and, in many cases, are reliant upon forests for regulating and supporting cultural and provisional services (MEA, 2005). However, the expanse of forest areas is declining across the globe, partly as a result of logging activities and also due to conversion of habitats to croplands, agricultural expansion accounts for up to 43 percent of tropical forest losses. Forested catchments account for three quarters of the planet's accessible freshwater resources, which loses its quality as forest conditions worsen. Fresh water catchments and soil preservation are important inputs to agriculture and food production (MEA, 2005).

Participatory forest management (PFM) was introduced in Ethiopia around the mid-1990s as a new system of forest governance (Mogoi *et.al*, 2012). PFM was meant to avert the persistent problems of deforestation and to deliver better social and economic outcomes compared with the former centralized command-and-control resource management approach. In Ethiopian context, PFM is recognized as a co-governance institutional arrangement where forest management responsibilities and use rights are legally shared between government agency and a community-based organization (CBO), such as forest user groups or forest cooperatives (Bradstock *et al.*, 2007; Winberg, 2010).

The introduction of PFM in Ethiopia was officially founded on three complementary beliefs held by forest authorities and donors:- (i) Centralized and expert led forest management practices have been unsuccessful so far and will not succeed in the future; (ii) Participation of local communities which hold the major stake in forest resources around them in most effective strategy to achieve sustainable forest management and; (iii) forests offer multiple social,

economic and ecological roles to local communities and are capable of generating sufficient and sustainable livelihoods to take them out of poverty; Kubsa *et al*, 2003 cited on (Akililu Ameha *et al*., 2014). PFM is designed to form a component of the broader rural development strategy that aims at improving rural livelihoods, promoting gender equality and reduce poverty whilst protecting the environment from degradation (Mulugeta and Melaku, 2008).In Ethiopia, PFM is used as a strategy to engage local communities to achieve a sustainable forest management objective while also generating livelihood benefits (Tadesse and Teketay, 2017).

The inception of PFM in Ethiopia was considered a radical departure from the centralized and technocratic forest management and conservation style to a more inclusive arrangement(Terefe, 2003). The PFM institutionalization process and its subsequent performance have proved controversial issues in the study areas among scholars, policy-makers, practitioners and international development partners. Some claim that a major transformation has taken place consequently to PFM on the management of physical resources, institutional arrangement and livelihoods of resource-dependent communities. Proponents of PFM present performance indicators such as a decline in the deforestation rate and an increase in forest regeneration (TakahashiandTodo, 2012; Tsegaye*et al*., 2019) and the establishment of community based forest management organizations (Bradstock, 2007).

PFM is recommended to contribute to improved food security and poverty reduction (Weinberg G, 2010); it could therefore have the potential to play a part in reaching two of the Millennium Development Goals (MDGs); Goal 1, Eradicate extreme poverty and hunger; and Goal 7, Ensure environmental sustainability. Nevertheless, PFM has often been criticized for not offering communities with enough revenue to get out of poverty, as it is usually designed with the main purpose of protecting forests and improving livelihoods of the community.In Ethiopia, PFM is used as a strategy to engage local communities to achieve a sustainable resources management objective while generating livelihood benefits (Tadesse and Teketay, 2017).

Studies conducted in Bonga forest, Chilimo forest and Beleta Gera forests concluded that when the local communities participate in PFM, community's livelihood conditions improved in one hand and improving the forest conditions on the other hand.

2.2.4.. Role of PFM on forest condition improvement

Though there is a strong consensus on the positive contributions of CBFMs to forest conservation relative to the state-controlled and centralized management models, the impacts are often place based and context specific. A similar analysis conducted by(Ribot *et.al., 2010*) also highlights the mixed reports of impacts of CBFM on forest conservation.Participatory forest management exhibits the most balanced goals as compared to other interventions in the sector. Where specifically targeted, these projects have also achieved positive environmental outcomes such as reduced deforestation rates, regeneration of degraded forests, and reduced incidence of fires and protection of biodiversity(FAO, 2013).After their improvement, the user groups have proved their capacity in wisely utilizing and regulating in access to the forests.

As a result, there has been a significant improvement in the forest regeneration status and regeneration of stamps by the presence and help of the local communities' participation. There has also been a significant reduction in the rate of illegal logging (Girma, (2005 andGirma, (2006)also found that the current level of wood consumption is far lower than the allowable cut. In most cases, the used groups are utilizing trees that have fallen down or were left behind the forest floor during past illegal logging. This also implies that the user groups are more protective than exploitative. Behind the strategy of the PFM, there is an assumption that forest area that is managed by or together with local, rural and adjacent communities towards the forest and regulated by local laws of management planning.

The basis for the establishment of the PFM in Ethiopia was the persistence of high levels of deforestation. Therefore, all the projects stated contribution to improved forest conservation as their main goal and objectives (Akililu *et al.,* 2014). Accordingly, PFM has shown that community based forest management has significantly contributed to successful forest conservation. The good works done in community mobilization, organization and sufficient building coupled with the granting of legal forest use rights have realized forest rehabilitation and conservation success. The PFM of the farm Africa/SOS Sahel project performance in Ethiopia had shown the following achievements in forest conservation.

Forest boundary maintained: while forests outside PFM scheme continue to degrade both in volume and in spatial coverage, those managed by local communities under PFM scheme maintained their demarcated territorial integrity.

Forest regeneration status improved: Though the extent differs from site to site PFM helped several forest species to regenerate and to form healthy/viable vertical and horizontal stand structure of the forest resources

Degraded forest parts treated: In some of the sites in PFM, FFMI have exercised enrichment planting to threat previously degraded forest selections. PFMIs have implemented enrichment plantings by raising seedlings of various indigenous and exotic species that improved the state of the forest

Forest productivity rose: upon gaining legal rights of access to their forests, communities swiftly decided for discontinuation of any use which they considered were damaging the forest. Accordingly, local communities banned charcoal making, excessive harvest for firewood, illegal logging, overgrazing, fire incidence and other similar activities and put in place systems of controlled uses coupled with intensive management(Agresti, and Finlay, 2009). On the other hand, regulated harvest of forest products, mainly proper production and marketing of NTFPs, has raised forests productivity and income opportunity for the locals; mainly, the poor in some PFM forests while forest damage, forest volume decrease, illegal logging, charcoal making excessive harvest, fires incidence, highly extraction of timber products and overgrazing were seen in NPFM forest (Kinyashi, 2006)

Fauna diversity retained: number of footpaths in the forest sharply reduced, indicating reduced human and other external intervention of animal intrusion.

Community's self-initiatives for forest management verified: In some cases local communities took self-initiatives to establish nurseries, raise seedlings, and sale or distribute free of charge. This may witness the level of awareness created among the community members (Alexandratos, 1995)

Forest fire incidence reduced*:* The protection role played by forest management institutions(FMI) and the gaining of legal right of ownership has significantly reduced incidence of fire since PFM. For instance, before PFM was launched in Borana, fire was a major forest management problem that occurred annually. However, following the introduction of PFM, and discussion of legal rights of access, local people and GOs officials confirmed that there has been a drastic decline in fire incidence. This was because of FMIs having recognized identified and

willingly banned those forest use activities that could result in fire breaks;(Khan, and Manderson, 1992)

Rehabilitation of degraded forest lands*:* In many cases locals rehabilitated forests on the anticipation of future benefits and increment of forest area.

All at no cost to the governments*:* Through the strong social fencing established PFM was able to eliminate the cost that otherwise should have been paid to forest guards, which was demonstrated ineffective in insuring conservation of the natural forest (Blomley Said, 2009)

2.2.5Consideration of community needs in forest management

Worldwide, approximately 60 million people depend entirely on trees and forests for a living, while 350 million depend on trees for subsistence and income. Many studies indicated that majority of communities agree that their needs are being considered through the forest management initiatives and value, some of the forest products considered as needs by local communities. These include firewood, building materials, non-timber forest products (such as honey, mushrooms and butterfly pupae), fruits and herbal medicines (Matiku, 2013). Trees also make an essential contribution to food and nutrition as well as income (which also needed in order to secure food (Matiku *et al*., 2013).

Some authors also describe the non-cash forest functions, which communities depend on, which include provision of forestry resources for agricultural purposes and climate change mitigation; forests also provide services such as soil and water protection, maintenance of soil quality, regulation of local climate, provision of habitats for useful agricultural pests and storing biodiversity, services which are crucial in agriculture(CIFOR, 2014). A significant number of people in the world rely on agroforestry systems for subsistence farming. In this regard, communities have started appreciating the interventions because some have started paying dividends with some early planted exotic trees now being harvested for various uses by the villagers. However, Isager *et al., (*2002), argue that the interests of people in forests are usually more than financial. The importance of planting and taking care of the trees has shifted from being a verbal educational programme to some reality that they are witnessing and living. With more benefits being accrued from forest management, less effort will be needed to persuade and encourage the communities to plant and manage trees and forests.

2.2.6. Function of CF for Socio-Economic and Environmental well being

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. In order to measure progress towards the implementation of sustainable forest management, it is necessary to monitor changes in the outputs provided by forest management in social and economic, as well as environmental dimensions (FAO, 2010).

Forests and other natural resources are crucial to the livelihoods of millions of poor people worldwide. According to the World Bank, over 90% of the 1.2 billion people living in extreme poverty depend on forests for many parts of their livelihoods. Eradicating poverty is therefore impossible without paying specific attention to the 410 million people (including 60 million indigenous people) who live in or near tropical forest areas and depend on these forests for their subsistence and survival needs (World Bank, 2004. Community forests contribute substantially to the livelihoods of millions of rural people in the developing world. Development agencies have estimated that forests provide substantial livelihood benefits to more than half a billion people, many of them are very poor (World Bank, 2004; Eliasch, 2008 cited in Agrawal and Angelson, 2009).

Moreover, Economic and Social Survey of Asia and the Pacific (2003), pointed out that well managed forest and forest products are the major support system of livelihood income to the rural poor. Some of these life support systems of major economic and environmental importance are: supply of timber, fuel wood, fodder, and a wide range of non-wood products; Natural habitat for bio-diversity and repository of genetic wealth; Provision of recreation and opportunity for ecotourism; Playing an integral part of the watershed to regulate the water regime, conserve soil, and control floods; and Carbon sequestration and carbon sink.Protected forest areas with restricted access for local communities have often been introduced as a solution to tackle deforestation and its effects (Weinberg 2010). When looking at the approach from a social perspective, restricting access to forest resources and relocating communities living in forest areas is, at present, becoming more frequently considered as unsustainable from a social perspective(Bradstock *et al*. 2007;Weinberg 2010).

3. MATERIALS AND METHODS

3.1. Description of the study area

3.1.1. Location

The study was conducted in SNNPR, Hadiya Zone, Gibe district, which have the only one PFM intervention site and many non-PFM forest intervention sites. Its absolute location is roughly between 7^0 37'53"–7^0 42'43''N Latitude and $37^0$37'07''–37^0 44'25''E Longitudes. Gibe district is located 105km north east of Hawassa which is capital city of SNNPR and situated at 260 km south of Addis Ababa, 30 km south west of Hosanna town. It is associated by neighboring districts and zones such as Misha district in north, Gombora district in the south and Yem special district in the south west (GWAO, 2019). The altitude of Gibe district ranges from 1994meters to 2028 meters above sea level. The total area coverage of Gibe district is 41,039 ha (GWFEPO,2019).

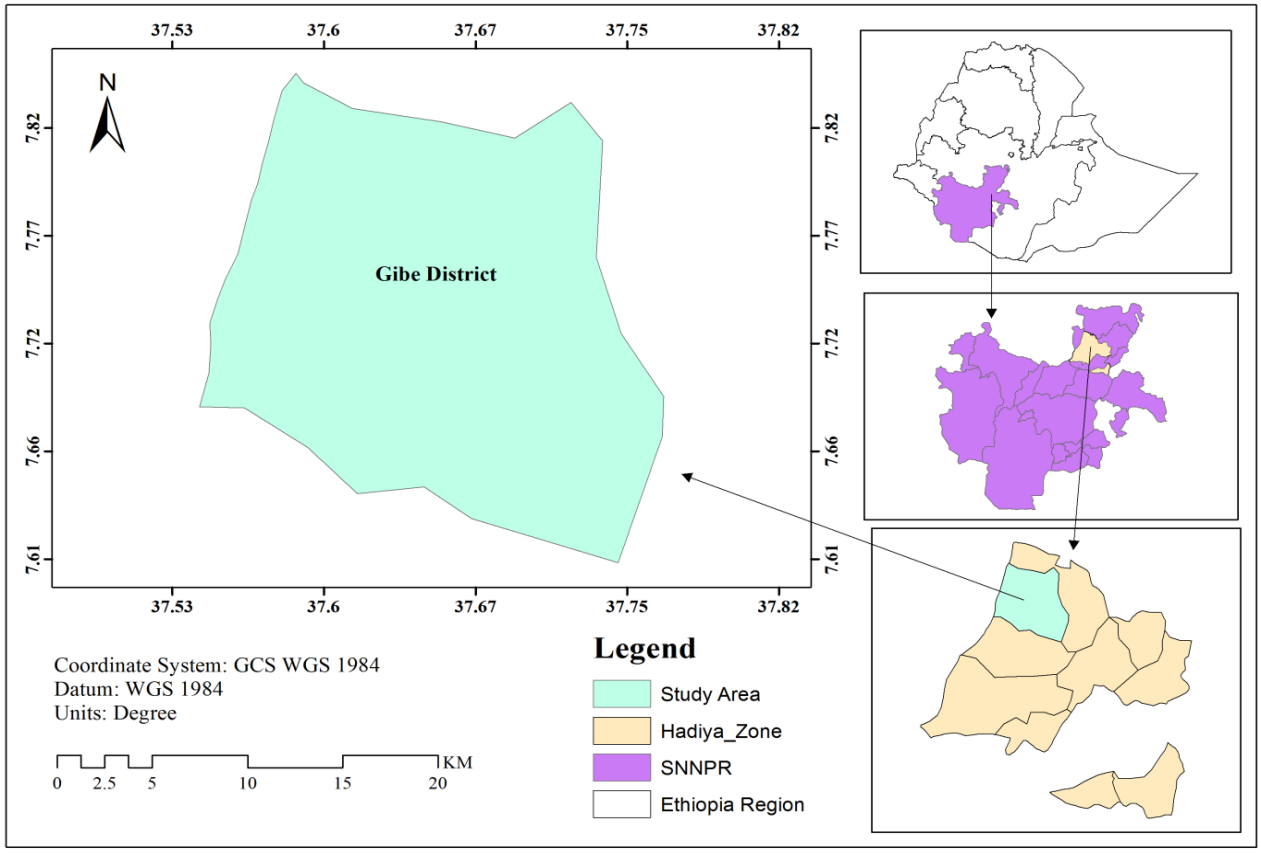

Figure 1.Map of the study area

3.1.2. Topography and climate

The topographic feature of Gibe district is mostly flat and undulating landscape. This district is characterized mostly by Weyinadega (Mid-altitude) and a little bit with Dega (Highland) agro-climatic zones. These agro-ecological zones differ in altitude and in rainfall distribution. The rainfall distribution is bimodal type, which occurs in two main rainy seasons, Belg and Maher. Belg is short rainy season that starts from March to April and that of Maher takes long rainy season that runs from June to the end of September. The annual average rainfall of the district is 900mm with minimum of 600mm and maximum of 1200mm. The mean maximum temperature of district is 27.8°C and its minimum is about15.1°C (GWAO, 2019).

3.1.3. Demography

Gibe district consists of 19 total kebeles; from these 14 kebeles are rural and five kebeles are urban (small towns) and has total human population of 141,312 of which 70,181(49.5%) are males and 71,129(50.5%) are females, from this, total number of household heads are 12,390 (male 6,208 (50.1%) and female 6182 (49.1%). The total number of the population of both study areas(PFM and NPFM) are 5,430 of which 2710 (49.91%) are males and 2720 (50.09%) are females, from this total number of house hold heads of the study area (kebele) is 2110 male 1052(49.86%) and female 1058(50.14%). Out of the total population, 14 % are urban dwellers (CSA, 2015). The district has a population density of 222 persons per square kilometer, and average landholding per farm family is 0.63 hectare(CSA, 2007).The people of the study area speak Hadiyisa language which belongs to the Cushitic language family.

3.1.4. Soil type

The dominant soil type in the Woreda is Nitisols. Nitisols (nitosols) are deep, well-drained, red, tropical soils. They are generally considered as fertile soils. Besides, they are stable soils with favorable physical properties. The deep porous and stable soil structure permits deep rooting and make the soil quite resistant to erosion. Thus, they are the most productive soils to produce the commonly grown food and plantation crops (GWAO, 2019).

3.1.5. Flora and Fauna

The land cover is dominated by scattered naturally grown, planted trees and shrubs which are found around settlements. The vegetation in the area has been categorized under the

Semi-humid woodland with a mixture of broad and coniferous species. These vegetation types are characterized by several species *of Acacia seyal, Acacia saligna, Acacia abyssinica, Croton macrostachyus, and Dodonaea angustifolia, Phoenix reclinata, Rosa abyssinica, Carissa spinarum, Syzygiumguineense, and Oleaeuropaea, sub spp,*(*Enset ventricosum).* Based on the vegetation type, the study area is classified as main habitat, riverine forest, open grass land and wood land habitat.

The most common wild animals found in the area include hyena (*Crocutacrocut*) crested porcupine*(Histrixcristata*),Colobus,Monkey(Colobusguezera),commonjackal(Canisaureus) Bush buck (*Traglaphus scriptus*)White tailed monogoos (*Ichneuminalbicauda*),Wildcat(*Felisserval*)Bushduiker(*Sylvicapragrimmia*),Bushpig(*Potam ochoeruslarvatus*)Abyssinia hare (*Lepush abyssinicus),* Africancivate(*Civettictis civitetta);*andWaterbuck(*Kobus ellepsi)*(GWFEPO, 2019).

Table 1Distribution of forest resources coverage in the study areas

Types of forest in study area	Forest area in hectare	percent
State forest	563	41.94
Community managed forest	378	28.12
Private forest	390	29.94
Total	1332	100

3.1.6. Economic activities

Agriculture is the principal source of livelihood for most of the population. It is characterized by a subsistence mixed farming system, where rain-fed crop faming and livestock production coexist.It is characterized by small scale subsistence mixed farming-system, with livestock production as an integral part. The community in the study area practice various livelihood and income-generating activities mainly crop production, animal husbandry and daily labor. Crop production such as beans, sorghum, barley, coffee and wheat plays a major role in income generation in the study area. Cereals such as teff, wheat, maize, barley and sorghum are the major crops grown. Pulses crops, such as beans and pea are grown to a lesser extent in the area. Enset is the main staple food (GWAO, 2019).

The total land sizes of the study areas were 3979hectare, 2091 hectare and 1888hectares are respectively Hunase and Hadaye kebeles. Land use type in the study areas were dominated by the following

3.2. Research Design

In this study, a cross-sectional research design was applied where data collected at a point in time.The researcher adopted probability sampling namely stratified and purposive sampling techniques to select the households and the users of state forest were stratified into male and female household heads and then forest user groups and non-forest user groups. This is because male and female could have different attitude and perceptions towards forest resources management; and also to give equal chance for the whole target population to be selected as a respondent and to select high forest exploiters, charcoal producers from the state or non-participatory forest management (NPFM) forest in order to compare livelihood status of them with that of PFM.

3.3. Sampling technique and sample size determination

The sample population and sample size of the study areas area are clearly identifies and explained in the following table.

Table 2Number of respondents in each selected rural villages with their sample size

	PFM		NPFM			Sample population	sample size
Villages	population	S.size	villages	Population	S.size		
Amboro	120	20	Iti bira	268	32		
Maqana	220	27	Buquna	240	19		
Masmasa	175	13	Masi bira	259	26		
Handosha	185	25	Ololamo	133	13		
Total	700	85		900	90	1600	175

Survey questionnaireNB. S.size=sample size

The study also employed two-stage sampling technique to select sample respondents. In the first stage, from 19 *kebeles* of the district, two *kebeles* were purposively selected based on the major potential of forest coverage in the district. In the second stage, the two forest villages were selected by using purposive sampling techniques from the selected forests because of highest

forest destruction and exploitation on NPFM (Hadaye) or state forest while some improvements on forest conditions, forest status and forest spatial distribution increments on another comparative PFM (Hunase) forest.

Then the local leaders, development agents of respective kebelesstratified local communities in to forest user groups (FUGs) who are more adjacent/near to the forest and non-forest user groups (NFUGs) who are far from the forest and use another plantation forest for household consumptions and livelihood consumptions. Hence, in this study, communities use forest resources directly for day today activities living adjacent to forests were considered as forest user groups(FUGs) whereas those communities use forest products other than the study area and they live far from Hadaye state managed forest (NPFM) are considered as non-forest users groups (NFUGs).

The formula that helps to determine the required sample size assumes at 95% confidence level and the maximum variance (p=0.5). In-order to determine the sample size from the total population, the researcher used the following formula which is presented from (Cochran, 1977 and C.Kothari, 2004). In this study, due attention was given to the representativeness of the sample from the total population for better generalization of the findings. The sample size determination was computed by using Cochran (1977) sample size determination procedure. 5% sampling error was used as a standard. Then the formula used to calculate the sample size was as follows:-

$$N = \frac{Z*P*Q*N}{e^2*(N-1) + Z^2*q^2*p}$$

$$N = \frac{1.96*0.5*0.5*1600}{0.05^2*(1600-1) + 1.96^{2*}0.5^2*0.5} = 175$$

$$no = \frac{Z^2*P*q}{d^2}$$

$$= \frac{1.96^{2*}0.15*0.85}{0.05^2}$$

$= \frac{0.489804}{0.002} = 195.9216 = \approx 196$

$$n1 = \frac{no}{1+\frac{no}{N}}$$

$= \frac{196}{1+\frac{196}{1600}} = \frac{1796}{1} = 1.1225$(correction factor)

196

$$= \frac{196}{1.1225}$$

=174.6= ≈175 Total selected respondents from PFM and NPFM

Where n_o = desired sample size according to Cochran (1977) when population less than 10,000 n1= finite population correction factor. Z = standard normal deviation (1.96 for 95% confidence level) P = 0.15 (proportion of population to be included in sample i.e. 15%) q =is 1-P i.e. (0.85), N = is total number of sample population d =is degree of accuracy desired (0.05). The finite population correction factor was used because the total population/PFM and NPFM is less than 10,000 e=error which is 5% or 0.05; p= prevalence of the problem in population which is 50% or 0.5; q=1-p which is 50% or 0.5; and N=total forest users from the selected sectors.

3.4Methods of Data Collections

3.4.1. Forest inventory data collection

Different forests one under PFM and the other from non- PFM but bordering each other, were identified and an inventory was carried out using systematic line transect sampling design. The line transects were laid out across the contour at the regular interval of 150 m. Plots were then laid on transect at the interval of 100 m. Circular plots of 314 m^2 (10 m radius) were used as the main plot for inventorying mature trees (DBH > 10 cm). For seedlings and saplings respectively, an inner 2m and 5m radius sub-plots were used. A total of 20 plots; 10 in the PFM forest and 10 in the non-PFM forest were taken. Seedlings were defined as woody plants with height ≤ 1.5 m, and sapling as those with height > 1.5 m, and DBH < 10 cm (Kelbessa and Soromessa, 2004). Vernacular/local names of the plants were identified with the help of knowledgeable individuals from the community. Scientific names were identified with biology department professionals from Wachemo University by transect walking in the forest during the field data collection from forests and with the help of Jimma Botanical Institute (JBI) and following flora of Ethiopia and Eritrea (FEE).

3.4.2 Socio-economic data collection

The method of socio-economic data collection depends on the type (qualitative and quantitative) and sources (primary and secondary) of data collection method.The content of the questionnaire included semi structured questions. Focused group discussions(FGD)done in this study with local elders,women and youths in order to get detail information from different group of

community about major forest user's participation in PFM and NPFM in the study areaand consists of 6-8 number of respondents one group FGD in each PFM and NPFM areas.

Qualitative and quantitative research approach was employed to gain an in-depth understanding of the outcomes of community participation in the PFM program and the changes in their livelihoods and on the forest resources. Data for the study were generated through key informant interviews and document reviews about the size and background of the forest resources in the study area. Documents were retrieved and reviewed through consultations with relevant governmental and non-governmental organizations, including the leaders of FARM Africa projects, Hadiya Development Associations (HDA) and Licha Farmers Associations(LFA).

These documents provided valuable information on the performance of the PFM program through inclusion of communities living in and around the forest resources as well as the key stakeholders involved in the process. Following this, knowledgeable key informants representing the various sectors of the local society in the community as well as local and external stakeholders in the forest management process were purposively selected. Using a structured questionnaire, quantitative data on the changes of the PFM program on household livelihood were collected through the administration of a household survey in the study communities HHs.

A preliminary informal survey was carried out with experts of the Agriculture and Rural Development offices from the kebele and worada, PFM project of Farm Africa, key informants from the local communities, including participants and non-participants in the PFM. The informal discussions focused on perceived trends and changes that PFM achieved on forest status and on household income. The role of the project of FARM Africa and its support; the role of PFM on community empowerment and the way of consumption of members and non-members of PFM, on the continuous use and way of management of PFM, and on challenges and opportunities of the groups on PFM.

The questionnaires prepared by the English language were translated into local language "Hadiyigna" by which the interview was conducted before providing to the respondents. A structured questionnaire was then prepared and pre-tested before use to improve its clarity and check for its accuracy to collect the required data. The formal survey focused mainly on household and demographic characteristics, on the changes of PFM on local livelihoods in general and in terms of self-reported changes in income level.

Income sources and budget accumulations on aspects of empowerment before and after PFM, and how non participants of the local communities get forest resources; their way of consumption in order to get their livelihoods with respect to participants on participatory forest management (PFM) on the sustainability of forest user groups(FUCs) for the next times. Two of the four forest user groups of the Hunase PFM project were selected randomly. Then among all members of these two groups and NPFM forest users, the questionnaire was administered on total of randomly selected 85 PFM members' and 90 non-participant households; then a total of **175** respondents selected assuming representatives of the rest groups and forest users in the local communities.

3.5. Data Analysis

3.5.1. Vegetation data analysis

The density of naturally regenerated woody plant species per hectare was derived from the number of individuals recorded in the sample plots from the PFM and non-PFM areas. Different measurements like relative density, relative frequency, relative dominance and importance value index (IVI), Shannon diversity index, Evenness values and relative basal areas of species in both forests were computed to compare the status of forests with PFM and without PFM. A two-tailed t-test at 5% level of significance was also used to test differences in tree, sapling and seedling densities between the forests in participatory forest management (PFM) and non-participatory forest management (NPFM) sites.

Woody plant structural composition of the study area was described based on the analyses of the distribution of individual plants in various DBH and height size classes, and computation of basal area which is the actual space covered by the tree and shrub stems, dominance, density, frequency, and importance values index. To examine tree/shrub DBH size distribution, DBH data were classified into eight size classes as: 1= 10-20 cm, 2 = 20.01-30 cm, 3 = 30.01-40 cm, 4 =40.01-50 cm, 5= 50.01-60 cm, 6 = 60.01-70 cm, 7 = 70.01-80cm, and >80cm.

Similarly, tree/shrub height data were classified into ten height classes as: 1=2-6m, 2=6-9m, 3=9-12m, 4=12-15m, 5=15-18m, 6=18-21m, 7=21-24m, 8=24-27m, 9=27-30m,and 10=>30m.The number and percentage of individual tree/shrub stems in each DBH and height size classes were then calculated and some of them were graphically illustrated. The number of individuals of each species was counted and diameter at breast height (DBH) of woody species

>10 cm was measured using a measuring tape following Martin (1995) and Cunningham (2001). Individuals of those species with DBH<1.5 cm were recorded and considered for regeneration status assessment as seedlings.

3.5.1.1. Importance value index

Important value index IVI is a good index for summarizing vegetation characteristics of a given habitat, ranking species management and conservation practices useful to compare the ecological significance of species and for conservation practices (Bekele *et al*., 2014). It reflects the degree of dominancy and abundance of a given species in relation to the other species in the area (Kent and coker, 1992). The result of Importance Value Index (IVI) is calculated from relative density, relative basal area (relative dominance) and relative frequency, of woody species tree/shrubs.It reflects the degree of dominance and abundance of a given species, and thus its ecological importance, relative to the other co-occurring species in the community (Kent and Cooker, 1992). The importance value index (IVI) of a species (Mueller-Dombois and Ellenberg, 1974)was calculated by summing up relative density, relative frequency, and relative dominance, where density is the total number of individuals of a species per total area sampled, frequency is the number of plots where a species occurs per total number of plots sampled, and dominance is total basal area of a species (sum of basal area of each individual plant) per area sampled.

Basal area (m^2) of each plant is calculated as $(DBH/4)^2 \times 3.14$, where DBH is in cm.

Relative frequency (RF) = (n/N)*100Relative density (RD) = (Di/DN)*100

Basal area (BA) = $(DBH/4)^2$x3.14 Relative dominance (RDO) = (Di/DN)*100

IVI = RF + RD + RDO

Where: n = number of individuals of a particular species in the sampled plots N = the total number of all species in the sampled plots Di = the density of individuals of a particular species in the sampled plots Di=Dominance of individual species in a sampled plots

DN = the density of all species in the sampled plots Ai = basal area occupied by individuals of a particular species in the sampled plots AN = basal area occupied by all species in the sampled plots IVI = Important Value Index.

3.5.1.2. Shannon diversity index

Shannon diversity index is calculated as follows:-

$$H' = -\sum_{i=1}^{S} DilnDi$$

$Ln = \log base_n$

Where, H'= Shannon-Wiener (1949) diversity index**S**=the number of species **Pi**=the proportion of individuals or the abundance of the **ith** species expressed as proportion of the total cover.

3.5.1.3Regeneration status of forests

To assess patterns of regeneration status of woody plants in PFM and NPFM forests, the sum of number of individuals of seedlings, saplings and matured trees/shrubs counted for each plant species was computed and these values were converted to density values to account for the different sample sizes used for counting both seedlings and saplings. Then, the relationship between species' stems density of seedlings, saplings and matured trees/shrubs were calculated in SPSS version 20 software.Regeneration status of the forest was analyzed by comparing saplings and seedlings with the matured trees according to Dhaulkhandi *et al.* (2008); andTiwari *et al*. (2010),i.e., Good regeneration, if seedlings >saplings >adults; Fair regeneration, if seedlings> or ≤ saplings ≤ adults; Poor regeneration, if the species survives only in sapling stage, but no seedlings (saplings may be <, > or = adults); and if a species is present only in an adult.

3.5.2 Socio-economic data analysis

The responses of the key informants and Focus Group Discussions (FUGs) weresummarized and discussed with them inorder to cross check an ideas raised and responses gained from the respondents. Relevant subject matter and concepts were identified and summarized accordingly. Livelihood income variations before and after participatory forest management (PFM); the past and current incomes were analyzed in non-participatory forest management (NPFM) sites were collected and analyzed. The formal survey data were cleaned, coded and analyzed with the help of SPSS version 20 software and using descriptive and inferential statistics.

4. RESULT AND DISCUSSION

4.1. Changes in Forest Conditions by PFM Application

4.1.1. Species composition and diversity

A total of 48 woody species belonging to 27 families were recorded in the field survey from the study areas(Appendix 2 and 3). Out of the total species recorded 30 (62.5%) were trees, 12 (25%) shrubs, 1(2.08%) liana 4(8.34%) climbers and 1(2.08) grasses (Appendix2). The families with highestspecies numberwere Fabaceae(ten) species constitutes(20.83%) and others like *Myrtaceae, Asteraceae,Euphorbiaceae* and *Rosaceae* having three families each and constitutes a total of (25%), *Verbenaceae,Araliaceae,Poaceae* and *Boraginaceae* constitutes(16.67%) of the total family and the remains 18 families also constitutes (37%) of the total families in the study areas (Appendix3).The species with the highest density was*Acacia abyssinica, Brucei antidysenterica, Podocarpus falcatus, Juniperus procera,Bersema abyssinica,Acacia etbaica, and Dodonaea angustifolia.*These most abundant species constitutes (23.8% of all species) contributed about 71.4 % of the total density. *Vernonia myriantha, phoenix reclinata, Millettia ferruginea, Ehretia cymosa and Psidium guajavaconstituted* 12.83% of the individuals and 4.28% of all individuals in Hunase PFM forest. The result agrees the report of the Alelign A. (2001) reported five species contributing more than half of all individuals recorded in Zegie peninsula.

On the other hand, Out of the total species recorded in the study areas of NPFM (Hadaye forests), 39(81.25%) were trees 5(10.43%) were shrubs, 2(4.16%) lianas and 2(4.16%) were climbers. The species with the highest density in the NPFM forest were *Brucea antidysenterica, Ficus vasta, Ricinus communis and Diospyros abyssinica.* They contribute 69.4% of the total density.The species with the highest frequency value was *Ricinus communis (13.96%) Schefflera abyssinica (13.13%), Cadaba farinosa (7.9%) Polyscias fulva (8.75%), Syzygium guineense (7.5%) Vernonia myriantha (7.3%) and Erythrina brucei (7.3%) contributing the total density of 31.6% and the remains have 68.4% the total frequency* in the NPFM forest whereas the species with the highest frequencies in NPFM forest is *Erythretia cymosa (19.8%), Acacia etbaica (15.42%), Ricinus communis (13.54%), Ficus sycomorus (8.75%) and Camaldulensis globulus (7.5%), Podocarpus falcatus* (5.8%) contributes total frequency of (70.81%) and the remains contributes a total frequency of (29.19%).

A high frequency value represents a wider distribution of the species in the forest. The frequency distribution of species showed high percentage of species at lower frequency classes with 72% of the species have high frequency values indicating high floristic heterogeneity of the study area in the PFM forest. The variation in density and frequency among species may be attributed to differences in site conditions, species characteristics, economic importance of species and disturbance. Therefore, this result agrees with Hundera and Gadissa, (2008) in Chilimo forest.

4.1.2. Population structure

The density distribution of individuals of woody species in the various diameter classes was not uniform in Hadaye and Hunase forests, but showed a progressive trend of decline and increment. The number of individuals decreased with the increasing diameter classes. Suggesting an inverted J-shaped population structure which is an indication of stable population structure or healthy regeneration status. The result is similar with (Shibru and Balcha, 2004). This indicates that the population of the PFM forest is more stable, and that reproduction, regeneration and growth of woody species are better in the PFM than in the non-PFM forests. However, the NPFM site showed a relatively lower proportion of seedling, sapling and mature tree/shrub individuals in comparison with PFM forest. Therefore, in Hadaye (NPFM) forest; it needs to be noted that some species are not in healthy regeneration status. For example, *a cordia Africana*, *Podocarpus Falcatus* and *Acacia abyssinica* had individuals missed in the middle or larger size classes, indicating more selective logging and removal of individuals of preferred size class for different timber, fire wood, and charcoal and for the similar purposes from this NPFM forest in the study areas.

4.1.3. Density and frequency

The density and frequency of woody plant species found in the sampled plots have shown differences among species (Appendix5 and 6). The total density of woody species in Hunase (PFM) and Hadaye(NPFM) forests were respectively 69.47and 31.7 individuals/ha. At DBH >10 cm, the density of species was 609.79 individuals/ha. The corresponding value at DBH >20 cm was 473.63 individuals/ha in Hunase forest and the ratio of density of individuals with DBH >10 cm to DBH >20 cm was 1.29, and individuals with DBH>20cm was 473.63 and DBH>30cm was 343.99 individuals/ha; therefore, the ratio of DBH>20 to DBH>30 was 1.38 implying the dominance of small-sized individuals in Hunase forest but in Hadaye (NPFM) forests. At DBH

>10 cm, the density of species was 458.53 individuals/ha. The corresponding value at DBH >20 cm was 393.18 individuals/ha and the ratio of density of individuals with DBH >10 cm (a) to DBH >20 cm (b), and the ratio of a/b was 1.16 this also implying the dominance of small-sized individuals in Hadaye forest while comparing the ratios of DBH classes in the PFM and NPFM forests, the density of the PFM forest is the greater this means the PFM forest has high density of the species. When we compare the ratio of the DBH classes of both forests with other forests like Yeshitila and Bekele, 2003), from Masha Andracha forests having the ratio of 2.5, Yineger *et al*., 2008), from Adelle forest having 2.52, both forests have higher proportions of small-sized individuals than Hunase and Hadaye forests but greater than ratios found fromwof-washa (0.8%) and Gedo(1.7%).When we compare diversity and evenness of PFM and NPFM forests, PFM forest has higher diversity index withH'= 4.14 and evenness E' value 0.48 whereas NPFM forest has a diversity index value of H'=2.72 and evenness value of E'=0.39.As a result, PFM forest has higherdiversityand evenly populated than NPFM forest in the study area. Therefore, the higher diversity index and evenness value shows the higher improvement conditions of the forest than the lower diversity index and evenness value of the comparative forests.

4.1.4. Importance value index (IVI)

Importance value index combines data for three parameters (relative frequency, relative density and relative abundance/dominance). That is why ecologists consider it as the most realistic aspect in vegetation study (Curtis, 2003). It is useful to compare the ecological significance of species (Lamprecht, 2009).Trees and shrubs with higher IVI were considered as the more important species than others. These most important species having higher important value indexes in the PFM forest were*Syzygium guineense,Crotomn macrostachyus, Schefflera abyssinica, Ficus sycomorus, prunus africana, Olea europaea and Diasporas abyssinica*are species having higher percentages of IVI in relative to another species in the PFM forest and comprised 62.83% of the total IVI of the species in the PFM (participatory forest management) and all the rest species constitutes 37.17% of the total species recorded in the PFM(Appendix 4) forest but *Lippia adoensis, Crotomn macrostachyus, Sapium ellipticum, Polyscias fulva, Maytenus arbutifolia and Maesa lanceolata*in the PFM are species having low IVI value(Appendix 4). As a result, these species in the study area needs management activities than those species having high IVI values because less IVI shows that a species is becoming in an exploitation and disturbance due to both anthropogenic and natural activities before the PFM in

the study area and conservation priorities is important because of the importance of these species in the study is very crucial.

In similar fashion with this, trees and/or shrubs with higher IVI in the NPFM (non -participatory forest were *Acacia etbaica, Acacia abyssinica, Ehretia cymosa, Ficus sycomorus,Albizia gummifera, Clausena anisata, Ficus vasta, Justicia schimperiana* were the species having the highest IVI in the non-participatory forest management (NPFM)(Appendix5) and these all species constitute a total of 40.34% of the IVI and 84.04% of the total species' IVI in the study area where as *Juniperus procera, Coffea arabica, Cadaba farinosa, Ricinus communis, Rhamnus prinoides, Vernonia amygdalina* are the species having low IVI values in the NPFM forests. In generally: IVI value is an important parameter that reveals the ecological significance of species in a given ecosystem. Species with high IVI values are considered more important than those with low IVI value. The IVI values can also be used to prioritize species for conservation, and species with high IVI value need less conservation efforts, whereas those having low IVI value need high conservation effort.

4.1.5. Natural regeneration status

Assessment of regeneration status of plant communities has a paramount importance for sustainable conservation and management**.** Based on the regeneration status of the selected 48 woody species occurring in both PFM and NPFM forests, somerepresentative figures that show the seedling,sapling and mature tree /shrubs status were checked. The total seedling, sapling and mature tree densities of 48 selected species were about 1547.792, 1115.925, 670.808 and 510.05, 543.413 and 468.29 individuals per hectare respectively in PFM and NPFM. The composition, distribution and density of seedlings and saplings are indicators of the future regeneration status of any forest.

Paired analysis of the densities of the seedlings, saplings and mature trees derived from different forest sites revealed the following results in both PFM and NPFM forests: In terms of mature tree density, there was 670.808 and 468.29 individuals'/ha in the PFM and NPFM forests, respectively. These differences were not statistically significant ($P>0.05$). For saplings, a total density of 1115 and 543.413 individuals/ha was counted and recorded in the PFM and NPFM forests respectively. This difference is statistically significant at ($P<0.05$). Concerning seedling population, a total density of 1543.79 and 510.05 seedlings/ha were recorded in the PFM and

NPFM forests respectively. This difference is also statistically significant at ($P<0.05$). The present study showed that regeneration of PFM forest is at good status (Fig 2) and this status indicates as PFM forest is improved and managed forest than NPFM forests.

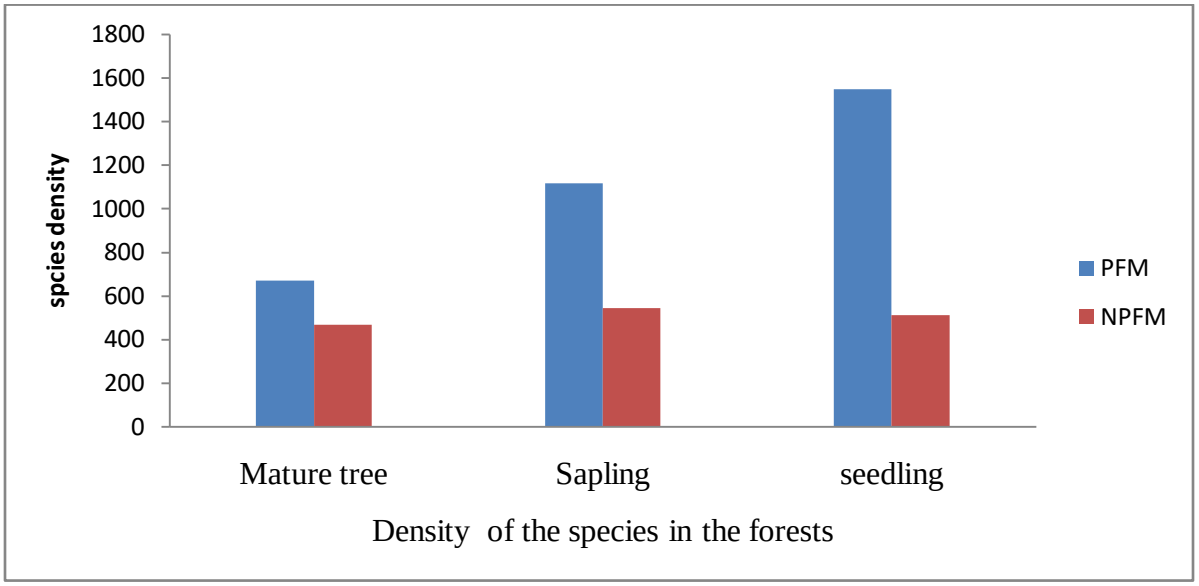

Figure 2density and regeneration status of both PFM and NPFM forests

4.1.5 DBH distribution

The DBH class distributions of the species exhibited different patterns (table 4), showed that there are species with high number of individuals in the lower classes, some species in the middle classes and others in the higher classes. The patterns of DBH class distributions in PFM indicated the general trends of population dynamics and recruitment processes of the species. From the DBH class distributions of the species, two types of regeneration status were determined; good and fair regenerations. Some species possessed high number of individuals in the lower DBH classes, particularly in the first class like, *Acacia etbaica,Ficus vasta,Crotomn macrostachyus, Prunus africana,Ficus sycomorus,Acacia abyssinica,Millettia ferruginea* and *Syzygium guineense* which suggests that they have good regeneration potential due to high amount of seedling and adaptability to the environment. Some of the remaining species possessed either no or few number of individuals in the lower DBH classes, particularly in the first class like *Psidium guajava,Arundinania alpina,Maesa lanceolataand Ricinus communis* which indicates that the species are in poor regeneration status; this is why this PFM forest were very disturbed by the anthropogenic activities before. The DBH class distribution of all woody

species in Hunase (PFM) forest showed a reverse "J" shape distribution. There are high number of individuals in the first and second classes with gradual decrease towards the middle and higher classes and then reverse "J" distribution is considered as an indication of stable population structure or good regeneration status. The result agrees with the findings of Alelign 2001, Tesfaye *et al.* 2010, Silvertown, 2012, and Bekele, 1995)

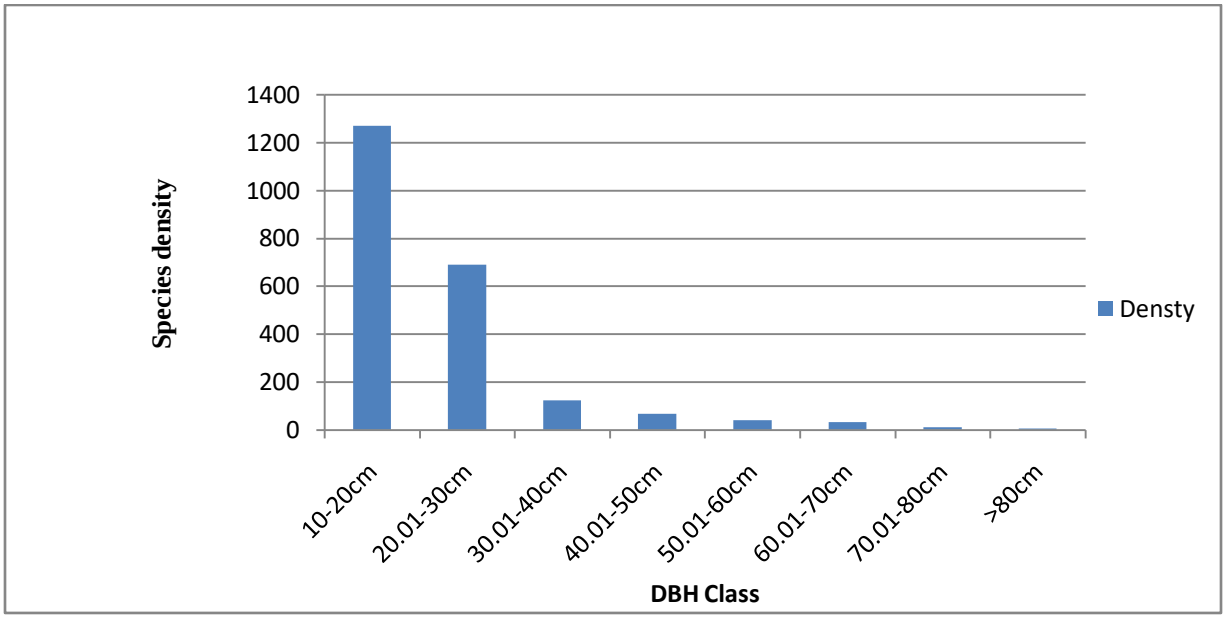

Figure 3. DBH distribution patterns of PFM forest in the study area

In the same way,non-participatory forest management (NPFM) forest; the patterns of DBH class distributions indicated the sign of selective removal from the second; the third and fourth DBH classes was observed for *Juniperus procera, Millettia ferruginea, Cordia africana, Podocarpus falcatus* and *Prunusafricana.* This is because the larger and longer plants have been cut for construction material, charcoal production and farm implements then latter for fuelwood and timber. This forest has fair regeneration status because of: i) over-exploitation of matured trees that might have led to reduced reproduction that is, flower production, pollination and seed production; and, ii) livestock browsing activities uprooting/removal and cropping of seedlings that might have probably inhibited seedling/sapling growth and recruitment processes of the plant species.

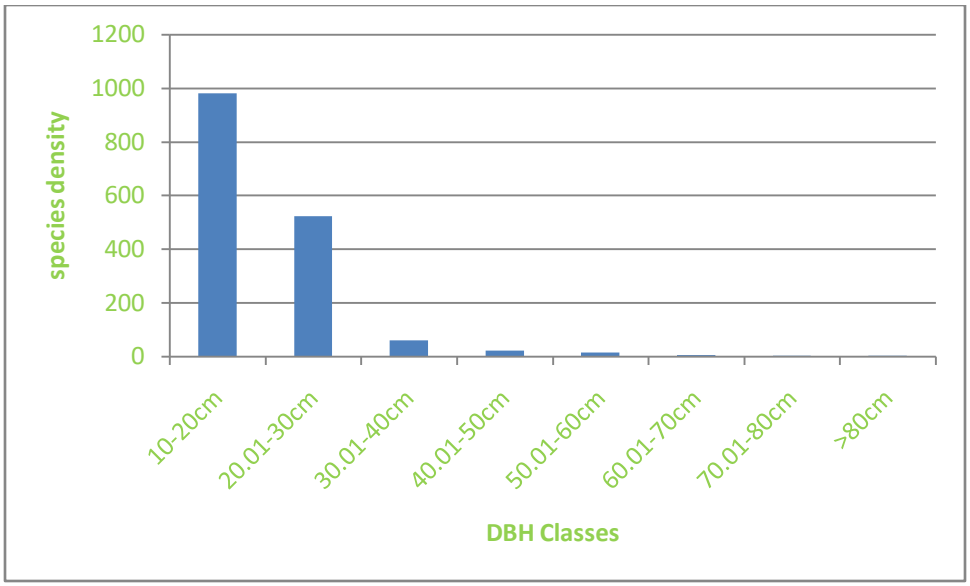

Figure4.DBH class and density of the species in each DBH classes in NPFM

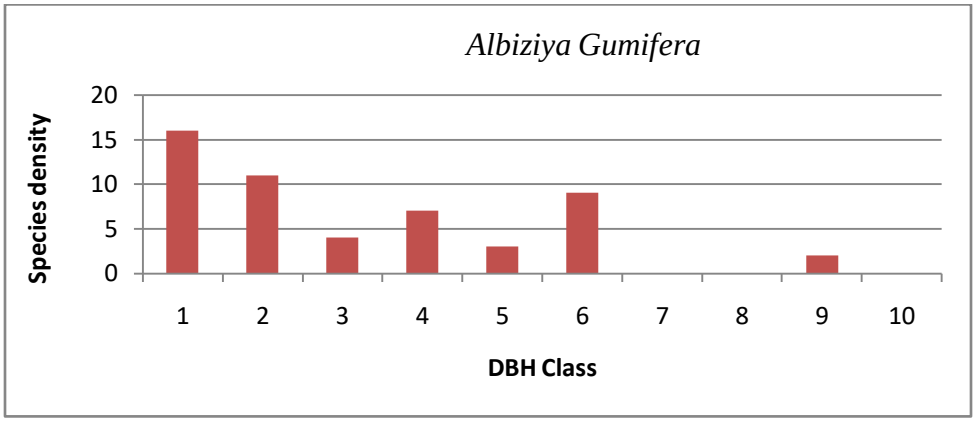

Figure 5DBH classes of some selected trees and their patterns in the NPFM forest

1=10-20cm 2=20.01=30 3=30.01-40 4=40.01-50 5=50.01-50 6=60.01-70 7=70.01-80 8=>80

Generally if the type of forest having density of mature tree <sapling<seedlings, this type of forest is good regenerating forest; if a type of forest which have mature tree>sapling<or=seedling it is said to be fair regenerating forest. Therefore; in the PFM forest mature tree (670.808) < sapling (1115) and< seedling (1547.792), this type of forest is therefore good regenerating forest. Where as in the NPFM forest, mature tree (468.29)< sapling (543.413)> and seedling (510.05). Therefore; this type of forest is said to be poorlyregenerating forest. This leads to the higher in improvements of the forest conditionsin Hunase (PFM) forest than Hadaye (NPFM) forest.In general, the differences observed in DBH and Height class distribution in different forests could

be attributed to the exploitation history of these forests. These data suggest that both of the forests were not free from exploitation. However, the extent of exploitation varies from forest to forest; therefore; relatively more number of huge and older trees in a given forest for example suggest that the forest has not been heavily exploited.In non-PFM forest, several species with no recruitment were identified. Future survival of those plant species would be at risk as there were no individuals that replace the mature plants.

Comparison of the maximum and the average DBH for certain species showed that the gap was quite high. Likewise, the gap between the maximum and the average height was also high. The existence of few individuals attaining larger diameter and height was probably due to selective cutting. The result agrees with Woldemariam (2003) reported similar findings in Yayu forest. If human pressure continues to influence the natural population, dynamics of a species as well as forest conditions and forest status would be affected. Therefore; NPFM (Hadaye) forest is being threatened due to conversion of forest into farmland, expansion of farmland at the edge of forest owned by private farmers, and illegal wood harvest for agricultural tools, firewood, house and traditional beehive construction, and regular grazing by domestic animals are the major treats of forest disturbances.

The major reasons for vulnerable or fair and/or poor regeneration are unfavorable and poor management activities practiced in the study area, human disturbance particularly charcoal burning, firewood extraction, timber product extraction and uncontrolled agricultural expansion. The responses from the key informants also forwarded that Hadaye (NPFM) forests are the major sources of fuelwood (55%), construction material (15%), timber (25%) and farm implements (5%). They are also the sources of medicines, animal fodder, bee forage and edible fruits. They are the only sources of forest products for the local people since there are no alternative forests than individual's forest in the locality and their own garden and land planted by them. These key informants response indicates that the higher the localcommunities in the NPFM forest depend on the forest resources directly; the less management conditions and the less forest condition improvement then the higher the forest exploitation would be.

4.1.6. Basal areas of the woody species

The total basal area of woody species in the participatory forest management (PFM) was 132.44m^2/ha (Appendix6).The larger basal area provides a better measure of the relative importance of the species than small stem count in general. Thus, species with the largest contribution to the total basal area in a given ecosystem/habitat can be considered as the most important species in that habitat**.** Therefore;Trees/ shrubs which have the highest basal areas relative to others in the study areas of the PFM forest are: *Mesa lanceolata, Ehretia cymosa,Prunus africana, Schefflera abyssinica, and Phytolacca dodecandra.*These species are the most ecologically important species and constitute total basal areas of 18.027$m^{2/}$ha and these species also are comprised 61.23% of total basal areas from the PFM forest in the study areas.

Therefore, such dominant species can be seen as the most ecologically significant, and the most successful species in regeneration, pathogen resistance and/or the least preferred by animalswhereas the mean total basal area of woody plants in the non-Participatory forest management (NPFM) in the study area was 109.99m^2/ha(Appendix7). Trees having the highest basal area in theNPFMforest:*Erythrina brucei, Podocarpus falcatus, Cadaba farinosa, Crotomn macrostachyus, Camaldulensis globulus and Acacia etbaica.* These species constitute a total basal of 12.29m^2/ha and covers 32.74% of the total forest species basal areas in the study areas (Appendix7). However, basal area of most species (85% of woody plant species recorded in the NPFM forest area was found to be relatively low density and basal areas/ha indicating that most of these species display, as is true for many forest ecosystems, small growth habit due to the constrains happened on them by anthropogenic disturbances, livestock browsing and human exploitation for house construction and charcoal production activities from the forest. This result agrees with the findings of Mueller-Dombois and Ellenberg (1974).

4.1.7. Height class distribution

Overall, both the number of species represented in each height size class showed decreasing trends with increasing height size classes that shows an ‘inverted J-shape’ pattern(fig6). As shown in figure below, the numbers of individuals in each successive height class were decreasing beginnings from the first lower height class to the highest height class.The majority

of individuals contributing to the first height class were;*Vernonia myriantha,Syzygium guineense*, *Cadaba farinosa* and *Diospyros abyssinica.* The second and the third class were mostly contributed by *Phoenix reclinata, Millettia ferruginea, Polyscias vulva, and Cordia africana, Diospyros abyssinica and Prunus africana.* In the fourth classes, *Ficus vasta, Crotomn macrostachyus, Juniperus procera, and Sapium ellipticum* are mainly contributed with many individuals.Thus, the height distribution patterns of Hunase (PFM) forest was characterized by fewer individuals at mature stage, than middle and young aged population; the forest was dominated by low size individuals. This agrees with the work of Birhanu Kebede, (2010).Therefore; the general height class distribution of this forest confirms the reverse "J" shaped pattern; showing almost stable size distribution of common natural forest. The pattern of height class distribution with respect to number of individuals shows different patterns which indicate different population dynamics.

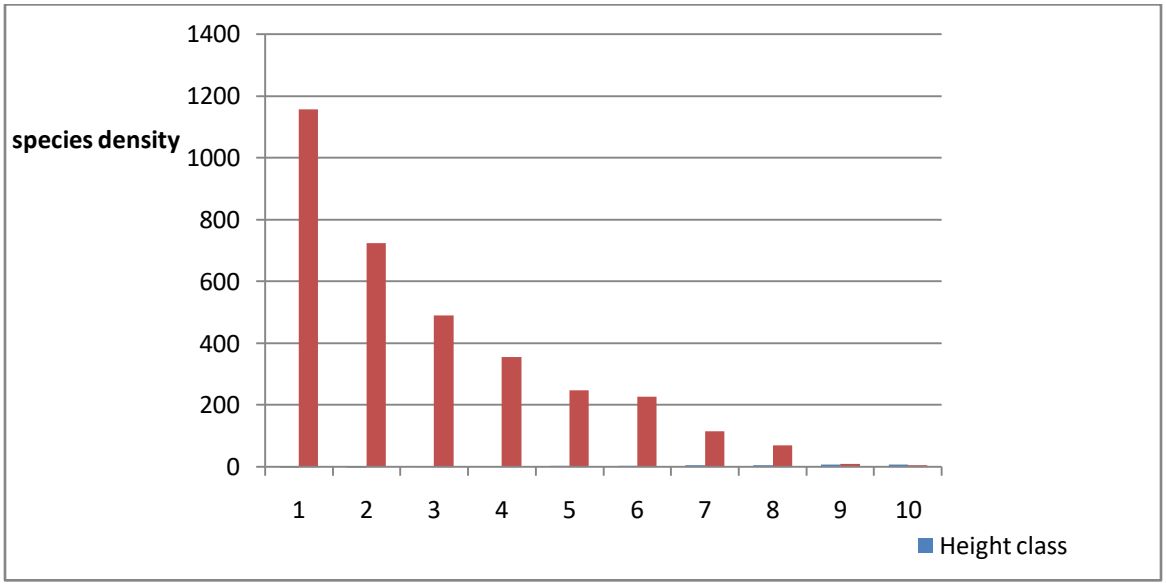

Figure 6height class and density distribution patterns of hunase PFM Forest.
1=10-20m 2=20-30m 3=30-40m 4=40-50m 5=50=60m 6=60-70m

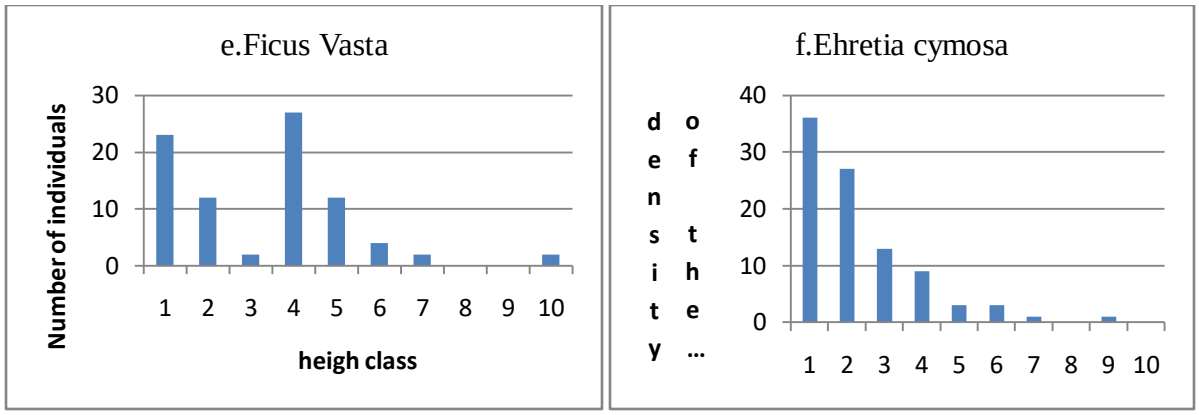

Figure 7.Individuals in height classes of woody species in Hunase PFM forest

1=10-20m 2=20-30m 3=30-40m 4=40-50m 5=50-60m 6=60-70 7= >70m

The first pattern indicates a normal distribution of species with reverse "J" shape (fig. a). Maximum values occurred in the first class and then reduced gradually up to second class and the increase in the third and declined in the fourth class.This pattern represents good reproduction status and regeneration potential. It includes *Acacia etbaica*, *Juniperus procera* and *Olea europaea* are taken as representative of this pattern. This result therefore agrees with Birhanu Kebede, (2010).

The second with the reverse "J"(fig. b)shape pattern and these kinds of pattern also shows as the forest was on the way good reproduction and regeneration status as the forest resources increase in the small height class and decrease in the larger/higher height class including *Asparagus africana* and the like in this pattern.The third pattern (Fig.c) was with few in the middle and/or many individuals in lower height classes but have no or few individuals in fourth, and with medium numbers of individuals in the last two height classes. This kind of distribution is observed when there is selective cutting in the middle classes. Thus, there is no reproduction and only few large and old individuals will be left after a certain time. This pattern is frequent in few woody species that are under uncontrolled exploitations. Species with such pattern could become endangered in the future, because individuals are being harvested before reaching reproductive ages, and this could result in the future decline of the species population because these reflects good reproduction but, bad recruitment. *Cordia africana* has shown this kind of pattern in the study area.

4.1.8Changes in the status of forest in PFM and state managed forests

As respondents from non-participatory forest management(NPFM) forest responded, more forest improvement conditions seen due to control of cutting trees(illegal logging), fire control by guards and local communities, restricted local laws provided by the local communities, and timber and charcoal extraction restriction, afforestation and natural regeneration provided by the local communities' after they are participating in PFM program within the given periods of time.

In Hunase first 308 hectares offorests controlled by Farm Africa in collaboration with Hadiya Development Association(HDA) andLicha Farmers Associations(LFA) to control these forest resources and provided all authority to the local forest user communities since 2004/5 without any incentives; then communities tried to raise the conflict towards this resource control, restriction and avoidance of the local communities and management; then FARM Africa, HDA and LFA again confirmed and signed to provide incomes to replace the forest resource consumption to forest adjacent communities; given more awareness creation and training since 2006. Within these periods there was high forest exploitation and destruction in this forest. After the given awareness creation and commitment done among them in 2006; communities begun management of the forest resources by their own and forest resource improvement in the forest condition became increasing; they applied afforestation programs in the area where deforestation for agricultural expansion, non-selective logging for timber production highly applied areas before PFM and local community awareness created in the area.

The higher increase in forest conditions in Hunase forest shown because of local community's active participation in afforestation programs and planned to plant considerable seedlings in each year for each PFM villages/sites to recover the degraded areas of the forest before PFM begin in the study area. Then, natural regeneration status of the forest resources increased in Hunase forest because forest boundaries were maintained and controlled by PFM members, forest guards employed by FARM Africa, in collaboration with HDA and LFA with the local communities in particular then forest conditions becoming increased.

Then, the degraded parts of the forests treated, forest non-timber forest productivities increased, fauna diversity retained due to the number of footpaths in the forest highly reduced, this indicated reduced human and other external intervention of animal intrusion and rehabilitation of degraded land around the forest are increased as a result; improved and more sustainable forest

product flows due to the improved condition of the forest resource and changed entitlements to use it.

The legal improvement of forest management has improved then community enables to use forest resources in a sustainable and prioritizing the use ofnon-timber forest products(NTFPs) than timber, charcoal, fuelwood extraction and their ability to influence its management and conservation of forest resources. Controlling misuse, extraction and grazing implies that forest income users have sometimes had to reduce their use.This study is in line with Takahashi and Todo (2012), who reported that on average, the forest area of the forest associations (PFM) increased by 1.5% in the first two years, whereas forest areas not managed as part of an association (NPFM) declined by 3.3%. But this study highly contrasts the study done by Oyono (2005), reported that community forests showed negative environmental results, such as the degradation of many community forests in the forested areas in Cameroon.

In contrast with this, users who are most dependent on the forest can feel at likelihood with the forest user communities in NPFM.Fuel wood sellers in particular have complained angrily of the restrictions on collection of TFPs, and have ignored the regulations in NPFM (state controlled forest) in the study area, communities those live around Hadaye highly depend on forest for day to day for household consumption, livelihood improvement and for charcoal production than PFM communities because there were no supporting organization in kebele to make the local forest dependent communities independent and off-farm activity users.

According to both PFM and NPFM forests, sample respondent's information from interviewee and focus group discussants the potential forest during imperial regime was very dense at the same time the forest was controlled by the state but freely access by the community. Due to low population density and the presence of high rain fall; the potential forest was very high. This was supported by the information obtained from local elders. Based on the information from study site focus group discussants, during the Derg regime, the ownership and access for forests were changed and PFM forest was under the control of the state. The potential forest during this time was highly degraded due to open access for trees with an increasing number of populations. More people used to come from outside the village to both forests and cut trees for sale. There was charcoal making inside the forest too. As a result the forests were highly exploited. Most sample respondents' approximately 95% replied that before the introduction of participatory

forest management in Hunase forest; the potential forest was very low because majority of this forest was vulnerable to open grazing and illegal cutting.

This all results forest area to be highly degraded and exposed to erosion. However, this new forestry program (PFM) has been encouraged all interested communities equally to participate in forestry program and become beneficial. Community forest has a large positive impact on environmental protection and forest condition improvements. Observations around forest site of respondents and information from focus group discussants and interviewee, they gave similar response about the potential forests recently as increased due to the introduction of PFM in Hunase forest. This mainly encouraged the participation of the users since it was based on bottom up approach without any external intervention.

4.2. Changes in livelihood conditions of theof PFM and NPFM HHs

4.2.1. Demographic characteristics of the respondents

4.2.1.1. Age of the respondents

Table 3 Age of the respondents

Age of the respondents	Name of the worada/kebele			
	Hunase		Hadaye	
	Fre	per	Fre	Per
<20 young age	13	15.30	12	13.30
20-35 working age	25	29.41	22	24.44
36-45 adult age	27	31.76	24	26.66
>45 old age	20	23.53	32	35.60
Total	85	100	90	100

NB. Fre=frequency per= percent

The findings show that respondents with ages <20, were relatively a small group compared with the rest of another groups of the respondents, this implies that community involvement in forest management in the study area is dominated by the communities with ages having greater than 20 because they are the responsible groups in the community and have different experiences on management of forest resources and their sustainable using system. This indicates that as the age of the respondent community's increases, the community's attitude towards natural resource management, conservation and consumption increases as they do many activities in the environment that affect them. This inturn being affected by the environmental resources also this contributes its own value to the natural resources in general and forest resources management integrated with non-forest based livelihood improvement in particular.

4.2.1.2. Sex of the respondents

Table 4 Sex of the respondents

Name of the forest in kebele					
Sex of the respondents	Hunase		Hadaye		Total
	Fre	perc	Freq	perc	
Male	51	56.65	37	43.53	
Female	39	43.35	48	56.47	
Total	90	100	85	100	175

Fre=frequency Perc=percent

This table shows that there was the significant difference between male and female in the study areas either by increasing or decreasing. The significant increase of females in the study area of Hadaye was due to the movement of men in working age from the village to South Africa in search of job opportunity compared to men in the Hunase Kebele's. However, men's do more about forest and agricultural activities than women therefore; more forest management interventions is also in the hands of men in the study area, thus most of the decisions about forest management were dominated by men when compared with women's involvement. This was due to the multiple roles that women have both at the family and community levels. The study result in Hunase shown that; women and men have about similar management, dependence on use of forest goods. Women also tend to be more dependent than men on small-scale forest products for income in Hunase forest, their participation and gender equality is respected. They also have different benefits from, access to and control over forests.

4.2.1.3. Educational level of the respondents

Table 5Educational characteristics of the respondents

Name of the worada/kebele	Can't write and read	Primary School	secondary school	College education	Adult Educ.	University education	total
Hunase	7	18	10	26	10	14	85
Hadaye	35	30	13	5	5	2	90
Total	42	48	23	31	25	16	175

As indicated in the table 5 as the level of education increases in Hunase forest, the number of participant communities on forest management by PFM significantly increased. Thus, education level has its own significant effect on forest management; because educated communities do not want to depend directly on forest resources then they search another job opportunities like off farm activities, small business, and trade, employ governmental and nongovernmental

organizations and this led them to be free from the dependency on forest resources directly inturn this made them as only managers of forest resources than exploiters. This result is in line with (Adhikari *et al*, 2004), they reported that education level has a tendency to reduce forest dependency because those educated provides a wider range of job options hence making fuel wood collection unprofitable due to greater opportunity costs of collection and inturn this minimizes forest dependence of the local community and improve forest condition. In line with this, if the education level increases, awareness increases not only for participation on PFM program but also in other activities with contemporary and new technologies.

4.2.1.4. Family size of the respondents

Table 6Basic household distribution in Hunase and Hadaye forests.

	Hunase		Hadaye		
Fam size	Frequency	Percent	Frequ	Percent	Total sample size
≤2	2	2.35	4	4.44	
3-4	30	35.30	24	26.67	
5-6	25	29.41	35	38.90	
7-8	20	23.54	20	22.22	
9-10	6	7.05	4	4.44	
>10	2	2.35	3	3.33	
Total	85	100	90	100	175
Aver. fam size	5		6		

HH size=household sizeAver.fam size=average family size. Frequ=frequency

The average household sizes in the study areas were 5 and 6 PFM and NPFM forest respectively. The maximum numbers of the households found at the frequency of the family sizes between 3-4, 5-6 and 7-8 inclusively; because in both cases the maximum family sizes found among these numbers. These increase or decrease of the family size leads to positive or negative effects on the forest resources as all family depends on the forest resources either directly or indirectly for their living condition improvement.

4.2.2. Variations in forest resources consumption in PFM and NPFM HHs

This section presents quantitative data on changes in the various income sources of households before and after the implementation of the PFM program in the PFM HHs and past and current incomes in NPFM HHs. Based on the results of the paired analysis sample*t*-test comparing past households incomes with their current incomes in NPFM HHs and incomes before and after PFM program in PFM HHs are shown in the (table 7). The results showed increased in almost all

incomes in PFM HHs after PFM than before PFM implementation. All these changes were statistically significant at (α=0.05) with the exception of traditional beehives which shows no significant difference before and after PFM implementations. Where as in the case of non-participatory forest management (NPFM), almost all changes in past and current incomes were not statistically significant except off-farm incomes and incomes from honey which were shown statistically significant difference at (α =0.05) in past and current incomes in the NPFM forest HHs. The changes of incomes in PFM and NPFM forests are displayed in table below.

Table 7Comparison of incomes before and after in PFM and past and current in NPFM HHs (paired analysis sample t-test)

Sources income	***PFM(n = 85)***				***NPFM (n = 90)***			
	Before	***After***	***t* value**	***p* value**	**past**	***current***	***tvalue***	***pvalue***
Charcoal product	2.74	1.21	1.470	0.002**	4.33	4.26	0.97	0.330*
TF products	3.90	1.62	13.10	0.001**	3.30	3.36	0.49	0.630*
Honey	3.60	8.89	2.70	0.008**	3.13	3.50	3.27	0.001**
Agriculture	2.94	5.18	2.03	0.045**	3.64	3.70	0.64	0.520*
Off-farm	4.31	4.58	1.75	0.080**	3.68	4.06	2.63	0.010**
Traditional hives	2.65	3.78	0.72	0.470*	2.83	2.67	1.07	0.290*
NTFPs	1.57	2.11	3.55	0.001**	1.72	1.72	0.001	1.000*

Table indicates significant at $p \leq 0.05$.

The results of this study revealed that the changes in the PFM programbetween the households of both communities in general and households in particular differ from each other. The analysis of the quantitative data showed that the PFM program has had variable changes within and across the various types of incomes that change community's livelihoods like honey product, improved wheat varieties of agricultural products like sheep, mango, papaya and avocado, cattle,agricultural crop product incomes, charcoal production, forest timber product extractionand livestock; use of modern beehives than traditional beehives shown different income variations between PFM and NPFM forest product user groups in the study areas. However, when comparing household income conditionsafter PFM with conditions before the PFM program; communities appeared to have experienced improvements in their livelihood conditions.

An extraction of charcoal for income generation from PFM forest has shown high difference before and after PFM implementation in PFM HHs; this is because of the provision of another

job options which are non-forest based income sources. This difference is statistically significant ($P<0.05$).Timber forest product consumption has shown in PFM forest even if the PFM participant HHs are used non forest extractive resources in the study area. Before the PFM introduction, local communities used high amounts of timber products from the forest but now days, local communities are promised to not to use timber forest products due to the knowledge and training received from the PFM project of FARM Africa. Therefore, the use and selling of timber products before and after the implementation of the PFM has shown more difference, this difference is highly statistically significant ($P<0.05$).

Another high income generating forest resources is honey. Incomes from honey and honey products in the study area of PFM HHs has increased highly because local communities who mostly used traditional beehives before PFM implementation directly to the improved and modernized beehives which provides high amount of honey and honey products like honey comb and wax. These income variations led the communities to change the incomes of the HHs after PFM than before PFM implementation. Therefore, incomes from honey has shown high difference before and after PFM implementation in the study areas and this difference is statistically significant ($P<0.05$).

Agricultural crop production is another major income sources in the PFM forest HHs. Before PFM implementation in the study area, local communities used wide areas of land for crop production by clearing large amount of forest resources but their product and productivity was very low and in turn this leads for huge forest extraction and low income sources. But; after the PFM implementation in these communities' forest, their agricultural crop product and production system became changing to the modern and using improved varieties of seedlings provided by the project of FARM Africa in the study area. Therefore, agricultural product and productivity with modified system of production after PFM and has shown higher difference than traditional crop production systems in the study area and this difference is statistically significant ($P<0.05$).

This results to the increment of the amount of income from honey. Thus, incomes from honey increased after PFM than before and this increment shows statistically significant variation at ($P<0.05$).The reverse is true for the traditional beehive using system because the incomes from the traditional beehive was so minimum when compared with modern one but some of the local communities those do not accept modern beehive with its products are still using this traditional

beehive, therefore; the use of this traditional beehive in the study area shown statistically not significant difference (P< 0.05).

Utilization of non-timber forest products in the PFM forest villages is became increasing after PFM than before because awareness creation on the communities' have done on the wise and sustainable utilization of natural resources in general and forest resources in particular. This trained local community increased and changed the management condition of the forest resources and non-forest destructive way of resource consumption and NTFPs than forest and timber products in the study area. Thus, the use and consumption of NTFPs has shown statistically high significant difference before and after PFM P<0.05).

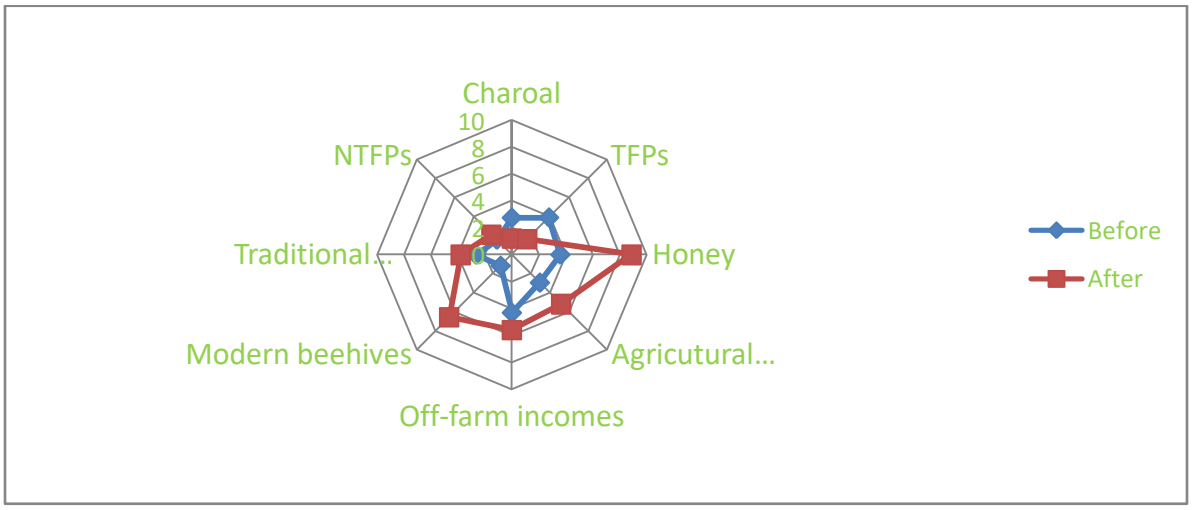

Figure 8Income sources and amount of consumption in the PFM HHs

The result is in line with Bedru (2007), who reported that; incomes from natural resources in general and forest resources in particular play indispensable role in rural livelihood improvement of most developing countries. Agrawal and Chhatre (2006) reported similar results from the northern part of India and Gebremdhin (2008) from Ethiopia, the justification for this can be that, as a rational being, community has reason to conserve forests because of higher economic benefits from forest resources that encourage communities to conserve and manage forest resources.

In contrary with this in non-PFM HHs, the use, consumption and production of charcoal for household income sources and for selling purpose were highly seen in the study area but there was a variation between current and past consumption level incomes from it and this variation is not statistically significant at (P<0.05). Another income sources for the local communities who

live near and adjacent to non-participatory forest management was the use of timber forest.Because of the use of timber products for sale became increased in the study area and due to less options of another non forest based income sources provided for them inorder to replace the incomes from the timber forest products to full fill livelihood income conditions in the study area. Thus, the consumption and use of timber forest products (TFPs) show the difference in the consumption amount of past and current income sources but this difference shows statistically not significant variations in past and current TFPs consumptions in the study area (P>0.05).

In the NPFM HHs as compared PFM HHs, honey production and extraction is the most income accumulation mechanisms in the study area because of the environmental availability for the production of the honey but the production system of the honey is traditional production mechanism oriented thus the product and amount of income from it was also less and less. While comparing incomes from honey in the study area's income from honey in the past with incomes from honey with currently, there was variation between them and this difference shows statistically highly significant variation (P<0.05).This difference is shown because of the use of some modern beehives given to the selected model farmers by the government which improves the product and productivity of honey and incomes from it.

The use of off-farm activities in the NPFM HHs was practiced similar as PFM HHs like restaurants, merchants and etc. and the use of these activities in the NPFM HHs differ from past to current activities and this difference is not significant (P<0.05).

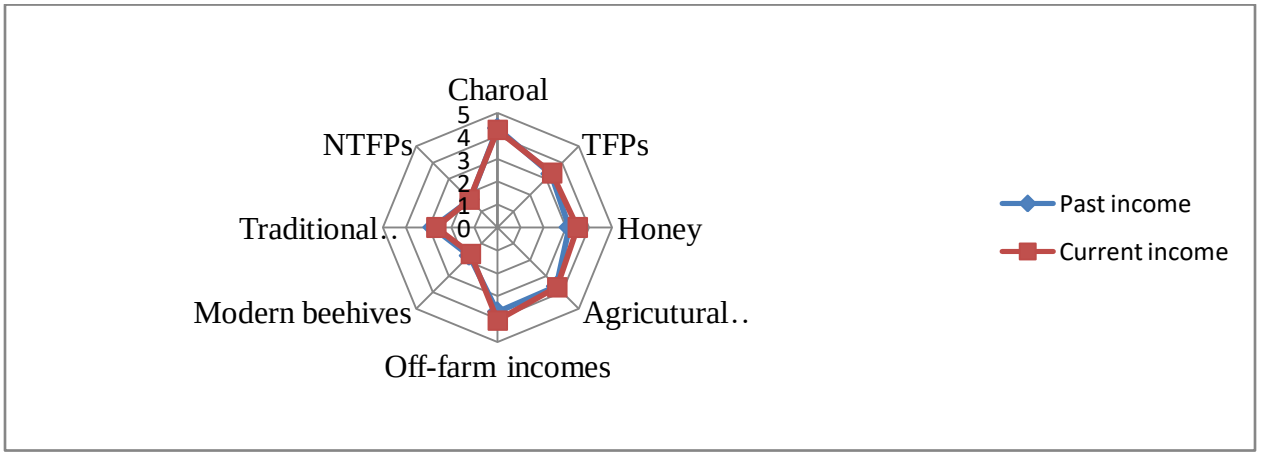

Figure 9Incomes from forest and amount of consumptions in the NPFM HHs

In generally, use and consumption of forest resources as income sources in the HHs of the PFM forest was shown almost all statistically significant differences before and after PFM except beehives use of which is not different before and after PFM because local communities and HHs are opted on the use of modern beehives than traditional and they didn't want to change and increase the amount of traditional beehives in the study area.

In contrast with this; in the non-participatory forest management HHs, the use and consumption of the incomes in the past and currently has shown almost all not statistically significant income difference in the study area except honey production and off-farm income activities which are shown statistically significant variations between past and current incomes in the NPFM HHs.

Figure10. Honey production as sources of income for the FUGmembers

Respondents from the communities in PFM justified that the price and market access for their NTFPs improved during PFM forest than before PFM. There is the member of honey union in which women saving account groups whom cooperate each other because the management activities of one group members is connected with another group member therefore, they are consistent and dependent with on each other. Crop production was reported in both PFM and NPFM survey sites. Due to the similarity of the land ecology of the Hunase and Hadaye, the types of crops grown are similar around both forest areas therefore; wheat, maize, teff, bean, pea and sorghum are the most commonly grown types of crops on both comparative sites. Besides, barley, potato and onions were commonly grown vegetables in the study areas. Regardless of their promise in firewood sales, no household in the Hunase reported as income from firewood sales because of that the majority of the households in Hunase had participated in the PFM.

In similar way with these results from the household quantitative data showed that household incomes in NPFM to have experienced a substantial decline over the use of non-participatory forest management because the resources which were high from the forest before became less and less now a days due to the increase of human population and competition on the forest resources with unsustainable consumption of the forest resources. One reasonable explanation for the observed differences among household findings is that assessment inequalities at the household.

Another explanation for the observed differences as PFM changes at household income levels was that due to the density of communities and co-management processes about common resource income and benefit sharing. For instance, while household income analysis has revealed that household characteristics, such as access to resources and local institutions are important factors shaping households' ability to benefit from PFM of forest resources due to inclusions of institutions in forest resources management and benefit sharing among them.An analysis of the changes of PFM program on household livelihood has revealed that the change of the PFM program at the households were moderately positive because it appears to gain modern way of forest resources consumption and off-farm activity users from the PFM program at the households that was equitably distributed while its change at the non-participatory forest management (NPFM) households were relatively negative. Thus, there is a positive association between participation in PFM, income from forest management and livelihood improvements.

The sample households relied on more than one source of income for their livelihoods. Among those, sale of agricultural product, off-farm activity and live stocks constitutes the largest source of incomes. As reported by the households of the local communities, income 19.12, 31.63 and 27.8 percent’s of the annual incomes generated were respectively from crop production, livestock sales and off-farm activities and these income sources constitute 78.55% of the total incomes of the sample households, followed by honey extraction 16.29% sale in the Hunase PFM programme. Similarly, when compared to Hunase PFM HHs, with the NPFM forest incomes from the agricultural product sale 15.19%, 17.44% from the sale of TFPs and 22.5% from the sale of the livestock. These incomes constitute 55.13% of the total incomes in the comparative NPFM forest areas. As a result; In the PFM area, consumption and sale of milk

from the genetically improved cows and eggs had increased, but consumption and sale of firewood, timber forests production, charcoal extraction and agricultural expansion decreased.

5. CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Globally, morethanhalf percent of the total forests are in tropical regions and they are known to be the most important areas in terms of species composition, structure, diversity and human consumption. Local communities living nearby depend on these forests for their livelihoods. For instance, forest trees provide resources like food, fuelwood, charcoal, traditional medicine, energy, shade, nonwood, woody, environmental services and habitats for other organisms. The rapid increase in human population near forest ecosystems has increased threats of degradation and fragmentation to these ecosystems.The change of the management system has its own contribution for improving forest resources for livelihoods as well as status of the forests.

Hunase and Hadaye forests consist of species that are economically and ecologically important. So far, some of these species have few population structures that showed patterns with individuals of thespecies at different size classes. Such species require urgent conservation measures that wouldenhance healthy regeneration, guarantee and sustainable use of these species. Some other economically important species in these forests were represented in the seedling or sapling stages in a very less amount in the NPFM forest than PFM forest. Such conditions refers that these species are under threat. It is therefore mandatory to implement conservation measures for such species in the forest.

The proportions of smaller diameter sizedindividuals (DBH>10cm) are greater than the medium sized(DBH>20cm)and the larger sized (DBH>30cm)individualsin PFM forest cases but their ratio is relatively lower than the results obtained for other forests.The general trend of population structure showed an inverted J-shape for DBH classes. The majority of the species had a large

number in smaller-diameter size classes with decreasing frequency as the size class increased inPFM forests. If a particular tree species displays such a size distribution, then continuous recruitment can generally be conditional, suggesting that the population is viable as sufficient regeneration is taking place for the population to be maintained.In contrary with this in NPFM; the proportion of small sized individuals (DBH>10) is greater than the proportions of medium sized individuals (DBH>20) but less than the larger sized individuals in the study areas. This shows that there was uncontrolled and selective logging of the trees from the medium and larger sized classes for different activities. The overall DBH distribution revealed inverse-J shape, in NPFM forest; even though different population dynamics for different species were revealed and the regeneration status of the forest is poor, it has been observed that there were few tree species which are either regenerating poorly or not regenerating in the forest.

The higher IVI value of the species is mainly due to their high dominance and density which may be due to their low demand by the local people for timber, charcoal, construction materials, fuelwood and fencing activities shown in the PFM than NPFM forest comparatively.

Compared to the adjacent non-PFM forest site seedling and sapling, mature tree densities are increasing in the PFM forests. Similarly, the vegetation population structure of the PFM forest showed a better structure that show a healthy population distribution across diameter classes compared with the non PFM forest site. This seems to have been achieved because of the regulated access and the forest management works communities exercised after the training given by FARM Africa about the forest management and conservation for the local communities.

The study also showed that PFM has improved the income sources of participant households. Another positive observation is those income generations from wood-based products significantly decreased since the introduction of PFM raise and created non forest destructive job opportunities like off-farm activities, improved agriculture and honey production. This reduction is a good indicator of the management of communities in regulating and controlling the forest destruction activities in the PFM and this in turn leads to the forest condition improvement.

Results from paired analysis sample *t*-tests comparing past and current household incomes using the quantitative survey data showed that most of the households in PFM had experienced almost all incomes from the forest resources shown statistically significant increments in incomes from

forest resources whereas most of the households in NPFM forest experienced almost statistically not significant changes in income from the forest resources.

PFM benefited the people by increasing and diversifying income sources led to the local communities' better income accumulation, and less dependence on forest resources. Increased income in the case of PFM project of FARM Africa originated mainly from agriculture which became modernized and productive after the PFM and not from the forest directly. This indicates that proper and complementary activities to diversify income could help to reduce pressure on the forest. Thus an appropriate balance is given to maximize benefits from the forest resources as well so that communities have optimum economic encouragement to responsibly manage forests. These encouragement for the PFM households came from the works of PFM groups like honey production, improved agriculture, NGOs and GOs of HDA, LFAand non-timber forest products from forest. Involving people in forest management and benefits sharing of the management programs; would inculcated the community to take part in participatory programs in order to improve their livelihoods; In contrast, non-participation (state centered) and exclusion of the local communities led to the misuse and over use of the natural resources and in turn this leads to the deforestation and degradation of natural resources in general and forest resources in particular.

5.2RECOMMENDATIONS

- ✓ Forests provide forest products and are homes to plant and animal species. Therefore, it must be protected and pass to the next generation. In the study area particularly in NPFM areas, shrubs as well as trees are cut for fuelwood and timber frequently therefore; animal rearing in the forest and timber cutting from the forest should be stopped if possible or at least controlled by the concerned body.
- ✓ It is essential to create awareness among the local community about forest conservation and wise utilization. Extension program including forest management should be extended so as to increase awareness on people for wise utilization of the forest. One of the major threats to the forest vegetation is expansion of farmland surrounding the forest and illegal logging. To reduce this and use the forest sustainably, participatory forest management can be used as an alternative.

- ✓ There is a need to minimize livestock grazing, tree cutting and other human disturbances in order to allow the natural regeneration of woody species in the forests.
- ✓ Sustainable utilization like controlled grazing, collection of dried logs, medicinal trees/shrubs, climbers for making beehives, in the forests, using genetically modified agricultural production system and the like should be allowed to develop sense of ownership in the local people and ensure the long-term maintenance of the forests.
- ✓ Moreover, the non-governmental and government in cooperation with other stakeholders must establish andcombine regular managing programs to the community on forest resource use.
- ✓ Efforts should be made to provide the local communities with energy-saving stoves and alternative sources of energy in order to reduce the dependency on the forests for fuelwood.
- ✓ The vegetation of the Hadaye State Forest is disturbed through grazing and browsing by domestic livestock and other human uses, these further affects the quality of regeneration processes of the trees and shrubs. Recognizing these issues as possible future scenario underlies the need for management intervention to increase quality of regeneration being recruited and to accelerate the growth of the young plants would be the homework of the concerned bodies.
- ✓ The reliance of the local people on the forest resources indicates an obvious link between the livelihoods of forest dependent households and forest resources which unless well checked could go against forest conservation objectives.
- ✓ Modern beekeeping and marketing should be initiated in the area to improve income of the local community.
- ✓ Change in the forest resource and livelihood improvements of the local communities should be checked in short periods of time and should be supported by research before the NGOs support terminates.

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APPENDICES

Appendix 1Questionnaires

I am a post graduate student from Jimma university of Ethiopia perpetuating a master degree on Nature and Forest conservation and carrying out the research study oncommunity participation in forest management and its role for improving forest conditions and people's livelihood: a comparative study of participatory forest management and state managed forests in Gibe district Hadiya zone, of southern Ethiopia**.**

The questions are designed for this research only. You are kindly requested to contribute and fill in the questionnaire which will be used in the study. I assure you that the information gathered will be used for the purpose of this research only and will be treated with the strict confidentiality.

1. Name of the district and or/kebele: _____ village/sub village: _____

2. Sex: Male_____ Female _____.Age _____

Thank you in advance for your co-operation!

Section A. Sociodemographic information

Choose from the following letters which is appropriate answer to the questions provided.

1. Indicate your gender 1. Male 2. female

2. Age 1.below 20 years 2.20-30 years 3. 31-45 years 4.above 45years

3. What is your Educational level?

1) Can't write and read 4.college education 5. Adult education

2) Primary school 3. Secondary school 6. University education

4. How long have you been a member of PFM in Hunase forest?

1. Less than one year 2.2-3 years 3.4-5years 4. Above 6 years

5. What is your religion? 1. Christian 2. Muslim 3. Other (specify)

6. What is your occupation? 1. Merchant 2. Civil servant 3. Wood seller 4 charcoal sellers

Section B: Role of NGOs and GOs on forest management and livelihoods

7. Do you know what forest management is? 1. Yes 2. No

8. What is sustainable forest management?

9. Is there any difference between forest management and consumption? How they differ?

10. What is the objective of FARM Africa in this worada and Hunase particularly?

11. Was FARM Africa used to the local communities? How?

12. What kinds of Agricultural inputs/resources provided by this organizations?

13. How these agricultural products are useful and productive than before?

14. Do you support the idea of embracing community participation in enhancing forest management? A. yes B. no

15. Why do you think community participation is an important concept in forest management? 1. Community is decisive to everything 2. Community participation avoids corruption 4. Community removes abuse of power from participation 5. Any other (specify)

16. Do you think the communities adequately involved in forest management? A. yes B. no

17. How can you rate the expectation level of PFM when joining as a member of forest management? A. very high B. high C. medium D. low E. very low

18. How can you rate the trends of forest resources management in Hunase from the last five years? A. Increasing B. Decreasing C. no change

19. How about the trends of forest management in Hadaye forest from last five years? 1. Increasing 2. Decreasing 3.no change

20. What about forest conditions of Hadaye forests than last 5 years? 1. Increasing 2.decreasing

21. Has the concept of community participation aided in increasing forest cover and forest resources? A. yes B. no

22 If yes in above Q12 how? 1. by minimizing potential of consumption 2.by avoiding consumption 3. by providing incomes 4. From NTFP

Section C. Role of PFM on livelihood improvement conditions

23. Is there any difference in livelihood conditions of the local communities while participating in PFM program than before? 1. Yes 2. No

24. Is forest conditions generally increased after community participation? 1. Yes 2. No

25. Do supporting NGOs and GOs provide genetically improved plant and animal species?

26. How many cattle's were in your house before participating in PFM? How it used?

27. How about cattle numbers after participating in PFM?

28 How milk cattle's were provided to you? 1 from NGOs and GOs 2. From neighboring towns

29. Are those provided dairy cattle produce high products than traditional? 1. Yes 2. No

30. What genetically improved agricultural products was provided by the NGOs and GOs? 1. 1.cattle variety 3.Maize, wheat, variety avocado, mango, papaya etc

SectionD. Overview of Community Participation on Forest Management

31. In your opinion what strategies can the government introduce at the local level to create community awareness and enhance efficiency of community participation in forest management efforts? 1. Sustainable consumption 2. Restriction and avoidance of consumption

32. In your opinion, do you think integrating the concept of community through PFM approach is an important move in confronting forest management efforts at the local level?

A. yes B no

33. Do you think the adjacent community embraces the idea of integrating community participation in forest management practices in Hunase forest? A. yes B. no

34. Do you think the variation in benefit sharing between the PFM members and other stakeholders? A. yes B. no

35. How can the variation be addressed to enhance their participation in forest management effort? 1. Providing education 2.minimizing corruption 3.providing incentive 4. Awareness creation

36. What measures has the FARM Africa, HDA and LFA Hunase forest put in place to promote community awareness? 1. School formation 2.infrastructure provision 3.information distribution 4. Consecutive training

Focus Group Discussions (FGD) Interview Guide for Key Informants

Section A:-General situation on the role of community participation on PFM

37. What is the relationship between the community and the management of the forest (from d/t groups)?

38. Do you think the adjacent community is adequately involved in PFM initiatives by the government? ----------

39. Which area do you think the government can improve to promote community participation and improve forest management? ----------

40. Has the idea of the integrating adjacent community in forest management efforts improved the livelihoods of the people and forest status in the area? Economic, environmental, ecological and benefit sharing

41. How can you compare the utilization of forest resources by the community in the last decades to now? and now? ----------

48. In your view, how would like forest resources to be utilized in the future? ----------
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42. What measures can the government introduce to promote equitable, sustainable and effective utilization of forest resources in Hunase forest? ----------
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43. Do you have a fear that PFM will restrict your use rights (such as firewood sells, honey?

and production timber of forest?

44. How the importance of participatory forest management is checked economically?

45. It is very important 2. it is important 3. it is not important 4. Indifferent 5. Loss of benefit

46.How about the role of participation of local communities on forest management? 1. Excellent 2. Very good 3.good

47. How do you rate the importance forest before PFM established? 1. Very high 2.high 3. Medium 4. Very low 5.low

48. How about the importance of forest after PFM established? 1. Very high 2.high 3. Medium 4.very low 5.low

49. How about the sources of livelihood after PFM established? 1. very high 2.high 3. Medium 4.very low 5.low

50. How about the sources of livelihood before PFM established? 1. very high 2.high 3. Medium 4.very low 5.low

51. How about the sources of forest income before PFM established? 1. very high 2.high 3. medium 4. very low 5.low

52. How about the sources of forest income after PFM established? 1.very high 2.high 3. medium 4. very low 5.low

53. What NTFPs do you get from PFM forests? 1. honey 2. Grass 3.Fruit 4.recreation 4.any other(specify)

54. Who are the owners of the Hunase forest? 1. Community 2. NGOs Government HAD, LFA 3. any other(specify)

55. Who controls the edge of the forest and demarcation of the boundary? 1. Community 2 .Government 3.any other (specify)

56. Do uncontrolled/clear cutting of plant species is high in Hadaye forest? 1.yes 2.no

57. How you rate selective non logging in Hadaye forest? 1.very high 2.high 3. medium 4. low 5.very low

58. What about the use of timber products in Hadaye forest? 1.very high 2. high 3.medium 4. low 5.very low

59. Why participation of the community is low in Hadaye forest? 1.no awareness 2.no education 3. no incentives 3. no government and NGOs support

60. Is there any livelihood diversification activities which are implemented to lessen the pressure on the forest in Hunase? 1.yes 2 no

61. What has been the contribution of state management of forest Rs in Hadaye forest? 1. It is managed symbolically 2. Managedbygovernment only 3. Managed culturally

62. Are there any livelihood diversification activities which are implemented to lessen the pressure on the forest in Hadaye? 1. Yes 2. no

63. If the answer for the question no 10 is yes, what activities are implemented? 1. Income provision from forest land consumption, from timber production from NTFP, 2.NGOs

64. If the answer is no for question no 10, why livelihood diversification is not implemented? 1. It is not participatory 2.we get diversification from timber products 3. Gov't alone could't control the forest and we use many products from it 4. we get many products and consumption from charcoal production

65. Deforestation and degradation is becoming high in Hadaye forest? 1.yes 2. no

66. In your assumption, what about forest condition of the Hadaye forest from last five years now? 1. Increasing 2. Decreasing 3.Unchanged 4. Others Specify

67. Is there any conflict arising on the Hadaye forest? 1. Yes 2. no

68. If answer to the question number 15 is no? Why conflict didn't arise? 1. it is free to use for every users 2. There is no resource scarcity 3. Community restriction is impossible 4. NTFPs is enough to consumption

69. How forest resources are used by the community from the Hadaye forest?

1. Mg't and consumption 2. Consumption and exploitation 3.other(specify)

70. Open access rights in the Hadaye forests are: - 1. None 2.extremely limited 3. no limitation

71. Use rights in Hadaye forest is 1. none 2.extremely limited 3. no limitation

72. Participation of local communities in the management activities are:-1.none 2.extremely limited 3. no limitation

73. Do you think the PFM need to be respected? 1. yes 2. no

Thank you for your response and participation by taking time!!

Thank you very much for your time!

Appendix 2

Species identification in the study areas

No	Local name	*Scientific name*	Family	Habit
1	Acoongara	*Ehretia cymosa*	Solanaceae	SH
2	Atura	*Cordia ovalis*	Apocynaceae	SH
3	Duubaana	*Syzygium guineense*	Myrtaceae	T
4	masana	*Crotomn macrostachyus*	Euphorbiaceae	T
5	Kasharberzef	*Camaldulensis globulus*	Myrtaceae	T
6	Zayituna	*Psidium guajava*	Myrtaceae	T
7	Ciroonta	*Brucea antidysenterica*	Simaroubaceae	T
8	Minantofa	*Ocimum lamifolium*	Lamiaceae	SH
9	Digiba	*Podocarpus falcatus*	Podocarpaceae	T
10	Gatama	*Schefflera abyssinica*	Araliaceae	T
11	Giraara	*Acacia abyssinica*	Fabaceae	T
12	waaturuuncho	*Asparagus africanus*	Rosaceae	Climber
13	Gora	*Rosa abyssinica*	Rosaceae	Climber
14	Shunxiige'e	*Ficus sycomorus*	Rosaceae	Climber
15	Guna	*Sapium ellipticum*	Euphorbiaceae	T
16	Hanja	*Phytolacca dodecandra*	Phytolaccaceae	climber
17	Bolfe	*Polyscias fulva*	Araliaceae	T
18	Hangada	*Millettia ferruginea*	Fabaceae	T
19	Heebba	*Vernonia amygdalina*	Asteraceae	T
20	Hooma	*Juniperus procera*	Cupressaceae	T
21	Huqa	*Pennistum spps.*	Poaceae	Grass
22	Jonge'e	*Maytenus arbutifolia*	Celastraceae	Sh
23	Kitkita	*Dodonaea angustifolia*	Sapindaceae	Sh
24	Koraqa	*Bersema abyssinica*	Melianthaceae	T
25	Barawa	*Vernonia myriantha*	Asteraceae	T
26	Dimbaba	*Phoenix reclinata*	Arecaceae	T
27	Koronte	*Pterolobium stellantum*	Fabaceae	Liana
28	Kowwada	*Maesa lanceolata*	Myrsinaceae	T
29	Maanda'e	*Albizia gummifera*	Fabaceae	T
30	Meewa	*Prunus africana*	Fabaceae	T
31	Waddeesha	*Cordia africana*	Boraginaceae	T
32	Weera	*Olea europaea*	Oleaceae	T
33	Ulaaga	*Ehretia cymosa*	Boraginaceae	T
34	Axxada	*Lippia adoensis*	Verbenaceae	Sh
25	Onama	*Diospyros abyssinica*	Ebenaceae	T
36	Gesho	*Rhamnus prinoides*	Rhamnaceae	Sh
37	Xummuga	*Justicia schimperiana*	Acanthaceae	Sh
38	Qobbo	*Ricinus communis*	Euphorbiaceae	T
39	Wora'a	*Erythrina brucei*	Fabaceae	T
40	Senna	*Calpurnia aurea*	Fabaceae	Sh
41	minqeshancho	*Clausena anisata*	Rutaceae	Sh
42	Leema	*Arundinania alpina*	Poaceae	Sh
43	Qawa	*Coffea arabica*	Rubiaceae	Sh
44	Oloola	*Cadaba farinosa*	Fabaceae	T
45	Booraara	*Grewia tanax*	Fabaceae	T

46	Ulli Booraara	*Calotropis procera*	Asteraceae	T
47	Qama'li haqqa	*Acacia etbaica*	Fabaceae	T
48	Senna	*Ficus vasta*	Verbenaceae	T

Appendix 3

Density of the species with its family

No	Name of the Family	Number of the species in the family	Percent of coverage/family
1	*Fabaceae*	10	20.83
2	*Asteraceae*	3	
3	*Euphorbiaceae*	3	
4	*Rosaceae*	3	
5	*Myrtaceae*	3	25
6	*Araliaceae*	2	
7	*Verbenaceae*	2	16.67
8	*Poaceae*	2	
9	*Boraginaceae*	2	
10	*Acanthaceae*	1	37.5
11	*Apocynaceae*	1	
12	*Arecaceae*	1	
13	*Celastraceae*	1	
14	*Cupressaceae*	1	
15	*Ebenaceae*	1	
16	*Lamiaceae*	1	
17	*Melianthaceae*	1	
18	*Myrsinaceae*	1	
19	*Oleaceae*	1	
20	*Phytolaccaceae*	1	
21	*Podocarpaceae*	1	
22	*Rhamnaceae*	1	
23	*Rubiaceae*	1	
24	*Rutaceae*	1	
25	*Sapindaceae*	1	
26	*Simaroubaceae*	1	
27	*Solanaceae*	1	
	27	48	100

Appendix 4

Relative frequency (RF),Relative density (RD), relative dominance (RDO) and Important Value index (IVI) of the species in the PFM forest

	species name	RF	RD	RDO	IVI	%IVI
1	*Ehretia cymosa*	1.5	2.5	0.8	4.8	1.6
2	*Cordia ovalis*	0.8	2.3	3.5	6.6	2.2
3	*Syzygium guineense*	15	10	0.5	25.5	8.33
4	*Crotomn macrostachyus*	15	15	0.4	34.5	34.5
5	*Camaldulensis globulus*	1.4	2	2.9	6.3	2.1
6	*Psidium guajava*	3.5	2.8	1.4	7.7	2.57
7	*Brucea antidysenterica*	3.5	4.5	2.2	6.3	2.1
8	*Ocimum lamifolium*	0.3	0.6	0.2	5	1.66
9	*Podocarpus falcatus*	1.3	4.2	3.5	9	3
10	*Schefflera abyssinica*	8	16	0.4	24.5	8.16
11	*Acacia abyssinica*	0.4	7.3	5.7	13.4	4.47
12	*Asparagus africanus*	2.8	0.2	0.6	3.6	1.2
13	*Rosa abyssinica*	1.8	1.5	1.9	5.2	1.7
14	*Ficus sycomorus*	5	3	10	18	6
15	*Sapium ellipticum*	2.5	0.1	0.4	3	1
16	*Phytolacca dodecandra*	3.5	1.7	4.9	10.1	3.36
17	*Polyscias fulva*	0.8	2.1	0.3	3.2	1.06
18	*Millettia ferruginea*	1.3	2.7	0.6	4.6	1.5
19	*Vernonia amygdalina*	1.4	0.5	5.3	7.2	2.4
20	*Juniperus procera*	1.6	3.3	0.4	15.5	1.7
21	*Pennistum spps.*	4.2	1.9	2	8.1	2.7
22	*Maytenus arbutifolia*	0.3	2.1	0.9	3.3	1.1
23	*Dodonaea angustifolia*	2.3	3.5	4.1	9.9	3.3
24	*Bersema abyssinica*	6.3	4	3.5	13.8	4.6
25	*Vernonia myriantha*	2.8	2.9	1.1	6.8	2.26
26	*Phoenix reclinata*	1.9	2.6	0.2	4.7	1.57
27	*Pterolobium stellantum*	1.7	1.8	5.1	8.6	2.89
28	*Maesa lanceolata*	0.2	1	2.4	3.6	1.2
29	*Albizia gummifera*	1.4	2.6	3.2	7.2	2.4
30	*Prunus africana*	7.5	4.5	3.5	15.5	5.16
31	*Cordia africana*	2.3	2.1	2.2	0.6	2.2
32	*Olea europaea*	6.5	4.5	4	14	4.66
33	*Ehretia cymosa*	2.1	2.1	3.5	1.7	2.56
34	*Lippia adoensis*	0.5	0.6	0.6	1.7	0.5
35	*Diospyros abyssinica*	4.5	6.5	2.5	12	4

36	*Rhamnus prinoides*	1.5	1.1	4.5	7.1	2.5
37	*Justicia schimperiana*	2.8	1.5	0.2	4.5	1.5
38	*Ricinus communis*	2.3	3.1	1.2	6.6	2.2
39	*Erythrina brucei*	3.5	0.7	0.1	4.3	1.43
40	*Calpurnia aurea*	0.7	1.6	1.6	3.9	1.3
41	*Clausena anisata*	2.1	1.1	1.4	4.6	1.5
42	*Arundinania alpina*	1.7	1.2	3.5	6.4	2.1
43	*Coffea arabica*	1.5	2.1	2.3	5.9	2.6
44	*Cadaba farinosa*	0.5	0.5	0.25	1.25	0.45
45	*Grewia tanax*	2.5	1.7	1.5	5.7	1.9
46	*Calotropis procera*	2.3	1.6	2.3	6.2	2.06
47	*Acacia etbaica*	7.2	4.1	2	3.1	2.2
48	*Ficus vasta*	3.8	2.1	0.7	6.6	2.3
	Total density	100	100	100	300	100

Appendix 5

Relative frequency (RF), Relative density (RD), relative dominance (RDO) and Important Value index (IVI) of the species in the NPFM forest

No	Scientific name	RF	RD	RDO	IVI	% IVI
1	*Ehretia cymosa*	0.1	2.6	4.2	6.9	2.32
2	*Cordia ovalis*	1.9	0.6	2.5	5	2.2
3	*Syzygium guineense*	1.5	0.1	2.5	4.1	1.76
4	*Crotomn macrostachyus*	1.5	0.5	6.5	8.5	1
5	*Camaldulensis globulus*	5.5	1.5	0.5	7.5	2.1
6	*Psidium guajava*	3.5	0.6	2.9	7	2.57
7	*Brucea antidysenterica*	4.5	1.2	0.6	2.5	2.1
8	*Ocimum lamifolium*	0.25	2.5	1.5	6.5	1.66
9	*Podocarpus falcatus*	1.5	1.5	2.5	5.5	3
10	*Schefflera abyssinica*	2.5	1.6	2.5	6.6	1.83
11	*Acacia abyssinica*	0.5	2.5	6.5	19.5	4.47
12	*Asparagus africanus*	2.5	2	1.5	1.5	1.2
13	*Rosa abyssinica*	1.8	2.4	1.9	6.1	1.7
14	*Ficus sycomorus*	3.1	1.3	1.1	5.5	1.8
15	*Sapium ellipticum*	0.2	0.5	3.5	4.5	1.6
16	*Phytolacca dodecandra*	2.5	1.9	2.7	4.6	3.36
17	*Polyscias fulva*	1.2	3.5	0.6	5.3	1.06
18	*Millettia ferruginea*	1.4	3.8	2	12	1.5
19	*Vernonia amygdalina*	0.5	2.5	1.5	4.5	2.4
20	*Juniperus procera*	0.5	6	0.4	6.3	1.7
21	*Pennistum spps.*	2.5	0.5	2.5	5.5	2.7
22	*Maytenus arbutifolia*	1.8	1.5	1.8	5.1	1.1

23	*Dodonaea angustifolia*	2.5	1.5	1.5	3.3	3.3
24	*Bersema abyssinica*	2	4.6	1.5	8.1	4.6
25	*Vernonia myriantha*	2.5	1.5	0.5	4.5	2.26
26	*Phoenix reclinata*	0.5	1.5	0.3	4.5	1.57
27	*Pterolobium stellantum*	2.5	5	2.5	10	2.89
28	*Maesa lanceolata*	0.5	0.6	2.5	3.6	1.2
29	*Albizia gummifera*	0.5	3.5	5.5	3.2	4.5
30	*Prunus africana*	2.5	0.5	1.5	4.5	2.06
31	*Cordia africana*	2.5	0.5	5.5	8.5	2.2
32	*Olea europaea*	5.25	0.5	2.5	8.3	1.8
33	*Ehretia cymosa*	1.5	2.5	1.2	5.2	2.56
34	*Lippia adoensis*	1.5	1.4	0.5	3.4	0.5
35	*Diospyros abyssinica*	2.5	2.5	1.5	9.3	1.76
36	*Rhamnus prinoides*	2	1.5	4.5	8	2.9
37	*Justicia schimperiana*	1.9	4.8	1.5	8.5	2.7
38	*Ricinus communis*	1.3	1.5	2.8	13	2.7
39	*Erythrina brucei*	3.5	2.4	0.5	6.3	1.43
40	*Calpurnia aurea*	2.5	2.5	1.6	6.6	1.3
41	*Clausena anisata*	2.5	7.5	1.5	12	4.0
42	*Arundinania alpina*	0	0	0	0	0
43	*Coffea arabica*	1.5	8.5	4.8	15	2.6
44	*Cadaba farinosa*	9	0.1	2	11	2.9
45	*Grewia tanax*	3.5	0.2	2.5	5.2	5.3
46	*Calotropis procera*	1.5	2.3	0.5	4.3	2.06
47	*Acacia etbaica*	2.5	0.5	5.1	16	2.2
48	*Ficus vasta*	0.5	1.5	0.7	2.7	2.3
	Total	100	100	100	300	100

Appendix 6

Density of the species/ha in the PFM forest

Scientific Name	matured tree	Sapling	seedling	BA/m^2/ha
1.Ehretia cymosa	11.6	43.94	146.591	3.36
2.Cordia ovalis	12.5	42.42	29.545	10.05
3.Syzygium guineense	2.65	4.167	1.136	9.005
4.Crotomn macrostachyus	0.38	4.167	0.758	0.0022
5.Camaldulensis globulus	4.28	9.848	74.621	4.62
6.Psidium guajava	1.89	4.545	10.227	0.021
7.Brucea antidysenterica	1.14	41.67	11.894	0.235
8.Ocimum lamifolium	0.76	21.21	2.652	9.048
9.Podocarpus falcatus	2.65	2.652	6.439	0.01

10.Schefflera abyssinica	10.98	2.01	23.106		1.582
11.Acacia abyssinica	3.41	29.17	10.985		5.145
12.Asparagus africanus	0.76	10.76	14.015		0.051
13.Rosa abyssinica	1.52	45.68	10.606		0.262
14.Ficus sycomorus	4.92	13.64	6.439		0.05
15.Sapium ellipticum	1.14	12.12	50.758		0.322
16.Phytolacca dodecandra	2.27	105.3	29.545		1.475
17.Polyscias fulva	17.8	88.64	66.288		2.34
18.Millettia ferruginea	6.82	10.99	0.379		0.025
19.Vernonia amygdalina	55.68	6.818	8.712		0.4
20.Juniperus procera	41.89	19.14	31.136		19.666
21. Pennistum spps.	19.7	32.27	10.106		0.3
22.Maytenus arbutifolia	59.09	33.67	23.106		0.01
23.Dodonaea angustifolia	11.46	6.928	14.015		0.082
24.Bersema abyssinica	16.29	31.89	0.758	2.19	
25.Vernonia myriantha	22.38	2.477	39.015		0.32
26.Phoenix reclinata	13.03	4.167	69.47		0.59
27.Pterolobium stellantum	45.68	41.67	81.061		2.23
28Maesa lanceolata	13.32	121.2	9.47		1.626
29.Albizia gummifera	9.23	12.12	232.197		5.05
30.Prunus africana	7.95	10.99	140.152		1.99
31.Cordia africana	6.38	23.47	61.36	19.65	
32.Olea europaea	4.09	0.67	0.83		0.002
33.Ehretia cymosa	19.67	31.32	2.48		0.224
34.Lippia adoensis	0.24	27.38	0.55		0.062
35Diospyros abyssinica	1.41	0.62	13.6		10.02
36.Rhamnus prinoides	7.19	0.85	5.76		0.015
37.Justicia schimperiana	17.38	32.07	27.81		0.47
38.Ricinus communis	8.8	0.66	32.03		0.135
39.Erythrina brucei	0.91	6.03	6.39		0.014
40.Calpurnia aurea	11.7	4.6	24.43		0.13
41.Clausena anisata	14.48	48.82	12.31		0.45
42.Arundinania alpina	10.03	25.05	86.27		1.155
43.Coffea arabica	58.808	27.84	19.55		0.61
44.Cadaba farinosa	51.27	7.14	24.69		0.542
45.Grewia tanax	11.82	19.94	29.2		0.3
46.Calotropis procera	15.07	21.26	17.77		0.23
47.Acacia etbaica	28.21	13.07	26.09		0.36
48.Ficus vasta	0.18	8.92	1.49		16.009
Total	670.808	1115	1547.79		132.44

Appendix 7

Density of the species/ha in the NPFM forest

Scientific name	Mature tree	saplings	seedlings	BA/m2/ha
Lippia adoensis	0.68	11.29	10.32	0.8213
Maytenus arbutifolia	3.76	13.64	11.83	0.0974
Dodonaea angustifolia	0.46	10.97	4.42	1.0026
Calotropis procera	11.31	2.34	0.758	4.0162
Cordia ovalis	10.27	11.76	1.31	0.0771
Cordia ovalis	3.19	0.55	7.59	0.01
Arundinania alpina	2.61	7.96	19.47	0.0708
Coffea arabica	10.76	16.31	2.652	0.0305
Cadaba farinosa	2.65	2.652	4.53	2.0075
Ehretia cymosa	2.71	4.44	7.84	22.0176
Calpurnia aurea	1.69	9.41	4.55	0.0192
Acacia etbaica	0.76	13.72	9.73	3.0158
Ficus vasta	2.62	12.31	3.58	2.0268
Asparagus africanus	0.18	3.49	16.74	0.0327
Syzygium guineense	10.42	5.66	27.36	5.1481
Phoenix reclinata	1.36	27.27	9.5	0.4797
Grewia tanax	7.24	18.68	16.45	0.1409
Crotomnmacrostachyus	0.69	23.13	0.9	3.0259
Camaldulensis globulus	13.92	32.4	9.74	0.0533
Psidium guajava	10.17	6.22	7.94	6.0925
Brucea antidysenterica	32.58	11.83	23.5	0.0251
Podocarpus falcatus	11.34	5.62	17.87	4.0952
Schefflera abyssinica	2.76	11.53	3.62	0.0251
Acacia abyssinica	6.98	18.29	14.59	8.1247
Sapium ellipticum	9.32	22.41	12.54	0.1608
Polyscias fulva	2.46	3.44	22.11	5.5681
Prunus africana	25.21	19.26	16.47	0.2915
Albizia gummifera	30.26	17.82	12.43	0.643
Maesa lanceolata	10.63	2.121	20.86	0.0886
Pterolobium stellantum	11.43	3.79	17.69	0.1445
Phoenix reclinata	0.22	2.46	13.42	3.0912
Vernonia myriantha	24.09	41.83	2.41	0.0054
Bersema abyssinica	1.42	4.69	3.12	0.0582
Juniperus procera	10.24	18.81	9.64	0.1174
Vernonia amygdalina	1.41	0.62	10.9	2.1385

Millettia ferruginea	8.86	2.68	6.72	0.0261
Polyscias fulva	6.66	21.3	8.23	0.1028
Pennistum spp	4.27	8.66	0.55	0.0879
Ficus sycomorus	7.91	4.99	13.33	0.0674
Prunus africana	12.42	41.58	2.43	11.0211
Albizia gummifera	13.67	14.59	3.72	0.0379
Maesa lanceolata	27.55	1.24	8.44	0.2571
Pterolobium stellantum	41.36	6.41	7.32	1.4325
Phoenix reclinata	16.25	2.45	32.76	7.0361
Vernonia myriantha	21.69	1.37	13.57	1.0271
Bersema abyssinica	15.12	3.61	21.95	12.0335
Juniperus procera	14.55	5.52	4.33	2.0927
Vernonia amygdalina	0.18	10.29	8.32	0.006
Millettia ferruginea	468.29	543.413	510.05	109.99
Total	Mature tree+sapling+seedling=1521.753			