ADDIS ABABA UNIVERSITY



SCHOOL OF POST GRADUATE STUDIES

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES

DEPARTMENT OF ZOOLOGICAL SCIENCE

ASSESSING THE IMPACT OF EUCALYPTUS PLANTATION EXPANSION ON AGRICULTURAL PRODUCTIVITY IN SELECTED KEBELES OF DANO WOREDA, WEST SHOA ZONE, OROMIA REGIONAL STATE, ETHIOPIA.

A THESIS SUBMITED TO THE SCHOOL OF GRADUATE STUDY OF ADDIS ABABA UNIVERSITY, IN PARTIAL FULFILMENT OF THE REQUAREMENTS FOR THE MASTERS OF SCIENCE IN BIOLOGY.

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ADVISOR: Dr. BIKILA WORKINEH

AUGUST, 2024

ADDIS ABABA, ETHIOPIA.

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Table of contents

Contents **pages**

Acknowledgement iii

Table of contents iv

List of Tables vii

List of Figures viii

LIST of ACRONYMS AND ABBREVIATION ix

ABSTRACT x

CHAPTER ONE 1

1.INTRODUCTION 1

1.1. Back Ground of the Study 1

1.2. Statement of the problem 3

1.3. Objectives of the study 3

1.3.1. General objective 3

1.3.2. Specific objectives 4

1.4. Research Questions 4

1.5. Significance of the study 4

1.6. Scope of the Study 5

1.7. Limitation of the study 6

CHAPTER – TWO 8

2.1. REVIEW OF RELATED LITERATURE 8

2.1.1. Impact of eucalyptus on plants of Ethiopia 10

2.1.2. Potential competitive Mechanisms of Eucalyptus 11

2.1.3. The impact of Eucalyptus shade on light intensity 11

2.1.4. Competition for Nutrients 11

2.1.5. Effect of Eucalyptus on Soil Fertility 13
2.1.6. Effects of Eucalyptus on Maize Crop 14
2.1.7. Competition for Water 15
2.1.8. Effects of Eucalyptus on Coffee Plant 16
2.1.9. Agro-biodiversity and human nutrition security 18
CHAPTER THREE 20
3.1. RESEARCH DESIGN AND METHODOLOGY 20
3.2. Research Design 20
3.3. The study population 20
3.4. Sample Size and Sampling Techniques 20
3.5. Instruments for Gathering Data 22
3.6. Techniques for Gathering Data 22
3.7. Methods of Data Interpretation 23
3.8. Ethical considerations 23
CHAPTER FOUR 24
4.1. RESULT AND DISCUSSION 24
4.2. Features of the respondents 24
4.3. Impact of eucalyptus plantation expansion on soil fertility, water availability, and usage for agricultural purposes 26
4.4. Socio-economic impacts of eucalyptus plantation expansion on local agricultural communities 30
4.5. Income generation from the sale of eucalyptus biomass compared to crop yields 32
4.6. Awareness of the negative impact of eucalyptus plantation expansion on cereal crop productivity. 35
CHAPTER – FIVE 41

5.CONCLUSION AND RECOMMENDATION 41
5.1. Conclusion 41
5.2. Recommendations 41
REFERENCES 43
APPENDIX A 47
APPENDIX B 48
APPENDIX C 49
APPENDIX D 50
APPENDIX E 52
APPENDIX F 54

List of Tables

Table 1 Plants Water Use Efficiency (source: Davdison, 1989). 16
Table 2 Summary of Educational Background of the respondents (n=252) 25
Table 3 How the expansion of eucalyptus plantations has affected the soil fertility of their agricultural land 26
Table 4 Ways in which the usage of water for agricultural purposes has been impacted by the presence of eucalyptus plantations. 28
Table 5 If there are any adjustments to their agricultural productivity due to changes in water availability caused by eucalyptus plantation expansion. 29
Table 6 summary of respondents on income generated from Eucalyptus trees and other cereal-crops. (n =252) 32
Table 7 Identifying the engagement of the respondents in the sale of eucalyptus biomass as a source of income 33
Table 8 Awareness of any negative impacts of eucalyptus plantation expansion on cereal crop productivity, ... 35

List of Figures

Figure 1 above indicates the location map of the study area in Dano woreda 6
Figure 2 Effect of Eucalyptus on other vegetation (source Michelsen et al (1998) 18
Figure 3 Summery of age and sex of respondents……24
Figure 4 changesinwateravailabilitysinceeucalyptusplantationsinthearea……27
Figure 5 Eucalyptus trees intercropped with Zia maize corn 37
Figure 6 Eucalyptus trees intercropped with Sorghum. 38
Figure 7 broadlly Eucalyptus plantation on graizing land 39
Figure 8 Extenssivelly Eucalyptus plantation on farm land 40

LIST of ACRONYMS and ABBREVIATION

C.G.S:- Council of Graduate Studies

D.G.C:- Department of Graduate Committee

F: - Number of respondents (frequency)

F.A.O:- Food and Agricultural Organization

I.A.R:- Institute of Agricultural Research

I.P.E.S:- International Panel of export System

Kg:- Kilogram

N.G.O:- None Governmental Organization

S.G.C:- School of Graduate Committee

S.O.M:- Soil Organic Mater

ABSTRACT

This study was mainly aimed to investigate the impact of eucalyptus plantation expansion on agricultural productivity. To achieve the objectives, mixed (quantitative & qualitative) research design was employed. Data were gathered from 252 target populations of Dano woreda farmers. The findings, therefore, suggest that farmers prefer cereal-crop productivity on their fertile land than Eucalyptus plantation. Many dwellers gave suggestion about the negative impact of the Eucalyptus plantation expansion on the environment; but some of them practicing the plant expansion till now. The farmers were only following the income generated from the selling of the cereal-crop product. They gave attention to the ecosystem degradation which is resulting by Eucalyptus plantation and the redaction of food crops in this area year by year. Therefore, the study recommended that the government agencies responsible for land use planning and environmental management, as well as to non-governmental organizations working on sustainable agriculture and land use practices. There could also findings and recommendations with eucalyptus plantation owners and farmers to raise awareness and promote collaborative solutions & keeping the maximum distance of eucalyptus and crops is good for better agricultural production.

Keywords: Agricultural productivity, Eucalyptus Plantation, Impact, Farmers, Tree

CHAPTER ONE

INTRODUCTION

1.1. Back Ground of the Study

The term Eucalyptus has been derived from two Greek words, "eu" meaning "well" and "kaluptos" meaning "covered", a botanical reference to the trees, flowers and fruits (Boland et al. and FAO, 2006). Eucalyptus, a genus of more than five hundred species, has become the most planted genus of trees in the world that dispersed from its native country australia (Teketay D, 2000). Globally, over 500 Spp, as Africa about 50 Spp & in Ethiopia 10 to 15 species, of Eucalyptus are there.

Eucalyptus plantation expansion has become a significant issue in many agricultural regions around the world. Planting of Eucalyptus was introduced to East Africa in the late of 19th century and by the early 1970s. In Ethiopia it was introduced during the reign of Minelik II (1868-1907) to fulfill the construction and fire wood requirement of people in Addis Abeba.

The rapid growth of eucalyptus plantations has raised concerns about its potential impact on agricultural productivity and the environment. Eucalyptus trees are known for their fast growth, high water consumption, and ability to success in a variety of soil types, making them an attractive option for timber production. However, the expansion of eucalyptus plantations has raised questions about its impact on agricultural land, water resources, and local communities.

Eucalyptus plantation is mainly ongoing in Ethiopia in 1895, to satisfy the increasing demand for construction poles and firewood in the capital city of Ethiopia, Addis Ababa (Moges Y, 2010). Eucalyptus plantations playing an important role as the major source of fuel wood, construction materials, and provide income for both urban and rural dwellers (Zerfu, 2002).

Today, in Africa Eucalyptus plantation covers at least 12 million hack throughout the tropical zone, 90% of which have been established since 1955 (Turn bull 1999).

Since 1895 Eucalyptus tree has highly planted every year due to the rising demand of the people for fuel wood and construction materials. To manage through the exceedingly scarcity of wood products, primarily fuel wood, more than 100,000 ha of land covered by *Eucalyptus globules* (Nech-Bahir-Zaf) plantations (Pohjonen and Pukkala, 1990). Currently, in Ethiopia huge amount

of lands covered by Eucalyptus plantation while the deforestation rate of inhabitant forests is increased due to the demand for crop and grazing lands (Abebe and Tadesse, 2014).

The livelihood of 85% of the Ethiopian population depends on agriculture. There are more than seven million predominantly subsistence farm families who produce about 90% of the agricultural output such as food crops (cereals, pulses, vegetables and oil seeds), livestock and coffee. In the past, Ethiopia was rich in natural resources. As population pressure increased, resources have been exploited excessively. The needs to expand cultivated land and shortages of fuel biomass have led to the removal of well-adapted, nutrient additive indigenous trees. Cropping areas have expanded into marginal lands, such as steep slopes and mountainous areas, and fallow periods have been shortened or abandoned (Jouquet et al., 2007). Despite this expansion, food insecurity remains because agricultural productivity has been seriously eroded by resource depletion. Lane et al., (2004) found in China described that the expansion of Eucalyptus plantation on lands previously used for crops and occupied by indigenous trees and grass lowers water tables and reduces water availability for irrigation due to soil hydrophobicity (water repellency) and its deep and dense root network. Eucalyptus seedlings are vulnerable to severe water stress unlike the seedlings of indigenous deciduous tree species in Ethiopia (Gindaba et al., 2004). This shows that Eucalyptus trees need more water and compete with neighboring plants for the available water in the soil. EI-Amin et al., (2001) in Sudan reported that Eucalyptus caused agricultural productivity reduction due to nutrient depletion and production of toxic exudates (allelo chemicals).

Due to the impact of Eucalyptus tree species on ecological health and agricultural productivity, ecologists, policy makers and politicians have had a negative view on this tree species. Hence, attempts are made to remove the tree from the agricultural landscape in some part of Ethiopia. In contrast, the farmers of Ethiopia prefer the fast growing, economically attractive, and the quality wood yields of Eucalyptus tree species.

This research aims to investigate the impact of eucalyptus plantation expansion on agricultural productivity. It would examine how the expansion of eucalyptus plantations affects soil fertility, water availability, and crop yields in agricultural areas. Additionally, the study would explore the social and economic implications of eucalyptus plantation expansion on local communities and small holder farmers. By understanding the potential impacts of eucalyptus plantation expansion, this research seeks to provide valuable insights for policymakers, land managers, and agricultural

stakeholders to make informed decisions about land use and resource management.

Overall, this research seeks to contribute to the ongoing debate about the sustainability of eucalyptus plantation expansion and its implications for agricultural productivity and rural livelihoods. By addressing these critical issues, this study aims to provide valuable information for sustainable land management and resource allocation in regions where eucalyptus plantation expansion is occurring.

1.2. Statement of the problem

The rapid expansion of eucalyptus plantations in agricultural regions has raised concerns about its potential impact on agricultural productivity and the environment. This practice is ongoing, particularly in the researcher's district of rural area nearer to the town. Eucalyptus trees are known for their fast growth and high water consumption, which can potentially deplete soil nutrients and water resources, leading to reduced crop yields and decreased agricultural productivity. Additionally, the expansion of eucalyptus plantations may have social and economic implications for local communities and smallholder farmers, who rely on agricultural land for their livelihoods.

The problem statement of this research topic is to investigate the impact of eucalyptus plantation expansion on agricultural productivity, including its effects on soil fertility, water availability, and crop yields. Additionally, the study aims to explore the social and economic implications of eucalyptus plantation expansion on local communities and smallholder farmers. By addressing these critical issues, this research seeks to provide valuable insights for policymakers, land managers, and agricultural stakeholders to make informed decisions about land use and resource management in regions where eucalyptus plantation expansion is occurring.

1.3. Objectives of the study

1.3.1. General objective

To understand the impact of eucalyptus plantation expansion on agricultural productivity, including its effects on soil fertility, water availability, and crop yields in Dano woreda, west showa Zone, oromia regional state.

1.3.2. Specific objectives

The specific objective of this research is:

- To understand the effect of eucalyptus plantation expansion on soil fertility components, water availability and usage for agricultural purposes in the specific region.
- To identify the socio-economic impacts of eucalyptus plantation expansion on local agricultural communities in the specific region.
- To compare the income generated from Eucalyptus plantation biomass with cereal-crops product of farmers in the study area.
- Identify whether the farmers have concept about the negative impact of Eucalyptus plantation on agricultural productivity or not in the area.

1.4. Research Questions

The study also tried to provide answer for the following questions:

1. How you understand the impact of eucalyptus plantation expansion on soil fertility, water availability and usage for agricultural purposes in the specific region?
2. What are the socio-economic impacts of eucalyptus plantation expansion on local agricultural communities in the specific region?
3. Do farmers of the locality produce more income from the sale of Eucalyptus biomass than crop yields?
4. Do farmers of the research area have enough awareness about the negative impact of Eucalyptus plantation expansion on their cereal-crop plant productivity?

1.5. Significance of the study

The significance of researching the impact of eucalyptus plantation expansion on agricultural productivity lies in the potential implications for food security, environmental sustainability, and the livelihoods of local communities. Understanding the effects of eucalyptus plantations on soil fertility, water availability, and crop yields can inform land use and resource management strategies to mitigate negative impacts and promote sustainable agricultural practices. Additionally, investigating the social and economic impacts on local communities and smallholder farmers can provide insights into potential challenges and opportunities for inclusive

and equitable development. Ultimately, the result of this study may help to minimize the impact of eucalyptus plantation expansion on agricultural productivity by improving awareness of local communities.

1.6. Scope of the Study

The study was conducted in Oromia regional state, West Shoa zone, Dano woreda. The emphasis of the study was on Villages (Kebeles) where the Eucalyptus plantation expansion is increasing in fast rate and where there is more change of cereal-crop fields, natural forest area and grazing land with Eucalyptus plantation.

Dano is located at 8°, 39', 59.99" N and 37°, 19', 60.00" E latitude and longitude, respectively. The altitude of the study area is 1700m above the sea level. Dano Woreda bounded, on the North by Ilu Gelan and Chaliya Woreda, on the South by Nono Woreda and Jamma Zone, on the east by Jibat Woreda and on the west by Jima Zone. Its land mass coverage is about 65,919 hectars (659.19km^2) and subdivided into 27 kebeles of which 5 are urban and the rest 22 are rural kebeles. Dano is found at a distance of 275km from Addis Ababa and 128km from Ambo, the capital city of West Shoa Zone. (Dano woreda Agricultural Office, 2019).

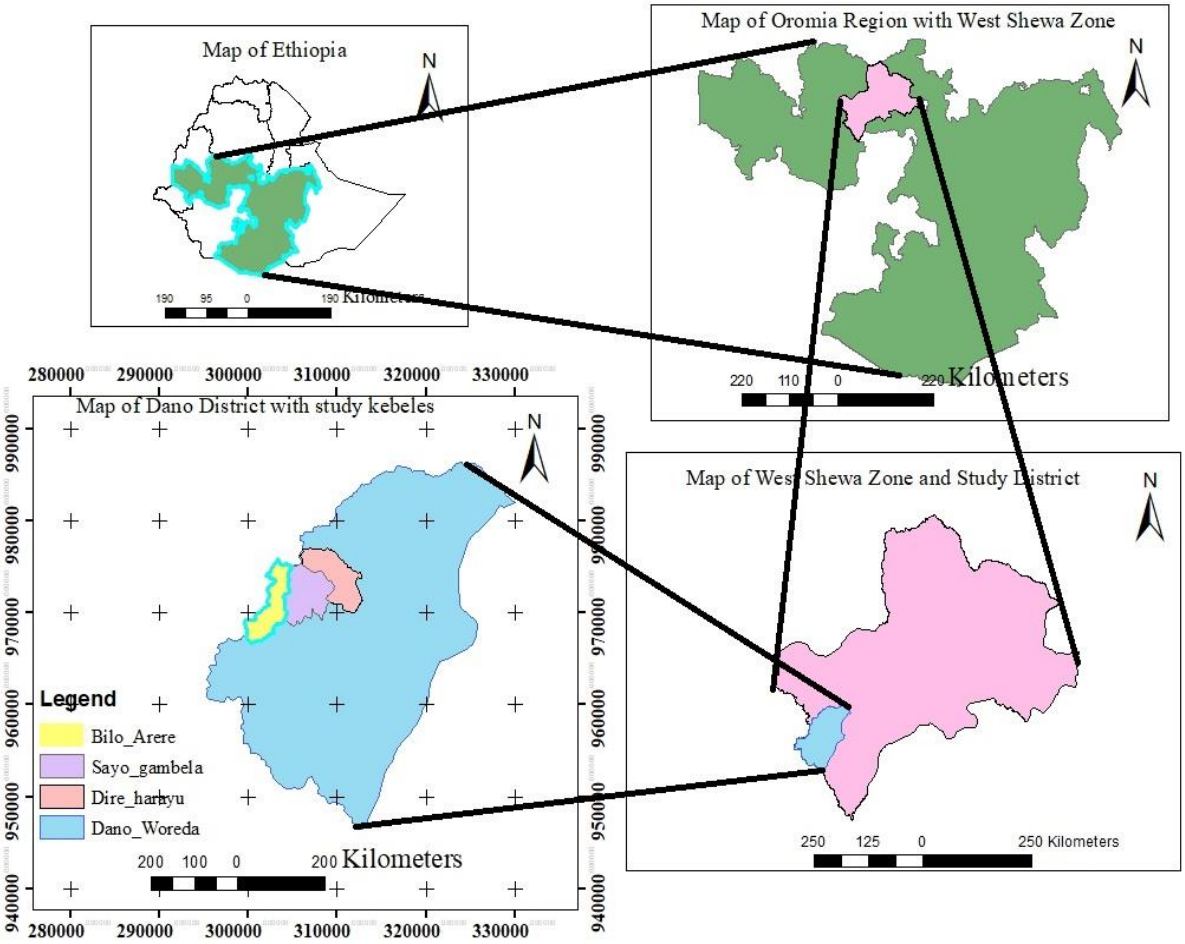


Figure 1 above indicates the location map of the study area (Source Dano woreda agricultural office)

1.7. Limitation of the study

- ✓ Lack of enough laboratory: Due to lack of enough laboratory equipment in selected kebeles, there could affect the accuracy and robustness of the findings.
- ✓ Scope and scale: The study may focus on a specific region or community, which may not be representative of broader trends or variations in the impacts of eucalyptus plantations on agricultural productivity.
- ✓ Time constraints: The study may be limited in its ability to capture long-term effects of eucalyptus plantation expansion on agricultural productivity, as well as the potential for adaptive responses and changes in land use practices over time.
- ✓ Methodological challenges: Conducting research on complex and interconnected systems such as land use, agriculture, and forestry may present methodological challenges,like

lack of laboratory equipment's in measuring and attributing the impacts of eucalyptus plantation expansion by experimental on agricultural productivity.

- ✓ Stakeholder perspectives: The study may not fully capture the diverse perspectives and experiences of different stakeholders, including local communities, smallholder farmers, and plantation owners, which could limit the understanding of the social and economic impacts of eucalyptus plantation expansion.
- ✓ External factors: The study may not account for external factors such as climate change, market dynamics, and policy interventions, which could influence the relationship between eucalyptus plantation expansion and agricultural productivity.
- ✓ Biological factors: The study may back warded due to some biological factors.

CHAPTER – TWO

2.1. REVIEW OF RELATED LITERATURE

This chapter aims to highlight impact of eucalyptus plantation expansion on agricultural productivity and it provides a theoretical framework for the researcher's study.

This section focuses on the impact of eucalyptus plantation expansion on agricultural productivity.

In Ethiopia due to the population pressure and unwise resource utilization, crop lands, forest lands and marginal lands are converted to cultivation and fast growing trees plantation like Eucalyptus species. For this reason, the replacement of well-adapted, nutrient additive indigenous trees by Eucalyptus tree plantations is becoming a common practice (Jouquet et al., 2007). This is on the other hand reasoned out that the expansion of fast growing native and exotic tree species plantation is with the intention of delivering the current market demand of quality timber and other wood products in Ethiopia (Laclau, 2003; Lemma, 2006). The natural forests in Munesa Shashemane, Ethiopia was converted into agricultural land for crop cultivation, and later on the same land was converted to Eucalyptus, saligna and Cupresus lusitanica tree plantations when the land productivity got low (Lemenih et al., 2004). Apart from this, there are several examples in southern part of Ethiopia where Eucalyptus has expanded at the expense of natural forests, agro-biodiversity in the cultivated lands, and grazing lands (personal observation). The land use land cover classification with the use of land image has shown that exotic tree plantation mainly Eucalyptus has spatially increased with time next to cultivated land use while the forest, shrub lands, wetlands, and grass land cover was shrinking from 1984 up to 2010 in Wallecha water shade, Southern Ethiopia (Babiso et al., 2016).

Eucalyptus is one of the most important planted tree species in Ethiopia, covering about 506,000 ha (FAO, 2009). Out of 133,041 ha of community tree plantations in Ethiopia between 1978 and 19889, Eucalyptus species comprise 58% (Yitebitu et al., 2010). Nearly all of the reports on Eucalyptus tree species indicate that the rate of expansion of Eucalyptus is accelerated by a quality and amount of goods it provides per a given land use time, and economic importance of this species compared to other tree species (FAO, 2011).

The farmers noticed the negative influence of Eucalyptus on neighboring food crops from the low performance for crops which might be due to the competition of soil moisture and nutrients, and shade effect of the tree in Amhara region, Ethiopia (Alebachew et al., 2015). Despite farmers recognition of adverse effects of Eucalyptus tree on the ecosystem; the Eucalyptus plantations are expanding at the expense of biodiversity of the forest and the agricultural lands from time to time in Ethiopia. This is mainly influenced by the economic benefits, ease of cultivation and high productivity of the tree (Mekonnen et al., 2007; FAO, 2009; Bekele, 2015). The expansion of Eucalyptus tree species can also be attributed to the rapidly changing global market for products from the tree and the interest of wide-scale planting for the production of biofuels (Richardson and Rejmanek, 2011).

Eucalyptus is a genus of more than five hundred species, has become the most planted genus of trees in the world (Teketay D, 2000).The major planting of Eucalyptus outside of its native environment of Australia. The genus was introduced to East Africa in the late of 19^{th} century and by the early 1970s. Today Eucalyptus plantation covers at least 12 million ha throughout the tropical zone, 90% of which have been established since 1955 (Turn bull 1999).In Ethiopia Eucalyptus was introduced during the reign of Minelik II (1868-1907) to fulfill the construction and fire wood requirement of people in Addis Ababa at the back of deforested native trees around the town. Since then the plant was expanded to all corners of the country and the concerns began to be felt around this time about possible negative impact of this plantation on the environment. Its effect is the concern of the country and the massive expansion of the genus created the fear of future food security of the country. Despite of this expansion, food insecurity remain the same because of agricultural productivity has been seriously eroded by resource depletion that followed the introduction of early maturing tree specious ,such as nutrient replenishing, leguminous trees in to agricultural system in area where trees can combined with production of crops groups Garay et al,(2004).

Eucalyptus plantations are extensively managed for wood production in Ethiopia. Concomitantly, traditional agro forestry practices in Ethiopia needs tree planting in different ways to get multiple values for farmers like wood (fuel wood and constriction material) and fodder (Kidanu et al., 2005). The growing demand for construction material and fuel wood, and the wider adaptation potential of Eucalyptus in to different agro-ecological zones resulting increased plantation of Eucalyptus by smallholders in the country. However, the policy in

Ethiopia discourages farmers from planting this exotic species, locality level politicians opposed it's planting, and researchers had doubts about it. The opposition of the politicians appears to be founded on fears of damage to the ecosystem (Mekonnen et al., 2007). Eucalyptus is the well-known tree in regime and community state plantations because of its easily propagation through coppicing, resistance to browsing by livestock, and rapid growth rate (Pohjonen and Pukkala, 1990). The yearly wood production rate, which was 345–903 kg ha_1 yr_1 with two- and four-year-old stands in the first cycle, was increased more than 2-fold in the subsequent two rotation cycles. With these productivities, eucalyptus boundaries on a hectare of land in the second and third cycle would satisfy about 70% of the annual biomass energy requirement of a rural household with a family size of five people for four consecutive years (Kidanu et al., 2005).

2.1.1. Impact of eucalyptus on plants of Ethiopia

The genus is highly common with farmers as cash crop, but on the other hand the Eucalyptus is blamed for a great evil, notably on nutrient cycling and soil properties (FAO 1988). There is main argument against the Eucalyptus plantation expansion which includes; it drains water resources, it suppresses biodiversity (under growth), it enhances soil erosion, it introduces allelopathic effect and large scale planting cause crop land reduction. In Ethiopia socioeconomic evaluation of Eucalyptus have been carried out mainly on *Eucalyptus globules* and *Eucalyptus camaldulensis.*

They showed that establishing the genus made a substantial contribution to the income of the house hold, even more than agricultural crop did (Tesfaye 2000, Amare (2002), Asaye (2000) reported that, on average, at least 26% of total family incomes come from such plantation. At a moment Ethiopia has the largest area of Eucalyptus plantation in East Africa and one of the 10 pioneer countries that introduced the Eucalyptus. Its cultivation has gradually expanded throughout Ethiopia encouraged by academic, research and development institution including Alemaya college of Agriculture, Institute of Agricultural research(I.A.R.) and chilalo Agricultural Development. In many developing countries, the area of private planting (N.G.Os) is much greater than that planted by government.

Eucalyptus globules has been a unique species introduced during past agro forestry efforts. The biomass energy demand of the country by 2004, 6 percent of the total land utilizable land area would to be put under Eucalyptus plantation entailing major shift in land use. Kidanu, et.al.

(2005). Increasing plantation would create competition between agricultural food crop and Eucalyptus trees for land area, main resources such as water, nutrients and light.

Lane et. al,(2004) found in china described that he expansion of Eucalyptus plantation on lands previously used for crops and occupied by indigenous trees and grass lowers water tables and reduces water availability for other plant species. El-amin et.al, (2001), in Sudan reported that eucalyptus caused agricultural reduction due to nutrient depletion and production of toxic exudates chemicals.

In comparison with agricultural crops and other tree crops species small-holders in Ethiopia produce Eucalyptus. The seed can be obtained local, fertilizers and chemicals are rarely required. (Gessesse and Teklu, 2011)

2.1.2. Potential competitive Mechanisms of Eucalyptus

Competition can occur between organisms when one reduces the supply of an essential resource to the determinant of another, the competition mechanism of Eucalyptus trees mostly involves nutrient and water that can be enhanced by climatic factors. Eucalyptus plantations have a negative environmental impact. There is no difference between crops species in resisting the negative effect, i.e., all crops such as finger millet, maize, teff, bean and other vegetables are affected because of the shading effect, water and nutrient competition, thinning of seedlings and forcing poor grain fillings Tilashwork, (2009). In addition to competing life supporting resources Eucalyptus can cause the wastage of some natural resources.

2.1.3. The impact of Eucalyptus shade on light intensity

Since light is one of the most significant plant growth factors, the impact of Eucalyptus shade on light intensity at the stand edge and on the undergrowth within the plantations was examined using a light meter. The measurements were taken above the canopy of neighboring plants. The data were collected inside the shade and at 0.5, 1, 2, 5, 10, 15, 20 and 40 m distances from the Eucalyptus stands in the maize fields at different times during a day (9:00 am, noon, 12:30 pm, 3:00 pm and 4:00 pm).

2.1.4. Competition for Nutrients

Eucalyptus trees have been shown to diminish soil nutrients when it was integrated in agroforestry system (Jagger and Pender, 2000), and this characteristics is believed to aggravate

the stress of competition when the trees are planted adjacent to agricultural crops. Chanie (2009) found out that there was a 10 fold (ten times) difference in biomass of maize between the 1m and 20m distance from Eucalyptus tree bole (steam). The nearer the crops to the Eucalyptus canopy were, the lower were the crop yield and biomass production, and the influence of Eucalyptus was higher as compared with *Croton macrostachyus* trees in the farmlands (Chanie, 2009). Another similar study by Alebachew et al. (2015) showed that with distance from the tree stand (2 to 20 m), plant height of maize, biomass, and plant count were increased as compared to the control in Amara region, Ethiopia. This may direct the influence of the tree on the yield and yield components of maize which could be associated with soil nutrient depletion close to the unmanaged Eucalyptus trees plantations. Jagger and Pender (2000) questioned the potential of Eucalyptus trees to increase soil organic matter stocks and found the potential to recycle soil nutrients is very weak. In the experiment made to compare the soil organic matter (SOM) under the tree canopy, the trees have not changed the soil organic matter compared with outside the canopy soil (Chanie, 2009). Considering long term land use effects in Munesa Shashamane, Ethiopia, *E. saligna* was indicated to be less preferable plantation species for soil fertility restoration as compared with Cupresus lusitanica tree species (Bajigo, 2017). Moreover, due to the fast growth and short rotation time, there is high chance of mining the soil nutrient by Eucalyptus tree plantation stand. In contrast to other commonly used afforestation and agroforestry species such as Leucaena spp. and Acacia spp., Eucalyptus species do not fix nitrogen and less likely restore the land with essential elements sustainably (Jagger and Pender, 2000). The yield of wood product is higher from Eucalyptus and therefore expected to have taken more nutrient too (Bajigo, 2017). Various soil physical quality indicators and some soil chemical properties, mainly organic carbon, and total N, P and K decreased as a result of reforestation with *Eucalyptus tereticornis* plantations and further decreased with increasing age of the plantations in the central Himalay (FAO, 2011). Despite of the aforementioned negative connotations with Eucalyptus plantations, however forest management such as litter management and frequency of harvesting can affect the SOM. Afforestation with *E. grandis* for 20 years returned the total SOC to nearly the native forest level after consecutive 35 years of pasture and 20 years of agriculture (Lemma et al., 2006).

Effect of Eucalyptus on soil were noted as it sucking up the soil nutrient exhaustion others un specified effects, the tree uses a lot of nutrient which is leading to soil exhaustion and reduction

of crop yields. This could be because of its fast growing rate than other most plants which perform poorly on site previously planted with Eucalyptus the growth rate of the plant leads to a high demand for nutrient. If the trees are harvested before attaining the age of the maximum growth, soil decline in nutrient and moisture content.

Considerable nutrient capital change should be expected in Eucalyptus wood lots managed for pole production because of the frequent thinning or felling of the wood.

The nutrient in the products are removed with in a comparatively short period of time because of Eucalyptus grow very fast and harvested with in short duration Sanginga, et al. (1992)

Nutrients are exported out from the plantation's soil system by removing trees from timber sales and fuel wood (zerfu, 2002). From the soil nutrients, total nitrogen percentage in the plow zone from 0 to 20 cm depth at all distances were in the very high range .Near the Eucalyptus stand, this might be due to its allelopathic effect, which oppose the mineral up take by the plants and low mineralization. Tlashwork,(2009).

According to Michelsen et al. (1993), Ethiopia's native wood land has significantly higher levels of nitrogen and phosphorus in above-ground herbaceous plants, suggesting that nutrient cycling is more restricted in areas where exotic tree species predominate. The results of the bioassay suggested that the low availability of phosphorus, calcium, and potassium in the soil of eucalyptus trees was probably the factor restricting the growth of agricultural crops like *Eragrostis teff*.

2.1.5. Effect of Eucalyptus on Soil Fertility

In the past decades the biodiversity and environments has been significantly degrading in Eucalyptus plantation forest. Land fertility has severely degraded; Chen, (1992) the stability and elasticity of forest soil worse. The soil structure and biological properties were injured. The traditional reclamation for eucalyptus forest lands led to vegetation reduction and thus the biological debris and above earth fertility decrease largely strong precipitation in rainy season sped up the loss of soil and water in eucalyptus plantation forest. The vicious cycle further induced the continuous reduction of soil fertility and productivity and further deterioration of forest environment and limited the growth and restoration of vegetation and biodiversity Wang, (2012).

As study made by Betre Alemu, (1998) effects of Eucalyptus on soil were noted as dry up the soil (48%), nutrient exhaustion (30%) and other unspecified effect(22%).

In crop yield this could be because of its fast growing rate. Eucalyptus hybrid established the fact mean annual increment reaches a peak in the 6th and 7th year of growth.

2.1.6. Effects of Eucalyptus on Maize Crop

Eucalyptus root density is realest at 5 meter from the tree and the macronutrient is most depleted at this point. Moisture content is also the lowest here, but not statistically significant difference. Yield and biomass of maize is also most reduced near the Eucalyptus stand Tilashwork (2009). At the maize maturity stage, moisture content was reduced even farther away 5m because of Eucalyptus border effect. Selamyhun and Strunider, (2004) reported that regardless of crop species, less water remained in the soil in tree - crop system than in the sole cropping. Since the growing medium is nit sol, both species can extend their roots deeper to take out water during the drier period. The nearest crop plants were wilted unlike the farther stands since Eucalyptus competes for moisture even deeper in the soil.

Yu et al. (2006) reported that the occurrence of most densely, maize plant rooted layers at or below 30cm soil depth was very conductive to maintain plant water under dry soil condition. In other words, The roots of Eucalyptus tree are usually well developed in the dry areas and enable them to use the water stored deep in the soil during the dry season. This oppose the maize plant to use the local water during the dry period by sending the roots deeply. Eucalyptus suctions excessive water from the soil and water stores. Thus, Eucalyptus trees unlike the other tree spp. compete with maize plants for soil moisture, and the plant available water is insufficient for the crop performance to get good yield.

Any type of stress reduced the amount of grain produced by a maize plant. As drought stress increases, the amount of pollen may decrease; Hall et al., 1981). Grain yield was lowered by drought stress two weeks after silking and one week prior to silking. Drought stress did, however, have minimal impact on the physiological maturity of the maize crop, despite shortening the grains filling duration of all the hybrids. Grain formation, silking, pollination, and flowering are the delicate stages of vegetative and reproductive growth in maize plants.

Water competition of Eucalyptus tree on maize plant during critical growth period reduce the grain yield up to 2t /hal. (1990) reported Leaf leach ate of Eucalyptus globules

was evaluated for allopathic effect on rice, sorghum black gram. The inhibition germination is dependent on the concentration of the extract; perhaps it may be due to the entry of water soluble allelochemical as well.

2.1.7. Competition for Water

Research has shown that eucalyptus trees compete with crops for water, reducing agricultural productivity up to 10 meters from the trees' planting sites (Jagger and Pender, 2000). This might suggest that eucalyptus trees can deplete soil water and water sources if they are planted in drought-prone areas.

This impact is often manifested in natural ecological processes, and there is still a need to further experiment to partition and understand the level of allopathic effects of different Eucalyptus spp.

Another cause for degradation of biodiversity and environment in Eucalyptus plantation forest is that eucalyptus grow faster than other any tree species it thus needs a large amount of water for growing. This would lead to the drought in Eucalyptus plantation forest and the environment degradation. The moisture at 5m from Eucalyptus tree was significantly lower than values at 1and 40m.In the other depths and times the moisture contents at 5m was generally lower. At the end of rainy season, the moisture content near the Eucalyptus stand in all depths were significantly less than the moisture contents farther away.

It is interesting that at 15m distance from the tree, the moisture content from Eucalyptus stand was statistically similar with another plant species.

As study made Yunnan academy of forest showed that the water content for Eucalyptus forest soil was 20.4% for mingled forest soil was 20% for bare land was 18 4% Wang, (2012). The water consumption of Eucalyptus tree to synthesize 1kg of dry matter is 510 liters.

The study of Davidso (1989), the competition for soil water between trees and crops is said to be predominant reason for stunted growth and decrease yield of agricultural crop in transition zone between Eucalyptus plantations in agricultural fields tree roots absorb vast quantities of water to replace loss due to transpiration and metabolic activities and water use efficiency per unit of bio mass vary among different species and highly dependent on plant development stage, stand density and environmental condition. The growing season begins with a moderately heavy series of rains which saturate all soils in the area. After these rains, soil moisture levels depend on duration, intensity, and spacing of precipitation, and evapotranspiration. The interaction of these

factors results in the aforementioned mosaic. The pattern of inhibition of herb growth was only partially correlated with the level of soil moisture. Gravimetric soil moisture determinations throughout the two growing seasons indicated soil in the bare zone to be consistently drier than that in the grassland. Since water holding capacity and wilting percentage differed little between soils in these areas, this was indirect evidence that plants, growing in the bare zone were inhibited substantially more by the effects of drought than were grassland plants. Soil moisture content in the litter zone was usually similar to that in the grassland, suggesting only slight differential drought stress. This results from shade and the mulching effects of the litter itself. Nevertheless, the density and vigor of litter zone plants is significantly less than that of even bare zone plants. The soil moisture differences observed between litter zone and grassland failed to explain the absence of herbaceous vegetation in the litter. If drought stress were substantially influencing the development of annual herbs, this effect should not be evident until differences in soil moisture content occurred.

Plants	Water usage in liters per kilogram of biomass	Water consumption for each harvested bio mass(liters/kg)	Harvest index
Cotton, coffee, banana	3.200	800	0.25
Sun flower	2.400	600	0.25
Soybean	1.430	500	0.35
Potato	500	600	0.60
Eucalyptus	600	510	0.65
Finger millet	592	225	0.40

Table 1 Plants Water Use Efficiency (source: Davdison, 1989).

2.1.8. Effects of Eucalyptus on Coffee Plant

Eucalyptus species were usually considered as having understory vegetation than the other types of forest stands due to its competition and hydrophobic effect. There have been

easily manageable, fast maturing and widely adaptable, leguminous tree species, which improve the productivity of the adjacent plantation.

The good performance of understory plants under these coffee shade trees due to absence of competition for resources with the over story plants as well as the advantage from the shade like nitrogen fixation. Hanil et al. (2008) stated that the undergrowth plant might show different patterns than the shade tree specious because of different responses to light level, nutrient availability and temperature. Shaded crops such as coffee shallower roots than the other fruit trees, then perform well Lehman, (2003). This not true for Eucalyptus since local farmers tried and failed growing coffee under its shade. In addition the different strata with in coffee garden shade facilitate infiltration, reduce erosion increases water table and improve soil physical and chemical properties throughout the under such as Acacia abide,

While primary metabolism has been related to biomass development and reproduction exhibit very slight difference among living organism, secondary metabolism possible to classify plants in different species through the chemical taxonomy, according to each particular profile Eucalyptus trees produce which were originally defined as secondary metabolite involved in plant to plant allelochemicals and plant to microorganisms interaction the chemicals provide protection towards competition by weed and other plants and to avoid detrimental action of herbivores, fungi, bacteria & viruses. This condition helps the plant to control other plant species and animal to be dominant over the environment. China Eucalyptus research center (2009) allopathic effect of eucalyptus is prominent in area with low rain fall (less than 400ml annually).

Allelopathic effect may have implications when other species are grown near the tree. These conditions were especially seen in agro forestry system .Eucalyptus trees have a negative effect on other plants. This is evidenced by the fact that very little vegetation is able to establish in eucalyptus woodlots, Michelson et.al (1996).

Effect covers 33% on agricultural field and 67% on natural forest plants area as represented in figure be low

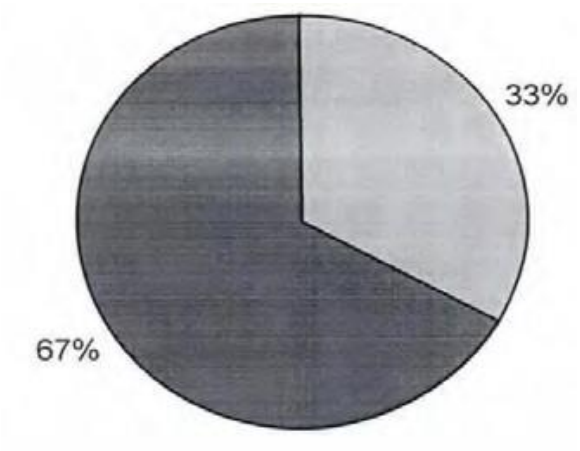


Figure 2 Effect of Eucalyptus on other vegetation (source Michelsen et al (1998)

2.1.9. Agro-biodiversity and human nutrition security

There is a growing global consensus that everything would continue as usual approach is not functioning for sustainable nutrient dense food production system. Rather, a paradigm shift, conserving the natural form and quality of land scape is critical (GPAFSN, 2016; IPES, 2016). As stated in the International Panel of Experts on Sustainable Food Systems (IPES) 2016 report, a significantly altered agricultural model predicated on the diversification farming landscapes is required for sustainable food system to satisfy the ever blooming food demand in terms of quantity, and nutritional value. The Sustainable Development Goals of 2030 Agenda and its provides a outline that includes the objectives in agricultural systemsboosting yields while keeping the amount of synthetic and inorganic chemichals in the system from rising and reshaping landscapes and improving environmental integrity (Biodiversity International, 2017). In this case it gives emphasis to agro-biodiversity that also includes agroforestry (Lundgren and Raintree, 1982). Beyond ecological services, agro biodiversity insures more sustainable and productive land scape and sustainable food production system (FAO, 2017).

Maintaining the landscape for agro-biodiversity is far better contributing to sustainable food system than converting it to monoculture tree plantation such as Eucalyptus tree species. Beyond its antagonistic characteristics to other plants monoculture plantations of Eucalyptus species simplifies the ecosystem ecologically and economically that meaningfully affects its ecosystem function.

For instance, fast growing Eucalyptus tree plantations affected hydric resources which in turn lead to diminish macro-invertebrate richness and diversity (Cordero–Rivera, 2017). This kind of

practices posing environmental impact and compromises the food production system through threatening the agro-biodiversity. In Wolaita, southern Ethiopia, Eucalyptus trees are planted along as roadside, in woodlots, home gardens and as boundary markers, Alemu (2016) in the expense of loss of agro-biodiversity.

There are ample research evidences to show the negative impact of eucalyptus tree species plantation on the biodiversity of the plantation site, and affects the nutrition security by discriminating a diversified food production (Scott, 2005; Jaleta et al., 2016; Cordero– Rivera, 2017). It is very aggressive characteristics to make Eucalyptus not compatible to the diversified stands, mainly the agroforestry systems. On the comparison made, the average undergrowth density of the Eucalyptus trees was lower than that of under coffee garden shade in agricultural land set up depicting that Eucalyptus with high fine root density competes more for nutrient than understory herbaceous crops (Chanie, 2009). Despite the Eucalyptus trees competition and allelopathic effects on the biological diversity in agro-ecosystem, land conversion to Eucalyptus tree plantation is aggravated due to high economic value (Gebrehiwot, 2013). Eucalyptus has expanded at the rate of about 18.82% at the expense of grassland, bushland, and its expansion was mainly due to the socioeconomic benefits it provides to the community; as it was one of the few cash earning means in Ethiopia (Jaleta et al., 2016). Hence, farmers in Ethiopia convert the land uses from ecologically and economically diversified agro-biodiversity into mono-cultural Eucalyptus plantation stands, which in turn affects the nutrition security of the community/eco-region.

CHAPTER THREE

3. RESEARCH DESIGN AND METHODOLOGY

The research design, study population, sample size and sampling methods, data collection instruments (questionnaire, field observation, and interview), data collection protocols, data analysis techniques, and ethical considerations were the headings that comprised this chapter.

3.1. Research Design

The researcher employed a random sample technique. Using random sampling, each person in the population has an equal chance of being chosen for the sample. By using this technique, it is ensured that the results can be extrapolated to a larger population and that the sample is representative of the total population.

Because random sampling ensures that the sample accurately represents the population and helps to minimize bias, it is preferred over other sampling techniques. Random sampling helps to lower the possibility of selection bias and guarantees that the sample is accurately representative of the population by granting each member of the population an equal chance of being chosen. Furthermore, because random sampling doesn't require complicated sampling procedures or in-depth population knowledge, it's frequently more practical and economical than other sampling techniques. Because of this, selecting a representative sample from a larger population through random sampling is a popular and trustworthy technique.

3.2. The study population

Dano woreda estimated the total population size of 229,323 from all 27 kebeles (of which 5 are urban and the remaining 22 are rural) based on the results of the 2007 national census. Which, in urban and rural kebeles, are 74,590 males and 154,733 females, respectively of these populations, 74,725 (91.25%) males and 90.25% females in rural kebeles, whereas 54,598 (8.75%) males and 9.55% females in urban kebeles.

3.3. Sample Size and Sampling Techniques

The areas where the research was conducted includes the villages (Bilo Arere, Seyo Gembela and Dire Hareyu kebeles.) in which the Eucalyptus plantation expansion mostly practicing, for this reason the researcher selected purposively simple random sampling method, because the

reliable information could be collected as the respondents are those who are participating in Eucalyptus plantation expansion in the study areas. The researcher used the Cochran (1977) formula which is widely used for determining the appropriate sample size for study. To determine the sample size using the Cochran (1977) formula, we can use the following equation:

$N = (z^2 \times p \times q) / (e^2 \times (n / (z^2 \times p \times q) - 1))$ $n = NZ^2Pq / e^2 (N-1) + Z^2Pxq$

Where:

- `N` is the total population size
- `n` is the sample size
- `z` is the confidence level (1.96 for 95% confidence level)
- `p` is the proportion of the population with the characteristic of interest (0.8 in this case)
- `q` is the proportion of the population without the characteristic of interest (0.2 in this case)
- `e` is the desired margin of error (0.05 in this case)

Dano district administrations reported a total of 748 families in Bilo Arere kebele, 900 in Seyo Gembela kebele, and 878 in Dire Hareyu kebele. As a result, the sample size was established based on a total of 2,526 households.

The required sample size was 252 respondets. The sample size for each kebele was estimated as the ratio of the number of households in each kebele to the total number of households in the kebele. With the population sizes for the three villages provided:

Bilo Arere kebele population (N1) = 748

Seyo Gembela kebele population (N2) = 900

Dire Hareyu kebele population (N3) = 878

And the total sample size determined as 252 from a total population of 2526, we can use the formula to allocate the sample across the Kebeles:

$n_i = (N_i / N) \times n$

Where:

- n_i = the sample size for village i
- N_i = the population of village i
- N = the total population
- n = the total sample size

So the recommended sample sizes would be:

Bilo Arere kebele population n1 = (748 / 2526) x252 = 75 (male =59 & female =16)

Seyo Gembela kebele population n2 = (900 / 2526) x 252 = 90 (male = 57 & female = 33)

Dire Hareyu kebele population n3 = (878 / 2526) x 252 = 87 (male = 60 & female = 27)

This allocates the total sample of 252 across the three villages proportional to their population sizes.

Among the total population (2,526) of house hold farmers, 252 (176 males and 76 females) sample farmers were represented.

3.4. Instruments for Gathering Data

Questionnaires, field observations, and interviews were the most common methods used to gather data. Some photos were obtained during field observation as additional information from planted farmers' farm land to corroborate the data collected through questionnaires regarding the growth of eucalyptus plantations on crop land and their impact on agricultural productivity.

3.5 Techniques for Gathering Data

Prior to giving out questionnaires, the researcher gave the participants an oral explanation of the study's goal. They were told that each item was finished on its own. This helped all of the participants understand the goal of the study and gave them the freedom to freely fill out the questionnaires.

Before the questionnaires were dispatched to individual, participants were given ordinal numbers according to the row of their seat by giving code. The purpose of coding the questionnaires before distributing was, to know each participant who fill the questionnaire and relate the impact of Eucalyptus plantation expansion on agricultural productivity security. In this case, no one knows which code relates to which participant except the researcher so that confidentially and ethical considerations was be maintained. At the same time the participants are provided with the questionnaire to complete it with their practice in mentioned plant and their crop producing conditions.

The impact of Eucalyptus plantation expansion on agricultural productivity was assessed through interviews, questionnaire and field observation with key information. Two hundred fifty two participants were participated. Among the total number of these participants, only fifty interested

farmers were involved in interview. However, the interviewed participants were also participated in the other data collection techniques.

3.6. Methods of Data Interpretation

In analyzing the data, the researcher used mixed (both qualitative and quantitative) approach. Therefore, analyses of both types of data were run independently. In relation to this Creswell and Plano (2011), forwarded that in a research design for mixed study, the analysis data proceeded independently of each other. The data which was collected using field observation were analyzed and presented qualitatively. Following this each item were interpreted through explanation.

The data which was gathered from interview was analyzed qualitatively and finally the information was interpreted through explanation.

The quantitative data from close-ended questionnaires were analyzed quantitatively and would be presented in numerical forms along with the relevant table. On the other hand, the data came through open ended questionnaires were analyzed qualitatively. Following this, the analyzed and organized data were interpreted through explanation.

Finally, the data merged to show the complete picture. This helps to determine the extent of data convergence, as well as how the quantitative and qualitative data results were similar to each other.

The collected data on the impacts of eucalyptus plantation expansion on agricultural productivity was analyzed by different techniques. The analysis was including quantitative and qualitative approach in assessing and interpreting the data. In this case, descriptive statistics and percentage differences among the respondents expressed.

3.7. Ethical considerations

The researcher asked a letter for cooperation from Addis Ababa University. Then, he could be easily communicated all institutions and individual participants legally and smoothly. The purpose of the study was made clear and understandable for all respondents.

Any communication with the concerned bodies were accomplished as their voluntarily consent without harming and threatening the personal and institutional wellbeing. In addition, all information was obtained from individual respondents and the documents would be kept confidential.

CHAPTER FOUR

4.1. RESULT AND DISCUSSION

This part of the paper deals with the analysis and discussion of data gathered from the targeted respondents of Dano Woreda kebeles: Bilo Arere, Seyo Gembela & Dire Hareyu kebele population. As noted earlier, the study focused to assess the impact of eucalyptus plantation expansion on agricultural productivity.

It has two parts: the first part deals with the character sites of the respondents and the second part presents the analysis and interpretation of the main data. The data gathered through interview was supposed to complement qualitative data.

Data gathered through interview was supposed to complement quantitative data and questioner was distributed to 252 respondents and all copies were returned back.

4.2. Features of the respondents

Summary of ages and gender of the respondents (n=252)

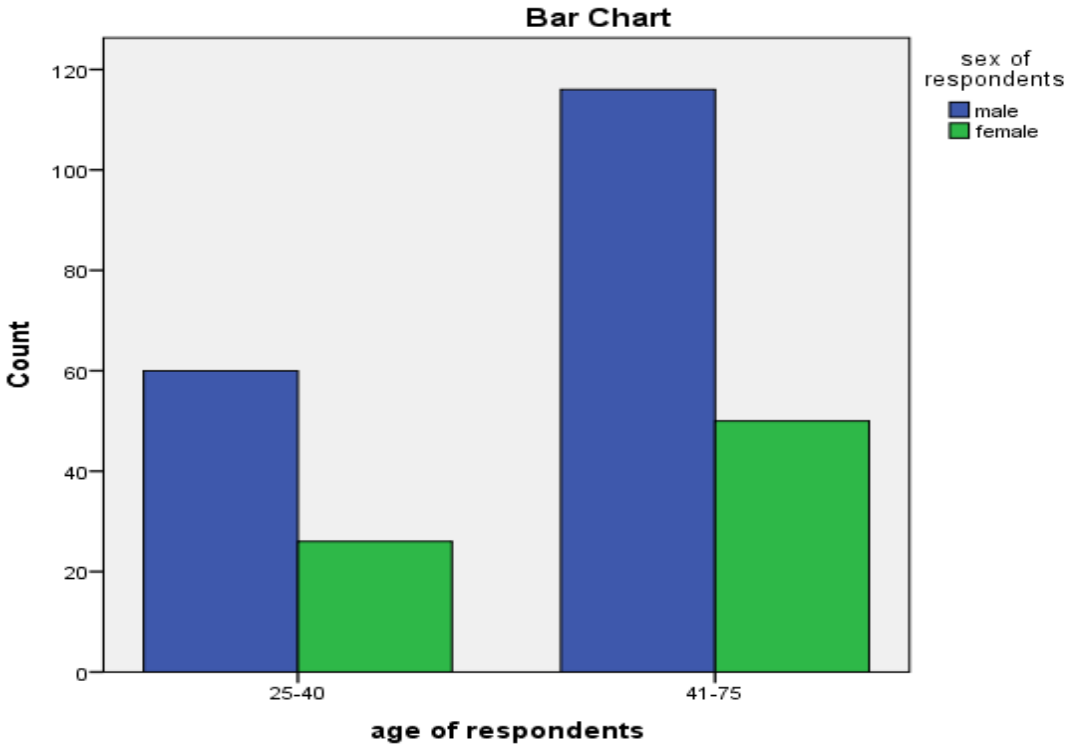


Figure 3: Summery of age and sex of respondents

As can be observed from the above bar-chart, from the total sample farmers (252), 176 (70%) were males and 76 (30%) were female house hold heads. The respondents' key information was approximately all males & females ranged in age from 25 to 75 years old. (Dano woreda agricultural office, unpublished book)

Table 2 Summary of Educational Background of the respondents (n=252)

Educational status	Sex	Number of respondents	Percent
Illiterate	Male	22	9
	Female	7	3
1-4	Male	43	17
	Female	35	14
5-8	Male	80	32
	Female	29	11
9-12	Male	19	7
	Female	5	2
12 & above	Male	12	5
	Female	---	----
Total		252	100

;

From table 2 above, we can conclude that 80 (32%) of the male respondents are ranged between 5-8 grades and 12 (5%) of them are ranged between12 & above. (Dano agricultura offece,un published book).

4.3. Impact of eucalyptus plantation expansion on soil fertility, water availability, and usage for agricultural purposes

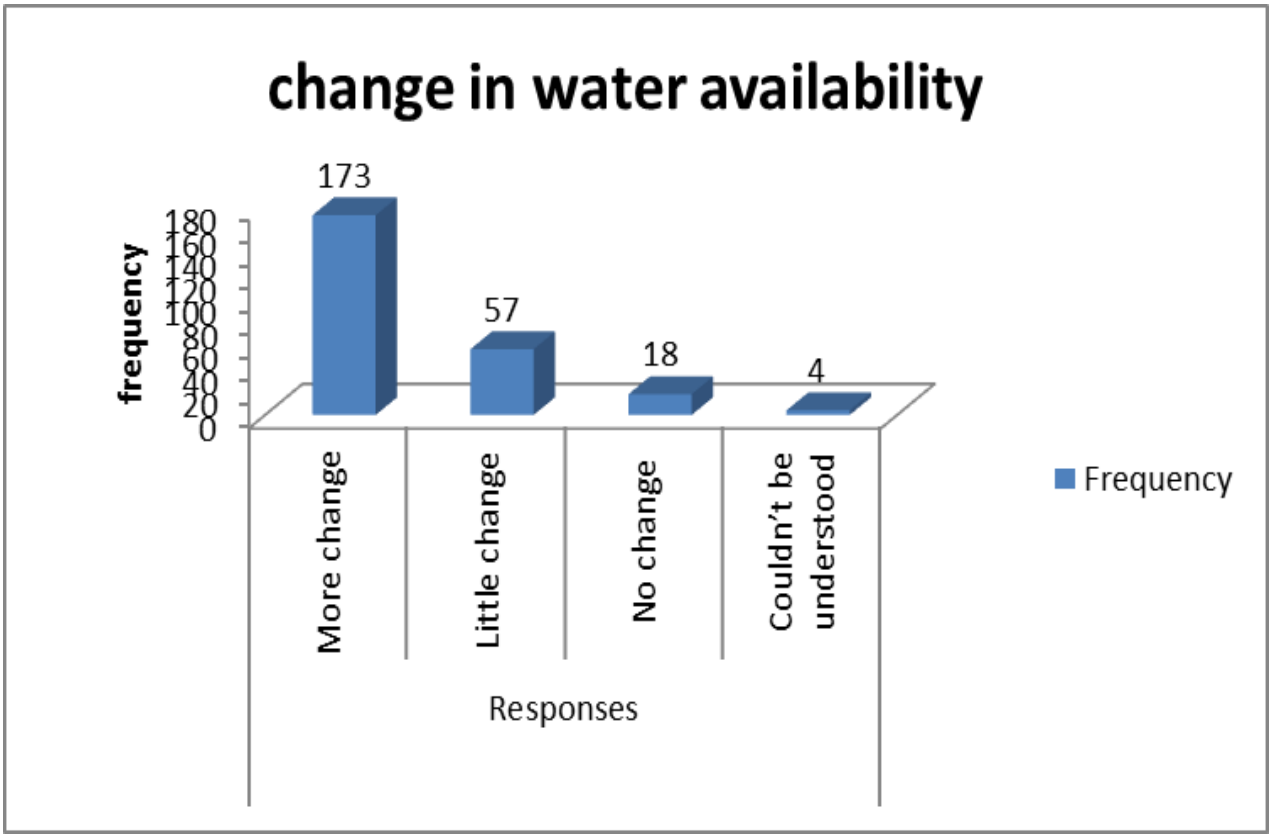
Table 3 How the expansion of eucalyptus plantations has affected the soil fertility of their agricultural land

No	Item	Responses					
		High demand for nutrients		High demand for Water		Reduce moisture levels	
		F	%	F	%	F	%
1	How you understood the expansion of eucalyptus plantations affected components of soil fertility of your agricultural land?	34	13	155	62	63	25

In the above table 3, the respondents were asked if the expansion of eucalyptus plantations affected the components of soil fertility of their agricultural land and then 155(62%) of them said that, the expansion of eucalyptus plantations affected the components of soil fertility of their agricultural land by up taking high demand for Water. On the other hand, the rest of the respondents responded that the expansion of eucalyptus plantations affected the soil fertility of their agricultural land by reducing moisture levels and high demand for nutrients. This argued that in line to Tlashwork, (2009), near the Eucalyptus stand, this might be due to its' allelopathic effect, which oppose the mineral up take by the plants and low mineralization. In general we understood from this table that, the expansion of eucalyptus plantations has had a negative

impact on the soil fertility of our agricultural land, making it more challenging to maintain productive and diverse crop yields.

Figure 4 identifying any changes in water availability for their crops since the expansion of eucalyptus plantations in the area.



From the above graph, we could understand that the respondents were asked whether the presence of eucalyptus plantations has affected the amount of water available for irrigation and crop growth. Most respondents (69%) replied that there was more change in water availability for their crops since the expansion of eucalyptus plantations in the area. This implies that since the expansion of eucalyptus plantation expansion, there is a reduction of water in the study area. Because it competes with other neighboring trees, in line of Davidson, (1998). Some of them (22%, 7%) responded that little and/or no change in water availability for their crops since the expansion of eucalyptus plantations in their area. The remaining small number of the respondents (2%) responded that they couldn't understand whether the presence of eucalyptus plantations has affected the amount of water available for irrigation and crop growth.

Table 4 Ways in which the usage of water for agricultural purposes has been impacted by the presence of eucalyptus plantations.

No	Item	Responses					
		consume large amounts of water		affect the quality of water sources		impact the water management and sustainability	
		F	%	F	%	F	%
2	In what ways has the usage of water for agricultural purposes been impacted by the presence of eucalyptus plantations?	157	62	79	31	16	7

From the above table, we could understand that the respondents were asked whether the usage of water for agricultural purposes has been impacted by the presence of eucalyptus plantation and 157 (62%) replied that the Eucalyptus plantations could consume large amount of water, potentially leading to reduced water availability for agricultural productivity and crop growth, in line to Wang, (2012). This could result in having to adjust their agricultural productivity and potentially face water scarcity. Some 79 (31%) of the respondents responded that the presence of eucalyptus trees could affect the quality of water sources, potentially leading to reduced water quality for agricultural use. Finally, 16 (7%) of the respondents said that the expansion of eucalyptus plantations could significantly impact the water management and sustainability of agricultural land.

Table 5 if there are any adjustments to their agricultural productivity due to changes in water availability caused by eucalyptus plantation expansion.

No	Item	Responses							
		Diversify crops		Implement water conservation strategies		Invest in water-capable technologies		Collaborate with local authorities and stakeholders	
		F	%	F	%	F	%	F	%
3	Have you had to make any adjustments to your agricultural productivity due to changes in water availability caused by eucalyptus plantation expansion?	133	53	83	33	12	5	24	9

Table 5 showed that most farmers, 133 (53%) needed to consider diversifying their crop selection to include more drought-resistant or water-efficient crops that can thrive in reduced water availability conditions. In addition, 83 (33%) of the respondents said that they coped with reduced water availability, and need to implement water conservation measures such as mulching, rainwater harvesting, and soil moistness monitoring to improve water usage and minimize wastage. 24 (9%) of the target respondents replied that they could collaborate with local authorities and other stakeholders to advocate for sustainable water management practices

and policies that prioritize agricultural water needs over other competing demands, such as eucalyptus plantation expansion. Finally, we could recognize from this table that 12 (5%) of the respondents said, they needed to invest in water-efficient technologies such as drip irrigation systems, moisture sensors, and precision farming techniques to maximize the use of available water resources.

4.4. Socio-economic impacts of eucalyptus plantation expansion on local agricultural communities

The respondents were asked the open - ended questions," How has the expansion of eucalyptus plantations affected your livelihood as a farmer?" and almost all of them forwarded the following ideas**:**

- Water consumption: Eucalyptus trees are known to be fast-growing and high water-consuming plants. They can deplete groundwater resources and lower the water table, reducing the availability of water for other vegetation and ecosystems.
- Nutrient depletion: Eucalyptus trees are highly efficient at extracting nutrients from the soil, leading to a gradual depletion of essential soil nutrients over time. This can lead to a decline in soil fertility and make it difficult for other plant species to thrive.
- Allelopathy: This response where forwarded from educated respondents who knows about allelopathy meaning as such, Eucalyptus trees produce certain chemical compounds, known as allelochemicals, which can inhibit the growth of other plants in the vicinity. This can result in a reduction in biodiversity and the dominance of eucalyptus trees in the ecosystem.
- Litter accumulation: Eucalyptus leaves and bark can form a thick layer of litter on the soil surface, which can be slow to decompose. So can prevent the growth of other plant species and lead to a reduction in soil microorganisms and nutrient cycling. Near the Eucalyptus stand, this might be due to its allelopathic effect, which oppose the mineral up take by the plants and low mineralization, Tlashwork, (2009).
- Soil erosion: The dense canopy of eucalyptus trees can intercept a significant amount of rainfall, reducing the amount of water that reaches the soil surface. This, combined with the reduced ground cover due to the inhibition of other vegetation, can make the soil more susceptible to erosion, especially on sloping or hilly terrain.

- Decreased biodiversity: The dominance of eucalyptus plantations can lead to a reduction in the diversity of plant and animal species, as the ecosystem becomes less diverse and more homogeneous.

Finally, the researcher asked them to explain the solution for the socio-economic impacts of eucalyptus plantation expansion on local agricultural communities and they forwarded that to mitigate these environmental impacts, it is important to consider the local conditions and potential impacts before establishing large-scale eucalyptus plantations, and to implement sustainable management practices that help maintain soil health and ecosystem balance.

The next open - ended question that the respondents were asked was," Have you experienced any changes in income or employment opportunities as a result of eucalyptus plantation expansion?" and they raised the following ideas:

- As a result of eucalyptus plantation expansion, they may experience an increase in income from the sale of eucalyptus firewood and other products. Additionally, there may be new employment opportunities created for local farmers in the establishment and maintenance of eucalyptus plantations. However, there could also be more negative impacts on income and employment opportunities if traditional crops and livelihood activities are displaced or if water resources are impacted by the expansion of eucalyptus plantations.
- Finally, they were asked, "Have there been any social or cultural changes in the community due to the presence of eucalyptus plantations?" and the following answer was made from about all the respondents:
- The presence of eucalyptus plantations may lead to social and cultural changes in the community. For example, the traditional way of life for local farmers may be disrupted as they transition to working in eucalyptus plantations. This could impact social dynamics and traditional practices within the community. Additionally, the landscape and environment of the community may change as eucalyptus plantations replace other types of vegetation, potentially altering the cultural significance of the land.

Overall, the presence of eucalyptus plantations may lead to changes in the social and cultural fabric of the community.

4.5. Income generation from the sale of eucalyptus biomass compared to crop yields

Table 6 summary of respondents on income generated from Eucalyptus trees and other cereal-crops. (n =252)

No	Items per ½ hectare	Cost in birr	F	Percent (%)
1.	Eucalyptus	20,000-35,000	4	1
2	Maize	35,000-40,000	186	74
3	Sorghum	45,000-47,000	45	18
4	Teff	40,000-50,000	15	6
5	Wheat	35,000-45,000	2	1
Total			252	100

In table 6, the sample groups were asked how much money they generated from Eucalyptus biomass per 1/2hectare, and then they responded as they gained about (1%) income relatively from their plantation. This implies that most farmers in the area generated less income from selling of Eucalyptus biomass than crop yields which is planted on similar size of land plot per year. This selling cost initiated the farmers to give less attention to fast plantation expansion of Eucalyptus trees.

Eucalyptus biomass may have less market value compared to cereal crops per kuntal (/Kg) especially where there is less demand for wood products or bioenergy. This could result in less income generation for farmers with eucalyptus plantations.

Cereal crops are food crops and are essential for food security, while eucalyptus biomass is primarily used for industrial purposes such as timber, paper, or biofuel production. Therefore, the income generated from cereal crops directly contributes to food availability and nutrition in the community.

In general, while both eucalyptus biomass and cereal crops can generate income for farmers, there are differences in market value, food security implications, and labor requirements that can impact the economic and social dynamics of the community. This response opposes the finding of Getachew Admasu thesis,(2008) worked on the impact of eucalyptus plantation expansion on food security in Bambasi woreda.

Table 7 Identifying the engagement of the respondents in the sale of eucalyptus biomass as a source of income

No	Item	Responses							
		Always		Some times		Rarely		Never	
		F	%	F	%	F	%	F	%
4	Have you engaged in the sale of eucalyptus biomass as a source of income?	---	---	20	8	181	72	51	20

In 7, the respondents were asked, whether they engaged in the sale of eucalyptus biomass as a source of income, and 181 (72%) of them replied that they rarely engaged in the sale of eucalyptus biomass as a source of income. The respondents were asked to explain why they rarely engaged in the sale of eucalyptus biomass as a source of income and forwarded the following assumptions:

- Lack of market demand: Farmers may be hesitant to invest in growing eucalyptus trees for biomass if there is limited demand for eucalyptus biomass in their local area. Without a

guaranteed market for their product, farmers may be wary of taking on the risk and effort of cultivating eucalyptus trees.

- Long-term investment: Eucalyptus trees can take several years to reach maturity and produce a significant amount of biomass. This long-term investment may deter farmers who are looking for more immediate sources of income.
- Environmental concerns: Eucalyptus trees are known for their fast growth and high biomass production, but they are also considered invasive in some regions and can have negative impacts on local ecosystems. Farmers may be hesitant to grow eucalyptus trees due to concerns about environmental sustainability and potential backlash from their community.
- Alternative income sources: Farmers may have other, more reliable sources of income from traditional crops or livestock, and may not see the potential benefits of engaging in the sale of eucalyptus biomass.

Overall, the decision to engage in the sale of eucalyptus biomass as a source of income is likely influenced by a combination of market factors, environmental considerations, and individual financial priorities.

The respondents were asked the open - ended question, "In your opinion, which source of income is more reliable and sustainable in the long term - crop yields or the sale of eucalyptus biomass?" And they forwarded the following points:

- Crop yields can provide a more reliable and consistent source of income for farmers, as they are often in high demand for food and other agricultural products. However, crop yields can also be affected by factors such as weather conditions, pests, and market fluctuations, which can impact their long-term sustainability.

4.6. Awareness of the negative impact of eucalyptus plantation expansion on cereal crop productivity.

Table 2 Awareness of any negative impacts of eucalyptus plantation expansion on cereal crop productivity,

No	Item	Responses			
		Yes		No	
		F	%	F	%
5	Are you aware of any negative impacts of eucalyptus plantation expansion on cereal crop productivity?	239	95	13	5

As we could understand from this table, 239 (95%) of the respondents responded that they aware of any negative impacts of eucalyptus plantation expansion on cereal crop productivity. The researcher wanted the respondents to explain their opinion deeply and they could put forwarded the following explanation:

- There are potential negative impacts of eucalyptus plantation expansion on cereal crop productivity. Eucalyptus trees are known for their fast growth and high water consumption, which can lead to competition for water resources with cereal crops. This competition for water can result in reduced water availability for cereal crops, leading to decreased productivity and yields.
- Additionally, eucalyptus plantations can also have allelopathic effects, where the trees release substances that inhibit the development of other plants, including cereal crops. This can further impact cereal crop productivity in areas where eucalyptus plantations are expanded.
- Overall, the expansion of eucalyptus plantations can have negative impacts on cereal crop productivity, especially in regions where water resources are limited.

The respondents were asked the open - ended question, “Have you personally experienced any decrease in cereal crop productivity due to the presence of eucalyptus plantations?” and almost all of them forwarded the following ideas:

The negative impacts of eucalyptus plantations on cereal crop productivity in areas where they have been expanded. These impacts are often related to competition for water and allelopathic

effect, as mentioned earlier. It is important to consider these potential impacts when planning and managing eucalyptus plantations in agricultural landscapes.

The respondents were asked the last open - ended question, "What measures, if any, have you taken to mitigate the impact of eucalyptus plantation expansion on your cereal crop productivity?" And they forwarded the following points:

- Some measures that they have taken to mitigate the impact of eucalyptus plantation expansion on their cereal crop productivity include: diversifying their crop rotation, establishing buffer zones, implementing soil conservation practices, efficient water management, participating in land use planning, and seeking support from agricultural extension services. These measures can help minimize the negative impacts of eucalyptus plantations on one's cereal crops and ensure sustainable productivity.





Figure 5 (a & b) Eucalyptus trees intercropped with Zia maize (corn)



Figure 6 Eucalyptus trees intercropped with Sorghum.



Figure 7 broadlly Eucalyptus plantation on graizing land



Figure 8 (c & d) Extenssivelly Eucalyptus plantation on farm land

CHAPTER – FIVE

CONCLUSION AND RECOMMENDATION

5.1. Conclusion

In the study area, farmers prefer cereal-crop productivity on their fertile land than Eucalyptus plantation. Because, Eucalyptus plantation has a negative effect on agricultural productivity where it grows nearby crop lands by competing resource such as water, soil nutrient and shade effect of the trees. Many dwellers gave suggestion about the negative impact of the Eucalyptus plantation expansion on the environment; but some of them practicing the plant expansion till now. The farmers were only following the income generated from the selling of the cereal-crop product. They gave attention to the ecosystem degradation which is resulting by Eucalyptus plantation and the redaction of food crops in this area year by year. Eucalyptus plantation on agricultural productivity could have a potential negative effect on soil health and water availability. So, this research indicates that eucalyptus plantations generally reduce agricultural productivity. In case of this, careful management practices are necessary to mitigate these impacts. Crop cultivating on productive land is advisable instead of expanding Eucalyptus tree on fertile soil. Even unfertile land should be treated traditionally or in scientific way to bring its productivity again, the nearer the crops to the Eucalyptus canopy, were the lower the crop yield. Therefore, keeping the maximum distance of eucalyptus and crops is good for better agricultural production.

5.2. Recommendations

Giving priority to cereal-crop production is better to have stable food security. Crops cultivating on productive land is advisable instead of expanding Eucalyptus tree plantation on fertile soil. Even unfertile land could be treated in scientific way to bring its productivity again rather than converting it to the Eucalyptus plantation expansion. Eco-friendly indigenous plants which increase soil fertility is to plant by mobilizing the community in continuous manner in and stating the crop land which can give dual benefit. Based on the researcher's findings, the following recommendations were drawn:

1. Conduct a comprehensive assessment of the potential impact of eucalyptus plantation expansion on farmers' crop productivity, including soil quality, water availability.
2. Implement sustainable land use practices, such as agroforestry or mixed cropping, to minimize the negative impact of eucalyptus plantation expansion on farmers' crop productivity.
3. Provide technical and financial support to farmers to adopt alternative land use practices that can coexist with eucalyptus plantations.
4. Engage in dialogue with relevant stakeholders, including government agencies, environmental organizations, and eucalyptus plantation owners, to develop and implement policies that promote sustainable land use and minimize the negative impact on farmers' crop productivity.

Generally, the researcher gave these recommendations to government agencies responsible for land use planning and environmental management, as well as to non-governmental organizations working on sustainable agriculture and land use practices, he could also share his findings and recommendations with eucalyptus plantation owners and farmers to raise awareness and promote collaborative solutions.

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APPENDIX A

Addis Ababa University

College of Natural and Computational Sciences

Department of Zoological Science

Summary of ages and gender of the respondents (n=252)

Sex	Age	Number of respondents	Percent
Male	25-40		
Male:	41-75		
Female:	25-40		
Female:	41-60		
Total			1

APPENDIX B

Addis Ababa University

College of Natural and Computational Sciences

Department of Zoological Science

Summary of Educational Background of the respondents (n=252)

Educational status	Sex	Number of respondents	Percent
Illiterate	Male		
	Female		
1-4	Male		
	Female		
5-8	Male		
	Female		
9-12	Male		
	Female		
12 & above	Male		
	female		
Total			

APPENDIX C

Addis Ababa University

College of Natural and Computational Sciences

Department of Zoological Science

INTERVIEW QUESTIONS FOR FARMERS

1. How has the expansion of eucalyptus plantations affected your livelihood as a farmer? _____

_____

_____

2. Have you experienced any changes in income or employment opportunities as a result of eucalyptus plantation expansion? _____

_____

_____

3. Have there been any social or cultural changes in the community due to the presence of eucalyptus plantations?_____

_____

_____

4. In your opinion, which source of income is more reliable and sustainable in the long term - crop yields or the sale of eucalyptus biomass?_____

_____

_____

5. Have you personally experienced any decrease in cereal crop productivity due to the presence of eucalyptus plantations? _____

_____

6. What measures, if any, have you taken to mitigate the impact of eucalyptus plantation expansion on your cereal crop productivity?

APPENDIX D

Addis Ababa University

College of Natural and Computational Sciences

Department of Zoological Science

QUESTIONNAIRES FOR THE RESPONDENTS

Impact of eucalyptus plantation expansion on soil fertility, water availability, and usage for agricultural purposes

No	Item	Responses					
		High demand for nutrients		High demand for Water		Reduce moisture levels	
		F	%	F	%	F	%
1	How has the expansion of eucalyptus plantations affected the soil fertility of your agricultural land?						

No	Item	Responses							
		More change		Little change		No change		Couldn't be understood	
		F	%	F	%	F	%	F	%
2	Have you noticed any changes in water availability for your crops since the expansion of eucalyptus plantations in the area?								

No	Item	Responses					
		consume large amounts of water		affect the quality of water sources		impact the water management and sustainability	
		F	%	F	%	F	%
3	In what ways has the usage of water for agricultural purposes been impacted by the presence of eucalyptus plantations?						

No	Item	Responses						
		Diversify crops		Implement water conservation measures		Invest in water-efficient technologies		Collaborate with local authorities and stakeholders
		F	%	F	%	F	%	F
4	Have you had to make any adjustments to your agricultural productivity due to changes in water availability caused by eucalyptus plantation expansion?							

APPENDIX E

Addis Ababa University

College of Natural and Computational Sciences

Department of Zoological Science

QUESTIONNAIRES FOR THE RESPONDENTS

Socio-economic impacts of eucalyptus plantation expansion on local agricultural communities

No	Items per ½ hectare	Cost in birr	F	Percent (%)
1.	Eucalyptus	20000-35000		
2	Maize	35000-40000		
3	Sorghum	45000-47000		
4	Teff	40000-50000		
5	Wheat	35000-45000		
Total				

No	Item	Responses					
		Always		Some times		Rarely	
		F	%	F	%	F	%
9	Have you engaged in the sale of eucalyptus biomass as a source of income?						

APPENDIX F

Addis Ababa University

College of Natural and Computational Sciences

Department of Zoological Science.

QUESTIONNAIRES FOR THE RESPONDENTS

Awareness of the negative impact of eucalyptus plantation expansion on cereal crop productivity.

No	Item	Responses			
		Yes		No	
		F	%	F	%
10	Are you aware of any negative impacts of eucalyptus plantation expansion on cereal crop productivity?				