



COLLEGE OF AGRICULTURE AND NATURAL RESOURCE

DEPARTMENT OF NATURAL RESOURCES MANAGEMENT

**ASSESSMENT OF AGROFORESTRY PRACTICE AND THEIR CONTRIBUTION ON
SOIL AND WATER CONSERVATION: IN CASE OF YEFEREZYE KEBELE GURAGE
ZONE CENTRAL ETHIOPIA**

SENIOR RESEARCH PROJECT

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Contents

ACKNOWLEDGMENT	i
List of Table.....	v
List of Figure.....	v
ACRONYM AND ABRVATION.....	vi
ABSTRACT.....	vii
1. INTRODUCTION.....	1
1.1. Background of the study	1
1.2 Statement of the Problem	3
1.3. Objectives of the study.....	4
1.3.1. General Objective	4
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. Limitations of the study.....	5
2 . LITERATURE REVIEW.....	6
2.1 Definition and Terminology	6
2.2. Common Agroforestry Systems and Practices.....	6
2.2.1. Alley Cropping	6
2.2.2. Silvopastoral Practice	9
2.2.3. Wind Breaks and Shelterbelts.....	11
2.2.3.3. Challenges and Limitations of Windbreaks and Shelterbelts.....	12
2.2.4. Mixed farming system.....	13
2.2.5. Boundary Planting and Live Fences	16
2.2.5.1. Ecological and Environmental Benefits of Boundary Planting and Live Fences.....	16
2.2.5.2.Economic and Socioeconomic Benefits Boundary Planting and Live Fence	17

2.2.5.3. Challenges and Limitations of Boundary Planting and Live Fences.....	17
2.2.6. Trees on Erosion Control.....	18
2.3. Agroforestry and the Use of Sloping Lands.....	18
2.4. Soil and Water Conservation.....	19
3. MATERIAL AND METHODOLOGY	20
3.1. Description of the study area.....	20
3.1.1. Location of the area	20
3.1. 2. Climate condition	20
3.1.3. Topography.....	21
3.1.4. Soil Types	21
3.1.5. Population.....	21
3.1.6. Land Use and Farming System.....	21
3.1.7. Vegetation and crops	22
3.2. Methods.....	23
3.2.1. Source of data and Collection.....	23
3.2.3. Sampling Size and Techniques.....	23
3.3. Data Analysis	24
4. RESULT AND DISCUSSION	25
4.1. Socio- Demographic Features of the Respondent	25
4.1.1. Age of respondent.....	25
4.1.2. The age factor on the influence of farmer`s perception and type of AF practice.....	27
4.1.3. Education level of the respondents	28
4.1.4. Farmer`s Attitude towards Agroforestry practice.....	29
4.1.5. Occupation of the respondent	30
4.1.6. Observed Agroforestry practice in SWC in study Area	30
4.1.7. The Existing Traditional AF Practice	32
4.2. Farmers perception on Uses of AF practices for SWC	34
4.3. Advantage of AF for SWC.....	36
4.4.Land Holding and Characterization of Land Uses	37
4.4.Tree Planting Purposes.....	38
4.5. Problems that hinders the extent of agro-forestry practices	39

4.6. Mechanisms to make the best AF practices	42
4.6.1. Best options to make the best AF practices	43
5. CONCLUSION AND RECOMMENDATION.....	44
5.1. Conclusion.....	45
5.2. Recommendation.....	46
<i>Reference</i>	47
Appendix	51

List of Table

TABLE 4.1 : SEX AND AGE OF RESPONDENT.....	25
TABLE 4.2 :THE AGE FACTOR ON THE INFLUENCE OF FARMER`S PERCEPTION AND TYPE OF AF PRACTICE.....	27
TABLE 4.3: EDUCATIONAL LEVEL OF THE HOUSE HOLDS.....	28
TABLE 4.4: FARMERS` ATTITUDE TOWARDS AGROFORESTRY PRACTICE.....	29
TABLE 4. 5: OCCUPATION OF THE RESPONDENT.....	30
TABLE 4. 6 : OBSERVED AGROFORESTRY PRACTICE IN SWC.....	31
TABLE 4.7: THE EXISTING TRADITIONAL AF PRACTICES.....	32
TABLE 4.8 : PERCEPTION OF FARMERS ON CONTRIBUTION OF AF TO SWC AND OTHER USES	34
TABLE 4. 9: THE ADVANTAGE AF PRACTICE FOR SWC WITH RESPECT OF PLANT PART.....	36

List of Figure

<i>Fig 3.1. Map of Central Ethiopia , Gurage zone (B), Cheha woreda in Gurage zone (C), Map of Cheha woreda- the study are.....</i>	20
FIG 4.1. ENSET, CHAT, FRUIT TREE BASED HOMESTEADS AT DIFFERENT MATURITIES IN THE STUDY AREA.....	38
FIG 4.2. CHARACTERIZATION OF TREE PLANTING PURPOSES.....	39
FIG 4.3. MAIN PROBLEMS THAT HINDER AF PRACTICES.....	41

ACRONYM AND ABRVATION

ICRAF	International Centre of Research on Agroforestry
AFS	Agroforestry System
MFS.....	Mixed farming systems
FAO.....	Food and Agriculture Organization
SWC.....	Soil Water Conservation
OM.....	Organic Matter
SPSS	Statistical Package for the Social Sciences
PP.....	Plant part

ABSTRACT

The study was conducted at Yeferezye kebele to assess agroforestry practices and their contribution on soil and water conservation with specific objectives to identify the agroforestry practice including alley cropping, boundary planting, home gardens, boundary planting, and Silvopastoral systems ,which were existed in the area, to know farmer`s perception on the contribution of soil and water conservation. the study identify the challenges of agroforestry practices including loss of organic matter and nutrient when trees harvest, Nutrient moisture computation between trees and crops, Inadequate Policy Support, Lack of Market Access for Agroforestry Products and Slow Return on Investment. By considering purposive sampling techniques and using Yamane`s formula 89 household sample size followed by random sampling techniques arranged by alphabetical order to select individual respondents was used, then after both primary and secondary data was collected through interviewing and observation. The study recommends include implementing Strengthening Awareness and Knowledge Sharing, Enhancing Policy Support and Institutional Involvement, Providing Financial and Technical Support, Encourage Agroforestry as Part of Integrated Land Management and Promote Indigenous and Adapted Tree Species. After collecting data both quantitative (descriptive statistics) and qualitative data analysis was carried out and the result was presented using table and figure.

Key term: Agroforestry, Soil , erosion, Conservation

1. INTRODUCTION

1.1. Background of the study

Agroforestry is a combination of agricultural and forestry technologies to create combined, diverse and productive land-use systems (Garrett *et al.* 2000). Agroforestry practices have increasingly been recognized for their potential to improve soil and water conservation in both smallholder and large-scale farming systems. By integrating trees into agricultural landscapes, agroforestry can help to stabilize soil, prevent erosion, and enhance water retention in the soil. A broader field is that of soil and water conservation is reduction in water loss through runoff is an integral part of soil conservation (Pagiola *et al.*, 2004).

Agroforestry also contributes to the conservation of water resources, particularly in areas experiencing water scarcity. Trees play a crucial role in regulating the water cycle by improving water infiltration into the soil and reducing evaporation rates. The deep root systems of trees allow them to access groundwater, which reduces the competition for water between crops and trees. Additionally, agroforestry systems with leguminous trees enhance the soil's nutrient content, which in turn supports water retention. By providing a natural buffer against water loss, these systems reduce the overall water demand for crops, ensuring that water resources are conserved more efficiently (Kuyah *et al.*, 2012) .

Agroforestry's contribution to soil and water conservation extends beyond the individual farm level to broader ecosystem-level benefits. The integration of trees into agricultural landscapes has been shown to improve biodiversity and enhance the resilience of farming systems to climatic variations. In regions vulnerable to soil erosion, the deep-rooted trees in agroforestry systems stabilize the soil, reducing the likelihood of landslides and waterlogging during intense rainfall. The diverse plant species in agroforestry systems also support pollinators and other beneficial organisms, which contribute to ecosystem stability and agricultural productivity (Kassam *et al.*, 2018).

Agroforestry fulfills both productive and service functions with its production functions include fuel wood, fodder, fruit and a range of other use full minor forest products such as gums and medicinal products while services functions include shade, fencing and soil and water

conservation. Even though agroforestry have more potential in protecting of our soils and improve the soil fertility and increases production. Agroforestry provides an integrated approach to land management that addresses both ecological and economic concerns. By fostering sustainable soil and water management, agroforestry can improve agricultural productivity, enhance biodiversity, and contribute to the long-term health of the environment (Leakey, *et al.*,2017).

Agroforestry is an integrated land-use management system that combines the cultivation of trees with agricultural practices to create a diverse and sustainable landscape. This approach not only enhances agricultural productivity but also supports environmental conservation. By incorporating trees into farming systems, agroforestry helps to improve soil health, reduce erosion, and manage water resources efficiently. Trees in agroforestry systems play an essential role in soil conservation by preventing the loss of topsoil, stabilizing soil structure, and enhancing the infiltration of water into the ground. The deeper roots of trees also contribute to the creation of channels for water movement, reducing runoff and improving groundwater recharge. These systems offer a holistic solution to soil and water management, ensuring that land remains productive while minimizing the environmental footprint of agricultural activities (Garrett, *et al.*2000).

The benefits of Agroforestry Practice in soil and water conservation is its ability to enhance water retention and regulate the local water cycle. The integration of trees into agricultural landscapes reduces water evaporation by providing shade and wind protection Agroforestry systems with leguminous trees further enrich the soil by fixing nitrogen, which in turn enhances nutrient availability and supports crop growth. In addition to reducing the competition for water between crops and trees, agroforestry systems also promote biodiversity, creating a resilient ecosystem that can withstand environmental stressors such as extreme weather events. Through these multiple mechanisms, agroforestry offers a sustainable solution for addressing soil erosion, water scarcity, and the long-term health of agricultural ecosystems (Kassam,2018).

1.2 Statement of the Problem

Agroforestry practices have been recognized globally as effective strategies for addressing environmental challenges such as soil erosion, water scarcity, and soil fertility degradation (Garrity, 2004). However, in Yeferezye Kebele, Cheha Woreda, Gurage Zone, Central Ethiopia, these practices are not widely adopted. This is primarily due to farmers' limited knowledge and inadequate awareness of the benefits of agroforestry, which hinders their ability to implement soil and water conservation measures effectively. Furthermore, the lack of training programs on climate-smart agroforestry techniques, such as selecting drought-resistant tree species and employing water conservation methods, exacerbates the problem (Bekele et al., 2019).

Land tenure insecurity in the region also plays a critical role in discouraging long-term investments in agroforestry practices. Farmers are hesitant to adopt agroforestry systems due to uncertainty about their rights to the land, which limits their commitment to sustainable land management practices (Mekonnen et al., 2020). Despite the potential benefits, agroforestry has not been incorporated into broader agricultural policies or development plans in Cheha Woreda. This policy gap prevents adequate support for the adoption of agroforestry practices that could improve soil health, enhance water retention, and reduce erosion (Suleiman et al., 2021).

The study will assess the role of agroforestry in soil and water conservation in Yeferezye Kebele, Cheha Woreda, Gurage Zone, by examining the potential of agroforestry systems to contribute to sustainable land management, erosion control, and water regulation in this specific area. Understanding the constraints and benefits of agroforestry practices in this region will provide critical insights into how these practices can be promoted and adapted to address the environmental challenges faced by the local farming communities.

1.3. Objectives of the study

1.3.1. General Objective

The general objective of this study is to assess the existed agroforestry practices and their contribution on soil and water conservation in the case of Cheha District Yeferezye Kebele in Gurage zone ,Central Ethiopia .

1.3.2. Specific Objectives

- ✓ To identify the common agroforestry practices implemented by farmers for soil and water conservation.
- ✓ To know farmer`s perception contribution of Agroforestry on Soil Water Conservation
- ✓ To identify the challenges of Agroforestry practices in the study area

1.4. Research questions

1. What are the benefits of agroforestry practice?
2. What are the key agroforestry practices that contribute to soil conservation in the study area?
3. What are the challenges of Agroforestry practices in the study area?

1.5. Significance of the Study

The results of the present study have beneficial effects to farmers, environmental experts, water management authorities, policy makers and planers. The results would serve as the base for decision making to enhancing sustainable land management and improved soil and water conservation. Moreover, the results of this study provide baseline information for other researchers to conduct similar or related studies elsewhere.

It provides valuable insights into soil conservation and fertility improvement. By examining agroforestry practices, the research highlights how these methods can preserve soil fertility and prevent erosion, which is crucial for sustainable agriculture.

The study addresses water resource management, a pressing issue in many parts of Ethiopia, including the Gurage Zone. Agroforestry systems have the potential to enhance water retention, regulate the local hydrological cycle, and mitigate the negative impacts of runoff and evaporation, ultimately contributing to better water availability. Lastly, the educational value for local farmers cannot be overlooked. The study's findings can help inform and educate farmers about the practical benefits of agroforestry. By encouraging the adoption of these practices, the study aims to enhance local farming systems and promote sustainable agricultural development.

1.6. Scope of the Study

This study focuses on investigating the role of agroforestry practices in improving soil and water conservation in the Yeferezye Kebele of Cheha Woreda, located within the Gurage Zone. Due to time and resource constraints, it is not feasible to cover all aspects of the study area. It examines the specific contributions of agroforestry systems, such as the integration of trees with agricultural crops, to soil health, erosion control, water retention, etc. The study aims to provide a comprehensive understanding of how agroforestry can be used as an effective tool for sustainable land management and improved soil and water conservation.

1.7. Limitations of the study

The study on agroforestry practices and their contribution to soil and water conservation in Yeferezye Kebele, Cheha Woreda, Gurage Zone, faces several limitations. One significant limitation is the geographic scope, data accuracy and availability pose challenges, as the research relies on local farmer reports and field observations, which may be influenced by subjective biases or incomplete data. The study's findings may also be affected by external factors such as climate variability, government policies, and market conditions, which influence the adoption and effectiveness of agroforestry.

2. LITERATURE REVIEW

2.1 Definition and Terminology

Agroforestry is an integrated land use system that involves the cultivation of trees alongside agricultural crops or livestock in a way that provides mutual benefits for both (Nair, *et.al*, 2018). This approach is gaining attention as a sustainable agricultural practice due to its potential to enhance environmental conservation, including soil and water management. The increasing need for soil and water conservation has led to a growing body of research exploring how agroforestry systems contribute to the protection and improvement of these critical natural resources,(Kassam,*et.al* ,2018)). Agroforestry is collective name for land use systems in which woody perennials(trees, shrubs, etc.) are grown association with herbaceous plants (crops, pasture) and or livestock in spatial arrangement, a rotation or both and in which there are both ecological and non-tree components of the system, (Lundgren, *et.al.*, 2018).

2.2. Common Agroforestry Systems and Practices

Agroforestry, the practice of integrating trees with agricultural crops or livestock, offers a multifunctional land use approach that enhances sustainability and provides numerous ecological and economic benefits, (Nair, *et.al* ,2018). In addition to improving biodiversity, agroforestry practices contribute significantly to soil conservation, water management, and climate change mitigation, (Young, A. 2018). As the global population continues to rise and the demand for food increases, the adoption of agroforestry systems is recognized as a key strategy for achieving food security while maintaining environmental integrity.

2.2.1. Alley Cropping

Alley Cropping (Hedgerow intercropping) has, and may be practiced on the flat or sloping lands. Sometimes the tree component is made up of single or multiple rows of trees but more often it consists of a dense hedgerow most experimental work has been conducted on level land, but the practice can adapted to sloping land by planting hedgerows along the contour.

Alley cropping improves soil fertility by providing organic matter to the soil and reducing erosion caused by wind and water. The trees in these systems often act as windbreaks, reducing the impact of high winds on the crops and helping to stabilize the soil. trees in alley cropping

systems can reduce the need for synthetic fertilizers by increasing soil nitrogen through biological nitrogen fixation ,(Young ,2018). The trees also help in fixing nitrogen in the soil, improving soil health for subsequent crops. Studies by (Buresh, R. J., & Cooper, P. J. M. ,2018) indicate that the combination of leguminous trees and crops in alley cropping systems can improve long-term soil fertility and reduce the need for synthetic fertilizers.

2.2.1.1. Environmental Benefits of Alley Cropping

Alley cropping offers several significant environmental benefits that contribute to sustainable land management. One of the primary benefits is soil conservation. Trees in alley cropping systems act as barriers that reduce the speed of surface water flow, thus decreasing the risk of soil erosion, especially in areas with sloping lands. Studies have shown that trees in alley cropping systems reduce soil displacement caused by rainfall, particularly in regions with heavy rainfalls. (Buresh and Cooper ,2018) argue that alley cropping reduces surface runoff by promoting water infiltration into the soil, thereby preventing soil erosion and degradation.

This effect is crucial in preventing the loss of topsoil, which can have long-term detrimental effects on soil fertility. Additionally, trees in these systems improve soil fertility through the process of organic matter decomposition, adding essential nutrients like nitrogen to the soil. (Nair ,2018) highlights how trees, particularly nitrogen-fixing species like *Leucaena leucocephala* and *Gliricidia sepium*, contribute to improving soil fertility by replenishing nitrogen levels in the soil, which enhances crop growth. These systems also enhance biodiversity by creating diverse habitats for various species of plants, animals, and beneficial insects. The structural complexity of alley cropping systems creates an environment conducive to higher levels of biological diversity compared to monoculture farming systems, as noted by (Altieri and Nicholls ,2004).

2.2.1.2. Economic and Socioeconomic Benefits of Alley Cropping

Alley cropping systems are also economically and socially beneficial for farmers. Increased farm income is one of the primary economic advantages of alley cropping. Farmers can generate income not only from crops grown in the alleys but also from timber, fruit, and fodder provided by the trees. This diversification reduces the economic risks associated with relying on a single crop or commodity, particularly in the face of market fluctuations or adverse weather conditions. (McNeely and Scherr ,2003) emphasize that agroforestry systems, including alley cropping, offer multiple products, making them more resilient to external economic shocks. Moreover, alley cropping can reduce input costs, particularly in terms of fertilizers and pest control. The organic matter contributed by trees enhances soil fertility, thus reducing the need for synthetic fertilizers. Young ,2018) highlights that the presence of nitrogen-fixing trees in alley cropping systems leads to a reduction in fertilizer use, improving both the economic and environmental sustainability of the farming system. Socially, alley cropping systems can support rural development by improving food security, providing employment opportunities, and enhancing the resilience of farming communities to climate change and economic stresses. As farmers grow a diverse range of crops and products, they can also access new markets and gain more opportunities for livelihood diversification.

2.2.1.3. Challenges and Limitations of Alley Cropping

While alley cropping offers various environmental and economic benefits, several challenges and limitations hinder its widespread adoption. Initial establishment costs and the time lag before full benefits are realized are among the major obstacles for farmers. Trees in alley cropping systems typically take several years to reach maturity, which means that farmers may not experience immediate returns from their tree-based investments.

According to Harun and Dagar ,2018), this delay in benefits can be a deterrent for farmers, particularly in areas where immediate food production is crucial. Management complexity also poses a significant challenge. Alley cropping requires careful management to ensure that trees and crops coexist optimally. Farmers need to balance the water, nutrients, and space requirements of both the trees and the crops. Proper tree spacing and selection are crucial to

avoid excessive competition for resources, as Buresh and Cooper ,2018) . Furthermore, knowledge gaps can hinder successful implementation. Farmers may lack sufficient knowledge or technical support on how to manage alley cropping systems effectively.

Lastly, there is the risk of trees overshadowing crops if not managed properly, which can reduce crop yields. McNeely and Scherr ,2003) mention that, while alley cropping can improve soil fertility, poor tree management or inappropriate species selection may lead to unanticipated competition for light, water, and nutrients, negatively affecting crop productivity

2.2.2. Silvopastoral Practice

Silvopastoral practices involve the integration of trees, livestock, and forage into a single land use system, aiming to enhance productivity while also providing environmental benefits. This agroforestry system has gained attention for its ability to promote sustainable land management by combining the benefits of tree-based systems with the advantages of livestock grazing. Silvopastoral systems offer a unique opportunity to diversify farm income, increase land productivity, and improve ecological services, such as carbon sequestration, biodiversity conservation, and soil and water conservation.

These practices can vary in design depending on the local environment, species chosen, and the needs of the farming system. According to (Murgueitio *et al.* ,2011), silvopastoral systems are particularly effective in tropical and subtropical regions, where they have shown potential to increase both livestock and tree productivity simultaneously, leading to a more resilient agricultural system. These practices includes scattered tree on pastures (e.g. cattle under coconuts sheep rubber) live fences fodder banks, wind breaks and shelterbelts, and hedgerow intercropping on pastures, and the potential of wind break to control wind is well established (nair, 2018).

2.2.2.1. Ecological and Environmental Benefits of Silvopastoral Practice

Silvopastoral systems provide several ecological and environmental benefits, one of the most significant being soil conservation. Trees in these systems help reduce soil erosion by stabilizing the soil with their root systems and reducing the speed of surface water flow. (José and Ferreira ,2014) explain that silvopastoral systems can significantly reduce soil erosion, especially in areas

prone to heavy rainfall and wind, as the trees act as physical barriers. silvopastoral systems enhance soil fertility by contributing organic matter from both tree litter and livestock manure, which enriches the soil with essential nutrients. (Hernández *et al.* ,2016) further highlight that the presence of trees in silvopastoral systems leads to improved biodiversity, providing habitats for various species of plants, insects, and animals that may otherwise not thrive in conventional monocultural systems. This increase in biodiversity has positive cascading effects, including the improvement of pest control and pollination services within the system.

2.2.2.2. Economic and Socioeconomic Benefits Of Silvopastoral Practice

Silvopastoral systems offer substantial economic benefits by increasing the productivity of land in a sustainable manner. Farmers can generate income from multiple sources, including timber, non-timber forest products, livestock, and forage. According to (Sileshi *et al.* ,2012), farmers adopting silvopastoral systems can benefit from the simultaneous production of high-quality forage for livestock and the ability to harvest tree products, such as fruit, timber, and firewood. This diversity in production helps to stabilize farm incomes, especially in regions where climate variability might otherwise affect crop or livestock production.

silvopastoral systems have been shown to reduce the need for external inputs like fertilizers and pesticides by improving the soil's natural fertility and pest regulation through increased biodiversity. (García *et al.* , 2018) argue that these systems can significantly improve the financial resilience of farms, particularly in the face of climate change, as they provide a diversified set of income streams that reduce dependency on a single agricultural activity.

2.2.2.3. Challenges and Limitations Of Silvopastoral Practice

Despite the numerous advantages, silvopastoral practices also face certain challenges and limitations. One of the primary challenges is management complexity. Managing the integration of trees, livestock, and forage requires a high level of technical knowledge and expertise, especially regarding the selection of compatible species. managing grazing patterns, tree growth, and forage quality can be complex, and farmers may struggle with optimizing the balance between these components (Murgueitio *et al.* ,2018) .

Additionally, there is a potential competition for resources such as water, light, and nutrients between trees and livestock, especially if trees are not adequately spaced or managed. (Hernández *et al.* 2016) argue that improper tree selection or insufficient grazing management can result in reduced pasture quality or excessive shading of forage crops. Furthermore, the initial investment required to establish a silvopastoral system can be significant, with long payback periods due to the time it takes for trees to mature and become productive. (José and Ferreira,2014) emphasize that farmers may be reluctant to invest in such systems if they do not see immediate returns, particularly in areas with poor access to finance or extension services.

2.2.3. Wind Breaks and Shelterbelts

Windbreaks and shelterbelts are agroforestry practices that involve planting trees or shrubs in rows to protect crops, livestock, and soil from the effects of wind. These practices are widely used in agriculture to reduce wind erosion, protect water resources, improve soil moisture retention, and enhance biodiversity. Agro forestry practices with major proposed of controlling wind erosion (depommeir, 2016). Wind break and shelterbelts are established to protect or shelter nearby leeward areas from troublesome winds.

Wind break and shelterbelts are normally established concurrently with other practice as part of a conservation management system Windbreaks typically consist of one or more rows of trees or shrubs planted along the edges of fields, while shelterbelts are broader, multi-row plantings designed to create more significant wind barriers. Allen *et al.* ,2004) emphasize that windbreaks and shelterbelts are particularly important in arid and semi-arid regions where wind erosion can severely degrade soil fertility and affect agricultural productivity. These systems can also improve microclimates by reducing wind speed and offering protection from extreme weather events, thus enhancing crop yields and livestock health.

2.2.3.1. Ecological and Environmental Benefits of Wind Breaks and Shelterbelts

The environmental benefits of windbreaks and shelterbelts are numerous, and their role in soil erosion control is one of the most widely recognized. Windbreaks help reduce wind velocity at the ground level, thereby preventing the removal of soil particles and the loss of soil nutrients.

Studies, such as (Ghosh *et al.* ,2007), have shown that windbreaks can reduce soil erosion by as much as 50% in wind-prone areas.

Moreover, these practices improve soil moisture retention by reducing evaporation from the soil surface, which is especially important in dryland farming systems. Nair ,2018) highlights that windbreaks create a microclimate that helps to conserve soil moisture and improve the overall quality of the soil. Additionally, windbreaks and shelterbelts contribute to biodiversity by providing habitat for a wide variety of species, including birds, small mammals, and beneficial insects. (Mayer *et al.* ,2018) argue that these systems enhance the ecological resilience of agricultural landscapes by increasing biodiversity and creating corridors for wildlife movement.

2.2.3.2. Economic and Socioeconomic Benefits of Wind Breaks and Shelterbelts

The environmental benefits, windbreaks and shelterbelts offer economic advantages for farmers. By reducing wind erosion, these systems help to maintain soil fertility, which in turn can lead to increased crop yields. Furthermore, windbreaks can protect crops from damage caused by wind and improve water use efficiency by minimizing evaporation. As Liu *et al.* ,2014) suggest, shelterbelts are particularly beneficial in areas prone to dust storms, as they reduce crop loss and protect valuable agricultural investments.

The diversification of income is another economic advantage, as trees planted within these systems may provide additional sources of income from timber, fruits, or nuts. Garrity *et al.* ,2010) explain that the use of windbreaks for firewood or timber harvesting can provide supplemental income to farmers, improving their financial resilience. Additionally, these systems can help reduce livestock mortality in windy areas by providing shelter and improving animal welfare, which is particularly important in regions with extreme weather conditions. Windbreaks also have significant socioeconomic value, as they contribute to enhanced food security, rural livelihoods, and community well-being.

2.2.3.3. Challenges and Limitations of Windbreaks and Shelterbelts

The initial costs of establishing windbreaks and shelterbelts can be significant, including expenses for tree planting, land preparation, irrigation systems, and fencing (Kerr, 2002). Additionally, there are long-term maintenance costs such as pruning, thinning, and pest control. These ongoing expenses can be a challenge for farmers, particularly those with limited financial resources or those operating on small-scale farms. Furthermore, in the early years, the benefits of windbreaks may not be immediately apparent, making it difficult for farmers to justify the investment if immediate economic returns are a priority (Young, 2018).

Windbreaks and shelterbelts require space, which could otherwise be used for agricultural crops or livestock. In regions with limited available land or where land values are high, farmers may be reluctant to allocate large areas to trees. This land use competition is particularly challenging in densely populated or highly productive agricultural zones where farmers face economic pressures to maximize their land's immediate productivity. In such areas, farmers may prioritize monoculture farming over agroforestry practices, despite the long-term benefits of windbreaks for soil health and productivity (Zhao *et al.*, 2014).

Windbreaks and shelterbelts require consistent and careful management to remain effective. Regular maintenance activities include pruning, thinning, and addressing any issues related to soil health or pest infestation. Management can be time-consuming and requires expertise in tree care. Farmers may face difficulties in managing these systems if they lack access to training or resources. In addition, extreme weather events, such as storms or droughts, may damage the trees, requiring further intervention and resources to restore the system's functionality (Zhao *et al.*, 2014).

2.2.4. Mixed farming system

Mixed farming systems (MFS) are integrated land-use systems where crops and livestock are produced together, often on the same plot of land. This system is practiced in diverse environments worldwide, from smallholder farms to large-scale operations, as it provides numerous ecological and economic benefits. The integration of crops and livestock offers greater flexibility and resource utilization compared to monoculture farming systems. Smith *et al.* (2017) describe mixed farming as an agricultural system that enhances land use efficiency by leveraging the complementary benefits between crop and livestock components.

In addition, mixed farming systems are considered resilient, particularly in the face of climate variability, as they allow for diversification of farm products and risk reduction. This system not only improves productivity but also helps in optimizing resource cycling through the integration of animal manure for soil fertilization and crop residue for livestock feed, as outlined by Peet *et al.* (2015).

2.2.4.1. Ecological and Environmental Benefits of Mixed Farming

Mixed farming systems offer significant environmental benefits by promoting sustainable land management practices and improving soil health. The integration of livestock in farming systems contributes to nutrient cycling through the application of animal manure to crops, which enhances soil fertility and reduces the need for synthetic fertilizers. (Mekonnen *et al.* (2013) emphasize that manure from livestock is an excellent organic fertilizer, providing essential nutrients like nitrogen and phosphorus, thus improving soil structure and microbial activity.

Additionally, mixed farming contributes to biodiversity enhancement by providing varied habitats for different species. The diversified landscape, which includes both crops and livestock, supports higher biodiversity levels than monoculture systems. (Khan *et al.* (2017) note that the agroecosystem in mixed farming is often more resilient to environmental stresses, such as droughts, as it allows for better water retention and soil protection, especially when crop residues are used for mulching or as feed for animals. Moreover, mixed farming systems often implement agroforestry practices or the integration of trees, which provide additional environmental benefits like windbreaks, shade, and carbon sequestration.

2.2.4.2. Economic Benefits of Mixed Farming

Mixed farming systems provide economic benefits by diversifying income streams and improving farm resilience. By combining the production of crops and livestock, farmers can spread risk and reduce vulnerability to price fluctuations or crop failure. that mixed farming systems are particularly advantageous for smallholder farmers in developing countries, as they allow for year-round income through the sale of livestock, milk, eggs, and crop products (Thapa

et al., 2015) . This diversification helps stabilize income, particularly during off-seasons or during market price volatility.

Additionally, livestock provides a ready source of organic manure that can be used to improve crop yields, thus reducing the need for purchased fertilizers and lowering input costs. According to Dube *et al.* (2016), mixed farming systems also help farmers save on transportation costs and labor, as they eliminate the need to buy commercial fertilizers and imported feed for livestock. Farm sustainability is also enhanced, as farmers can take advantage of complementary synergies between livestock and crop production, leading to an overall like windbreaks, shade, and carbon sequestration. more efficient farming system.

2.2.4.3. Challenges and Limitations of Mixed Farming Systems

While mixed farming systems have various advantages, they also face several challenges and limitations. One significant challenge is the complexity of management, as it requires balancing the needs of both crops and livestock. Effective management practices must account for factors such as feed supply, manure management, irrigation, and crop rotation, which can be demanding, particularly for smallholder farmers. that poor management practices can lead to overgrazing, soil degradation, and reduced productivity if the integration of livestock and crops is not properly managed Smith *et al.*, 2017).

Additionally, land tenure issues can limit the adoption of mixed farming systems, particularly in regions where farmers do not have secure land rights or access to sufficient land for both crops and livestock. the benefits of mixed farming systems are clear, access to finance, technical knowledge, and training is often inadequate, hindering the system's success (Mekonnen *et al.*, 2013) . Furthermore, there is a risk of livestock diseases, which can have detrimental effects on both animal health and crop production if proper veterinary care is not available. the successful integration of livestock and crops depends heavily on effective disease management practices and access to veterinary services (Khan *et al.*, 2017)

2.2.5. Boundary Planting and Live Fences

Boundary planting and live fences are agroforestry practices that involve the strategic planting of trees, shrubs, or other vegetation along property boundaries, farm edges, or around fields. These practices have long been used in traditional agriculture systems to demarcate land ownership, improve soil fertility, and reduce wind and water erosion. Boundary planting refers to the establishment of vegetative barriers along farm boundaries, while live fences involve the use of living plants, typically shrubs or trees, to form fences that serve multiple purposes, including protection against livestock, delineation of land ownership, and soil conservation. Field boundaries, where aligned along the contours, are an effective means of erosion control and it is all to the good if this can be combined with productive and service function through boundary or live fencing.

According to Stover *et al.* (2014), these systems can contribute significantly to improving farm productivity, protecting natural resources, and enhancing biodiversity. In addition to these benefits, live fences and boundary plantings also play a crucial role in enhancing land tenure security by providing clear markers of land ownership, thus reducing conflicts between neighbors and land disputes.

2.2.5.1. Ecological and Environmental Benefits of Boundary Planting and Live Fences

Boundary planting and live fences provide a range of ecological and environmental benefits that help maintain the sustainability of farming systems. These include soil erosion control, microclimate regulation, and habitat provision. The vegetation in live fences and boundary plantings helps reduce the speed of wind and water flow, thus minimizing soil erosion caused by wind or heavy rains. (Puri and Kaphle, 2017) that boundary plantings can reduce soil erosion by up to 60% in areas prone to erosion, as the roots of the plants help anchor the soil.

Furthermore, live fences contribute to the improvement of soil fertility by adding organic matter through the decomposition of plant material and providing a source of nitrogen through nitrogen-fixing species like leguminous plants. (Muller *et al.*, 2015) emphasize that such systems enhance

biodiversity by creating corridors for wildlife and providing food and shelter for birds, insects, and other animals.

By increasing the diversity of plant and animal species on farms, boundary plantings and live fences can contribute to the restoration of degraded landscapes and promote ecosystem services such as pollination and pest control.

2.2.5.2. Economic and Socioeconomic Benefits Boundary Planting and Live Fence

Boundary planting and live fences offer several economic and socioeconomic benefits to farmers. One of the most immediate benefits is their role in protecting crops and livestock. For example, live fences provide a physical barrier that prevents livestock from grazing on crop fields, reducing crop damage and increasing agricultural productivity. The use of live fences for animal control reduces the need for traditional fencing materials, which can be costly and labor intensive. (Müller *et al.* (2015) .

Additionally, boundary plantings can provide farmers with valuable non-timber forest products such as fruits, nuts, firewood, medicinal plants, and timber. According to Mimura *et al.* (2013), these products can be sold in local markets, providing additional income streams for farmers. Boundary plantings and live fences also enhance land tenure security by clearly demarcating property lines, reducing disputes and fostering a sense of ownership and responsibility toward land management. Furthermore, the presence of live fences can improve the aesthetic value of agricultural land, which may increase its desirability for tourism or eco-friendly agricultural enterprises.

2.2.5.3. Challenges and Limitations of Boundary Planting and Live Fences

While boundary plantings and live fences offer many advantages, they also face several challenges and limitations. One of the main challenges is maintenance: live fences require ongoing care, such as pruning, watering, and sometimes replacing plants that fail to grow. (Stover *et al.* 2014) suggest that the maintenance of live fences can be labor-intensive, and if farmers do not have sufficient knowledge or resources, these systems may not thrive. Another challenge is the initial investment required to establish boundary plantings and live fences.

While the benefits can be long-term, farmers may be reluctant to invest in planting trees or shrubs due to the upfront costs, especially in regions where land access is uncertain or where immediate returns are necessary.) note that the success of these systems depends heavily on the species selection and the specific environmental conditions, as the wrong species may fail to thrive, leading to reduced effectiveness in terms of erosion control and productivity(Puri and Kaphle ,2017. Additionally, invasive species can sometimes be a problem, especially if non-native plants are used for live fences, as these can compete with native vegetation and negatively impact biodiversity.

2.2.6. Trees on Erosion Control

Trees contribute significantly to erosion control by providing cover for the soil and enhancing water infiltration. Their root systems bind the soil, preventing its movement due to wind or water. Trees also reduce the velocity of surface water runoff, which helps prevent soil loss (Shrestha, A., *et al.* 2007). Research by Gichuki *et al.* (2004) showed that the presence of tree cover significantly reduces soil erosion rates, particularly in areas with high rainfall and steep slopes .

In this practice, the trees and other shrubs serve first to stabilize the earth structures and second to make productive use of land e.g. fruit, fodder, or fuel wood. Trees are functional on the erosion control through; reducing the velocity of runoff, interception process, obstructing the speed and amount of runoff and increasing rooting system of the infiltration capacity of the soil. Reducing wind speeds helps substantially in preventing wind erosion, and the damage it causes (chepil, 2015). This includes both damage due to the loss of nutrient-rich top soil, and damage, as a result of physical injury to crops and livestock, or the partial burial of fields.

2.3. Agroforestry and the Use of Sloping Lands

Agroforestry on sloping lands is an essential practice for sustainable land management, particularly in regions prone to erosion, such as mountainous or hilly terrains. The combination of trees and crops or livestock in agroforestry systems on slopes not only optimizes land use but also contributes to soil conservation, water management, and biodiversity enhancement.(Nair ,2018) explains that sloping lands are highly susceptible to erosion due to surface runoff and the detachment of soil particles caused by rainfall and wind. It is recognized that sloping lands

meaning areas dominated by moderate and steep slopes form a distinct and wide spread type of typical environment with spatial problems. The introduction of agroforestry practices may provide a solution to the dilemma of agroforestry practices implied by the existence of a high erosion hazard under conventional arable farming on slopping land together with the fact that large of areas of such land are already by under arable use and must remain so; certain practices including barrier hedges, hedgerow inter cropping and multistory tree gardens have the potential to permit arable cropping on slopping land coupled with adequate soil and water conservation leading to sustainable productive use (siderius,2016).

2.4. Soil and Water Conservation

Soil and water conservation (SWC) practices are diverse and include measures such as contour farming, terracing, cover cropping, and agroforestry. Among these, agroforestry, which integrates trees and shrubs into agricultural systems, has shown considerable promise in promoting soil and water conservation. (SWC) is essential for maintaining agricultural productivity, protecting water resources, and ensuring environmental sustainability.

Globally, SWC has become a key aspect of sustainable land management in both developed and developing countries, especially in regions with steep terrains, arid climates, and regions prone to flooding (Kessler, J. J., & Vandenberg, L. 2007. Soil erosion, water scarcity, and declining soil fertility have led to the growing recognition of SWC's significance (Lal, 2004). Studies emphasize the critical need to balance agricultural demands with the preservation of soil and water resources to maintain ecosystem health and human livelihoods (Pimentel *et al.*, 2018).

Soil and water conservation is a broader field since reduction in water loss through run of is an integral part of the soil conservation in turn soil and water conservation form part of the wider aim of the conservation of natural resources, which covers also a conservation of other resources including vegetation (forests, pastures) and also wild life (young,2018).The benefit of agroforestry practice (e.g. coffee and cacao) shade tree include reduced soil erosion as natural litter fall or pruning residues cover the soil and reduces the impact of rain drops, improve soil structure increase soil nitrogen content and enhance nutrient retention (Beer, J., & Fassbender, H 2017).

3. MATERIAL AND METHODOLOGY

3.1. Description of the study area

The study was conducted in yeferezye kebele , which one of the kebele is found in Cheha Woreda , Gurage Zone , Central Ethiopia .

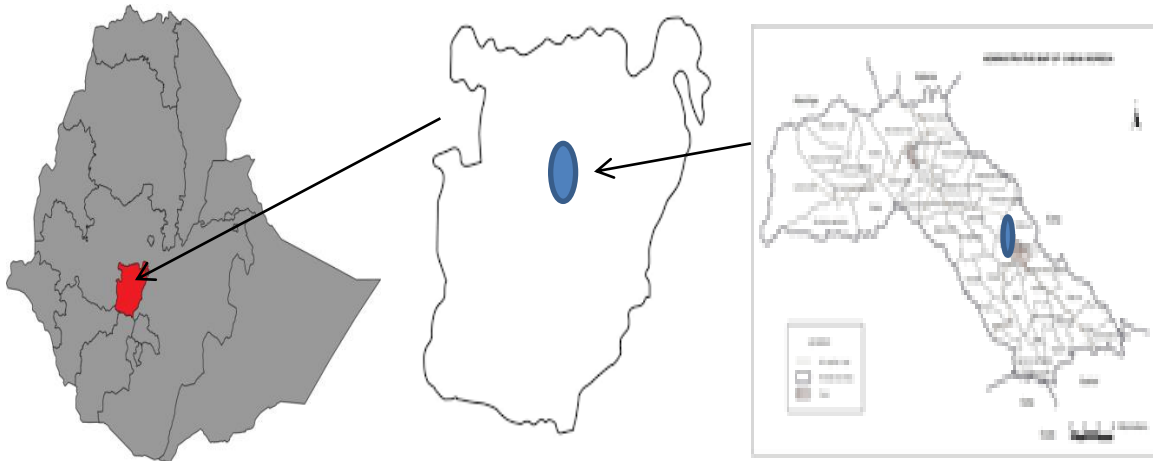


Fig 3. Map of Central Ethiopia , Gurage zone (B), Cheha woreda in Gurage zone (C), Map of Cheha woreda- the study area

3.1.1. Location of the area

Yeferezye Kebele is one of the administrative units within Cheha Woreda, located in the Gurage Zone of central Ethiopia. Cheha Woreda is situated approximately 185 kilometers southwest of Addis Ababa and about 32 kilometers from Wolkite, the administrative center of the Gurage Zone.

3.1. 2. Climate condition

The climate of Yeferezye Kebele and the surrounding Cheha Woreda is classified as tropical monsoon, with distinct wet and dry seasons. The area receives moderate to high rainfall, with the rainy season typically occurring from June to September. The annual rainfall ranges between 800 mm and 1,400 mm, making it suitable for crop cultivation and The temperature is generally

moderate, with average temperatures ranging from 18°C to 26°C. The cooler highland areas tend to have more temperate conditions, while the lowlands can experience higher temperatures (Cheha woreda Agricultural office 2007 E.C).

3.1.3. Topography

The topography of Yeferezye Kebele is characterized by hilly and mountainous terrain, typical of the Gurage Zone. The region's elevation ranges from 1,500 meters to 3,000 meters above sea level, giving it a mixture of highland and midland characteristics. The highland areas offer fertile land, ideal for growing a wide range of crops, including cereals and vegetables and The valleys in between the hills support agricultural activities as well, although the lowland areas can experience more challenging conditions due to water scarcity during the dry season (Cheha woreda Agricultural office 2007 E.C) .

3.1.4. Soil Types

The soil in yeferezye kebele are predominantly clay and silt in texture . The major soil type found in the yeferezye kebele are vertsoil . The fertility status of the soil ranges from high to low, but has limitation due to susceptibility to water erosion .

3.1.5. Population.

According to the Cheha woreda Agricultural office report from 2007, the total population of Cheha Woreda is 163307, of which 79788 are men and 83519 are women.

The total population of the study area is 6230 from this 4110 is male and 2120 is females and 890 households, from these 243 females and 647 males (Cheha woreda Agricultural office 2007 E.C.)

3.1.6. Land Use and Farming System.

The land use and farming system in Yeferezye Kebele are primarily centered around subsistence agriculture, with a strong reliance on mixed crop and livestock farming. The land use and

farming system in Yeferezye Kebele focus on subsistence agriculture, complemented by livestock rearing and agroforestry practices.

3.1.7. Vegetation and crops

The farming system in Yeferezye Kebele is predominantly subsistence agriculture, with a focus on food security and crop diversification. The primary crops grown in the kebele are well-suited to the area's climate, elevation, and soil types. Crop type in the study area includes the main species are Cereal Crops (Maize, Wheat, Barley) Legumes (Beans, Lentils, Chickpeas) Root Crops (Sweet Potatoes, Potatoes) Vegetables(Cabbage, Onions, Tomatoes) and Enset are more dominant in the area.

3.2. Methods

3.2.1. Source of data and Collection

Primary data were collected from local community, and through field observations. Structured and Semi-Structured Questionnaires after pre-tested for validity and reliability were used for collecting primary data. Interviews were also conducted with key informants including local community, and local administrators. Additionally, field observation was used as a primary method to collect data focusing on signs of Agroforestry Practices in SWC. This study also employed a secondary data analysis approach. The secondary data were obtained from published materials such as government reports, peer-reviewed journals, and alongside unpublished local administrative documents.

3.2.3. Sampling Size and Techniques

The households from study area was selected by random sampling methods. The questionnaire survey was conducted in yeferezye Kebele, Cheha Woreda of Gurage zone. Purposely yeferezye Kebele was selected due to the sever Agroforestry practice and contribution in SWC.

3.2.3.1. Determining Sampling Size

This study adopted select simple randomly sampling procedure where samples of n private households are selected by using the formula developed by (Yamane's formula ,1967). The reason for selecting simple random sampling method was the fact that the yeferezye kebele has above 80% homogeneous population Yamane's formula ($n = \frac{N}{1 + N(e)^2}$) was employed to determine a sample size.

The total population of yeferezye kebele is 6230 , with 890 households. Using the Yamane formula:

$$S = \frac{N}{1 + N(e)^2}$$

The calculated sample size is:

$$S = \frac{890}{1 + 890(0.1)^2} \approx 89$$

Where:-

S=sample size

N=total number of households

l=probability of event occurring

e=maximum variability margin f error

Due to time and budget constraints, we adjusted our original sample size of 100 households downward to 89 households for the study.

3.3. Data Analysis

After the data was collected from different sources, both quantitative and qualitative data were used for analysis. The qualitative data obtained from semi-structured interviews after substantial validations were presented in the form of statements and supported by arguments. The quantitative data were organized and presented in tables and figures. Descriptive statistics such as mean and percentages were used to summarize participant demographics. Quantitative data were also analyzed using SPSS software. Finally, conclusions and recommendations were forwarded based on the findings.

4. RESULT AND DISCUSSION

This chapter include the results and discussions part of the study clearly shows the overall findings of the study in different sections. The section briefly describes the result of each session throughout the chapter.

4.1. Socio- Demographic Features of the Respondent

4.1.1. Age of respondent

Table 4.1 : Sex and age of respondent

No.	Age range	Sex		Total	Percent (%)
		Male	Female		
1	21-28	12	8	20	22.47
2	29-39	12	7	19	21.34
3	40-50	8	9	17	19.1
4	51-61	9	7	16	18
5	>61	12	5	17	19.1
Total		53	36	89	100%

Source: field Survey 2025

As indicated on Table 4.1 provides a comprehensive of the respondents' age and sex distribution. With a total of 89 respondents, comprising 53 males (59.55%) and 36 females (40.45%), the data indicates a slight male predominance. This gender distribution is significant

as it may influence the adoption and implementation of agroforestry techniques, which are crucial for enhancing environmental sustainability.

The highest representation is found in the 21-28 age group, where 20 respondents (22.47%) participate. Engaging younger individuals in agroforestry practices is essential, as they are often more open to adopting innovative techniques and sustainable practices. Kumar and Nair (2004) emphasize that involving youth in agricultural initiatives can lead to enhanced productivity and more effective conservation efforts. This demographic's engagement is vital for ensuring the long-term sustainability of agroforestry systems, as they are likely to become the next generation of farmers and land stewards.

In the 29-39 age group, there are 19 respondents (21.34%), further reflecting strong participation among young adults. This group is particularly important for implementing changes in agricultural practices, as they tend to be more open to new technologies and approaches that prioritize sustainability. Ong *et al.* (2015) suggest that younger farmers are more likely to be tech-savvy, making them well-suited to integrate modern agroforestry practices that contribute to SWC.

The 40-50 age group includes 17 respondents (19.1%), with a balanced representation of males (8) and females (9). The slight female majority in this group is notable, as women's involvement in agroforestry has been linked to improved environmental outcomes and enhanced community resilience. Doss (2018) argues that empowering women in agriculture leads to better resource management and greater biodiversity, both of which are essential for effective soil and water conservation.

In the 51-61 age group, 16 respondents (18%) participate, with a slightly higher proportion of males. The participation of this demographic is valuable, as they often possess significant experience and knowledge of traditional practices that can complement modern agroforestry techniques. However, as this group ages, it is crucial to ensure that their knowledge is transferred to younger generations to maintain continuity in sustainable practices and The > 61 age group shows a decline in participation, with 17 respondents (19.1%), and a notably lower representation of females. This decline suggests that older farmers face physical limitations that affect their ability to engage in labor-intensive agricultural practices.

4.1.2. The age factor on the influence of farmer`s perception and type of AF practice.

Table 4.2 :the age factor on the influence of farmer`s perception and type of AF practice

Age distribution	Perception`s on AF practice	Major AF practiced
20-30	good	Home garden, tree on crop lands, live fencing and combination of more than three practices with the common crops
30-40	Very good	Home garden, tree on crop lands shifting cultivation, silvopastoral and combination of more than three practices.
40-50	Excellent	Boundary planting, lives fencing, alley cropping and combination more than three practices.
>50	Very excellent	Boundary planting, shifting cultivation, improved fallows and combination of more than three practice

Source: field Survey 2025

As indicated on the table 4. 2 the farmers had good perception on AF practices, Younger farmers (20-30 years) have a good perception of agroforestry and typically practice smaller-scale and less complex systems like home gardens and live fencing. Farmers aged 30-40 tend to have a very good perception and adopt more diverse agroforestry systems, including practices like silvopastoral systems and shifting cultivation. As farmers enter the 40-50 and 50+ age groups, their perception of agroforestry becomes excellent or even very excellent, and they are more likely to implement complex agroforestry systems like boundary planting, alley cropping, and improved fallows. This trend reflects a broader understanding of agroecological principles and a growing confidence in the long-term benefits of these practices. According to Zomer *et al.* (2016) reinforce this, indicating that experienced farmers often have more substantial networks and resources, allowing them to adopt and adapt complex systems more readily.

4.1.3. Education level of the respondents

In this study area population are categorized in different education levels

Table 4.3: Educational level of the respondents

Education status	No of respondents	%
Cannot able to read and writ	29	32.58
Can able to read and write	23	25.8
Elementary school	6	6.7
College or university	11	12.4
High school	20	22.5
Total	89	100

Source: field Survey 2025

The above table shows that out of 89 respondents, a significant portion—29 respondents (32.58%)—are illiterate, This group may rely heavily on oral communication, local knowledge, and traditional farming practices This indicates that over half (58.38%) of the respondents have low educational levels, which may limit their access to written agricultural information and new technologies , About 23 respondents (25.8%) they can read and write, but likely without having completed formal schooling. These individuals may have functional literacy that allows them to understand basic written instructions or signage, but they may still face challenges in interpreting complex technical information, A considerable number of respondents, 20 individuals (22.5%), have attained a high school education. These individuals likely possess better cognitive skills, are more exposed to new ideas, and are generally more open to adopting new agricultural innovations, including agroforestry. According to Khan *et al.* (2020), individuals with higher levels of education tend to be more open to innovation an essential trait for the successful adoption of agroforestry practices. Their enhanced cognitive abilities and critical thinking skills often position them as community leaders in introducing and promoting new agricultural techniques and technologies, Only 6 respondents (6.7%) have completed elementary school and Finally, 11 respondents (12.4%) have received college or university education. According to

Singh (2019) reinforces the notion that higher education fosters a deeper understanding of scientific concepts, enabling individuals to apply research findings effectively in agricultural contexts. This group is likely best equipped to understand and apply scientific agroforestry practices. They can act as a bridge between traditional methods and modern techniques, facilitating knowledge transfer and promoting the adoption of sustainable practices among less educated community members.

4.1.4. Farmer’s Attitude towards Agroforestry practice

Table 4.4: farmers’ attitude towards Agroforestry practice

No_	Attitude	No. of respondent	Percentage
1	Negative	61	68.5
2	Positive	22	24.7
3	No response	6	6.7
Total		89	100

Source: field Survey 2025

As shown Table 4.4 reveals that a significant majority of respondents—approximately 68.5%—hold negative attitudes toward agroforestry practices, while only 24.7% express a positive perspective. This notable disparity underscores the need to explore the underlying factors shaping farmers' perceptions and the potential obstacles hindering the adoption of agroforestry.

One likely reason for the predominance of negative attitudes is a limited awareness or understanding of the benefits agroforestry can offer. Kumar and Nair (2004) point out that misconceptions—such as fears of reduced crop yields or increased labor requirements often contribute to resistance among farmers. These misunderstandings can create significant barriers to the uptake of agroforestry, despite its proven advantages in enhancing biodiversity, improving soil health, and building resilience against climate change.

4.1.5. Occupation of the respondent

Table 4. 5: Occupation of the respondent

Occupation	No. of respondents	Percentage
Crop cultivation	58	65.16
Livestock rearing	11	12.35
Government employee	12	13.48
Labor worker	8	8.98
Total	89	100

Source: field Survey 2025

As shown in Table 4.5 indicates that a significant majority of respondents—approximately 65.16%—are primarily engaged in crop cultivation. This suggests that crop farming is the dominant livelihood activity in the study area. A smaller proportion of respondents are involved in livestock rearing (12.35%), labor work (8.98%), and a minority are government employees (13.48%).

This occupational distribution reflects a strong dependence on agriculture, particularly crop cultivation, as the main source of income and subsistence for the rural population. According to Ellis (2000), rural households in developing countries often rely heavily on farming, especially crop production, due to limited access to diversified income sources and employment opportunities. This over-reliance on crop farming can make communities more vulnerable to risks such as climate variability, soil degradation, and market fluctuations.

4.1.6. Observed Agroforestry practice in SWC in study Area

Table 4. 6 : Observed Agroforestry practice in SWC

Agroforestry practice in SWC	No. of respondent	Percentage
Yes	74	83.14
No	9	10.11
Not sure	6	6.74
Total	89	100

Source: field Survey 2025

As shown in Table 4.6 indicates that a significant majority of respondents, approximately 83.14%, report the presence of agroforestry practices in soil and water conservation (SWC) within their area. In contrast, only 10.11% of respondents assert that there are no observed agroforestry practices, while 6.74% remain uncertain. This widespread acknowledgment of agroforestry practices suggests a strong integration of these methods into local agricultural systems.

According to Schroth *et al.* (2004), who highlight agroforestry's crucial role in enhancing soil and water conservation. By integrating trees with crops, agroforestry systems can improve soil structure, increase organic matter, and enhance water retention, ultimately fostering more sustainable agricultural practices. The widespread recognition of these benefits among the majority of respondents indicates that the community is well aware of the positive environmental impact of agroforestry.

4.1.7. The Existing Traditional AF Practice

Table 4.7: the existing Traditional AF practices

Type of AF practice	No Respondents	Percentage (%)
Home garden	9	10.11
Boundary planting	7	7.86
Live fencing	10	11.23
Trees on crop land	11	12.35
Trees on conservation structures	12	13.48
Trees on conservation structure + trees on crop land,	7	11.9
Home garden +Boundary planting +tree on crop land	5	5.67
Boundary planting +trees on crop land	5	5.67
Combination of above three types of practice with the incorporation (sum) of common crops (sorghum, barley, and maize).	7	7.86
Shifting cultivation	8	8.98
Alley cropping and improved fallows	8	8.89
Total	89	100

Source: field Survey 2025

As shown in Table 4.7, the study area exhibits a variety of traditional agroforestry (AF) practices, reflecting the community's diverse approaches to integrating trees and crops. The most prevalent practices include trees on conservation structures (13.48%), trees on cropland (12.35%), and live fencing (11.23%), which represent a blend of traditional knowledge and strategies aimed at improving both productivity and sustainability. The inclusion of home gardens as a traditional agroforestry practice (10.11%) is particularly significant. These systems offer multiple benefits, such as enhancing food security, biodiversity, and income generation. Boundary planting and live fencing are also common, with 7.86% and 11.23% of respondents, respectively, reporting their use. These methods serve dual purposes: marking property boundaries while simultaneously providing ecological benefits, such as creating wildlife habitats and improving microclimates for crops.

The combination of various practices, such as trees on conservation structures and trees on cropland, reflects the community's adaptive strategies to local environmental conditions. This aligns with findings from Ong *et al.* (2015), who highlight that integrating trees with crops can improve soil health and water retention, ultimately leading to increased agricultural productivity. Kumar and Nair *et al.* (2004) note that boundary plantings can help enhance soil fertility and reduce erosion, which is crucial for sustainable land management.

Overall, the study area showcases a variety of traditional agroforestry practices, with the most common being trees on conservation structures, trees on cropland, and live fencing. These practices reflect a mix of traditional knowledge aimed at enhancing agricultural productivity and sustainability. Home gardens, boundary plantings, and live fencing contribute to food security, biodiversity, and improved microclimates. However, more complex practices like alley cropping and improved fallows are less widely adopted, likely due to limited understanding or perceived benefits. Promoting education and awareness about these systems could help increase their adoption and effectiveness, fostering greater environmental and agricultural resilience.

4.2. Farmers perception on Uses of AF practices for SWC

Table 4.8: Perception of farmers on contribution of AF to SWC and other uses

no	Contribution of AF practices	No of respondents	% of respondents
1	For source of fuel wood and animal forage	7	7.86
2	For SWC by increasing soil physical property, reducing rain drop energy, by mulching and bring moisture from deep.	14	15.73
3	Increasing soil fertility and productivity	9	10.1
4	sources of agricultural equipment and other materials	11	12.35
5	Protection fields from free grazing	8	8.98
6	For SWC by improving soils physical property, sources of fuel wood and forage	12	13.48
7	to maintain the climatic condition of the field	12	13.48
8	to protect from sun light (Sources of shade	8	8.98
9	to save land (to produce two or more species on a piece of land	8	8.98
	Total	89	100

Source: field Survey 2025

As shown in Table 4.8, farmers' perceptions of the contributions of agroforestry (AF) practices to soil and water conservation (SWC) and other uses highlight their multifaceted value. Notably, 15.73% of respondents recognize that agroforestry practices contribute to SWC by improving soil physical properties, reducing raindrop energy, and enhancing moisture retention through

mulching. This understanding underscores the crucial role that trees play in maintaining soil health and conserving water.

The perception that agroforestry enhances soil fertility is supported by 13.48% of respondents who acknowledge its role in improving soil properties, while also providing fuel wood and forage. Lal (2004) indicates that trees contribute organic matter and nutrients to the soil, which in turn improves soil structure and water retention.

Additionally, 12.35% of respondents view agroforestry as a source of agricultural equipment and materials, highlighting its economic value. This perspective is important as it shows that agroforestry not only offers ecological benefits but also provides tangible resources that can support farmers' livelihoods. Schroth *et al.* (2004) note that agroforestry systems can produce a diverse range of products, contributing to income stability and encouraging greater investment in sustainable agricultural practices.

Moreover, the recognition of agroforestry's role in protecting fields from free grazing (8.98%) and maintaining favorable climatic conditions (13.48%) further emphasizes its significance in enhancing agricultural resilience. By providing shade and shelter, trees help mitigate temperature extremes and protect crops, which is especially crucial in the face of changing climatic conditions.

The farmers' perceptions of agroforestry's contributions to soil and water conservation reflect an understanding of both its ecological and economic benefits. By improving soil fertility, enhancing water retention, and providing additional resources, agroforestry practices play a vital role in promoting sustainable agriculture. Increasing awareness and providing education about the diverse benefits of agroforestry can encourage wider adoption, leading to improved agricultural resilience and environmental health. Engaging farmers in training programs that showcase successful agroforestry examples can facilitate the broader implementation of these valuable practices.

4.3. Advantage of AF for SWC

AF practices conserves soil and water by their nature because of their ability to anchor soil by their root branches and reducing water losses, increasing infiltration, by adding OM to the soil. It have ability to reducing erosion, reduce the kinetic energy of rain drops by their canopy adding residues to the soil and gives mulching service, bring water from deep soil, they also protect the field condition and reduce wind erosion with their steams, roots and leaves based on the respondents reaction.

Table 4. 9: the advantage AF practice for SWC with respect of plant part.

PP	Function on SWC	No of respondents	%
Leave	As source of OM, mulching reduce kinetic energy of rain drop, protect wind erosion etc and finally conserve soil and water.	36	40.44
Root	Anchored soil by their roots, bring water from deep soil, obstacles for erosion.	30	33.7
Stem	Reduce the erosive power of wind energy, gives rise to the canopy that reduces the kinetic energy of rain drops, and Consequently reduce splash and sheet erosion on the field.	23	25.84
total		89	100

Source: field Survey 2025

Table 4.9 presents farmers' perceptions regarding the contributions of different plant parts in agroforestry (AF) practices to soil and water conservation (SWC). The data reveals that 40.44% of respondents recognize the significant role of leaves in conserving soil and water. This understanding highlights the multifaceted benefits of leaves, which include reducing the kinetic energy of raindrops, protecting against wind erosion, and contributing organic matter to the soil through decomposition. Lal (2004) notes that leave litter can enhance soil fertility and moisture retention, ultimately improving soil structure. By providing a protective layer on the soil surface, leaves also help to prevent erosion and water loss. The role of roots in SWC is also recognized by 33.7% of respondents, who highlight their function in anchoring soil, accessing deep moisture, and serving as barriers to erosion. Roots play a crucial role in maintaining soil

structure and stability. According to Kumar and Nair (2004), deep-rooted trees can improve soil permeability and water infiltration, thereby enhancing the overall hydrological balance of the ecosystem. This capability is vital for resilience in agricultural systems, especially in areas prone to drought or heavy rainfall.

Additionally, 25.84% of respondents acknowledge the importance of stems in SWC. Stems contribute by reducing wind energy and creating a canopy that lessens the impact of raindrops on the soil. This is consistent with findings from Schroth *et al.* (2004), which suggest that tree canopies can effectively reduce soil erosion by minimizing splash and sheet erosion, thereby protecting the soil from degradation.

the perceptions of farmers regarding the advantages of different plant parts in agroforestry practices for soil and water conservation highlight a strong understanding of the ecological benefits provided by leaves, roots, and stems. By reducing erosion, enhancing soil fertility, and improving water retention, these plant parts play crucial roles in promoting sustainable agricultural practices. To further enhance these benefits, educational initiatives that emphasize the importance of these plant structures and their functions should be implemented. Such efforts can help farmers maximize the potential of agroforestry systems, ultimately leading to improved environmental resilience and agricultural productivity.

4.4.Land Holding and Characterization of Land Uses

The primary land use in Yeferezye Kebele centers around agroforestry systems, notably enset-based farming, which is integral to the local diet and economy. The survey results of this study indicated that Enset (*Enset ventricosum*), along with coffee and chat (*Catha edulis*), forms the backbone of homestead agroforestry practices. These systems are complemented by the cultivation of root crops like , cereals such as maize and teff, and fruits including banana, citrus, papaya, mango, and avocado. Additionally, livestock farming contributes significantly to the local economy, with cattle, sheep, and goats being common. Agroforestry practices also include the cultivation of eucalyptus for timber and fuelwood, which has been increasingly adopted.

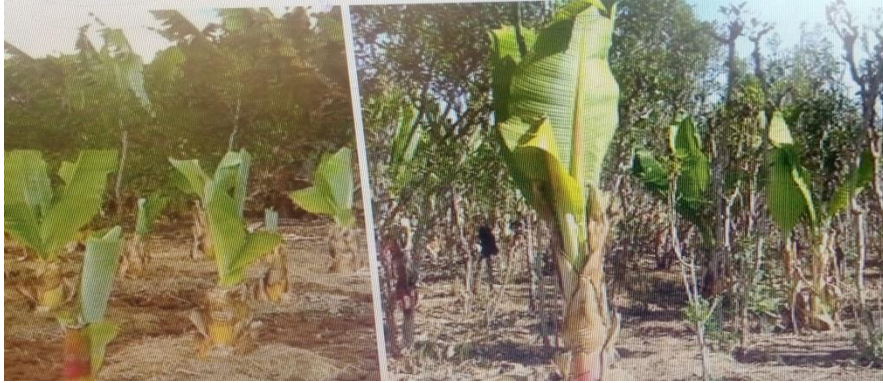


Fig 4.2. Enset, Chat, fruit tree based homesteads at different maturities in the study area

Landholding sizes in Yeferezye Kebele vary, with average holdings ranging from 0.5 to 3.15 hectares per household. A study indicated that, on average, households possess 3.15 hectares of land, with approximately 1.3 hectares dedicated to crop production, 1.3 hectares to crop farming, which includes the cultivation of enset, cereals (such as maize), and root crops and 1.31 hectares allocated for livestock feed, including grazing and forage production .

4.4.Tree Planting Purposes

In the study area trees are planted for various purposes. The survey results indicated that farmers plant trees and shrubs mainly for household consumption of products, source of construction material, cash income, shade and for soil and water conservation. Of all the various uses mentioned household consumption, ash income and construction in their decreasing order were found out to be the most predominant purposes mentioned for planting of trees by respondents .

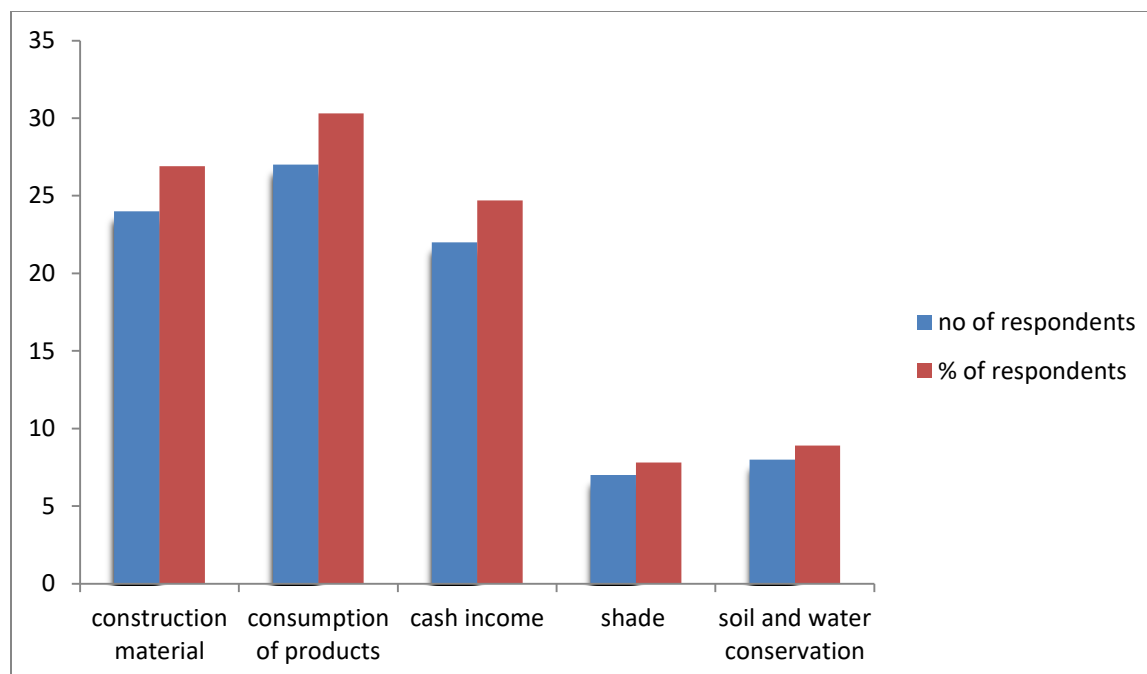


Fig 4.3. Characterization of tree planting purposes

As shown in figure the responses from participants highlighted various reasons for planting trees and shrubs in homegarden systems. The most common purpose cited was for the consumption of products such as fruits, leaves, or other usable parts, with 27 respondents (30.3%) indicating this reason. This was followed closely by construction material, selected by 24 respondents (26.9%), and cash income, which was a priority for 22 respondents (24.7%). A smaller proportion of respondents identified shade (7 respondents, 7.8%) and soil and water conservation (8 respondents, 8.9%) as their main motivations for planting trees.

4.5. Problems that hinders the extent of agro-forestry practices

Due to lack of management trees have direct adverse effect on soil, which results to decrease soil productivity by; the loss of organic matter and nutrients during tree harvesting. When mature trees are removed, they often take away substantial amounts of nutrients stored in their biomass, potentially reducing soil fertility if not managed properly. Additionally, competition for nutrients and moisture between trees and crops can negatively affect crop yields, particularly in systems where resource availability is limited or poorly balanced.

Another key limitation is the long gestation period of trees, which may take years or even decades to mature and provide tangible returns. For smallholder farmers who depend on short-

term crop yields for daily income, this delayed benefit poses a significant economic challenge. Furthermore, managing an agroforestry system is inherently complex, as it involves coordinating the growth cycles and needs of trees, crops, and possibly livestock. This level of integration requires specific knowledge and skill, making it more complicated than traditional monoculture farming.

Financial barriers also limit adoption. Agroforestry systems often require upfront investments in planting materials, tools, fencing, and technical knowledge. Unfortunately, many smallholder farmers lack access to affordable credit or financial support, which makes it difficult for them to invest in such long-term practices. Lack of awareness and technical know-how further compounds the issue. Many farmers are unfamiliar with how to effectively design and manage agroforestry systems or how such systems can enhance both productivity and ecological health.

An additional biological challenge involves the allelopathic effects of certain tree species, such as eucalyptus. These trees can release chemicals through their roots or fallen leaves that inhibit the germination and growth of nearby plants, reducing the productivity of understory crops. Lastly, even when farmers successfully implement agroforestry practices, they may struggle with underdeveloped markets for agroforestry products. The limited demand and infrastructure for selling timber, fruits, nuts, or medicinal plants can make it difficult for farmers to realize economic gains from their investment in agroforestry.

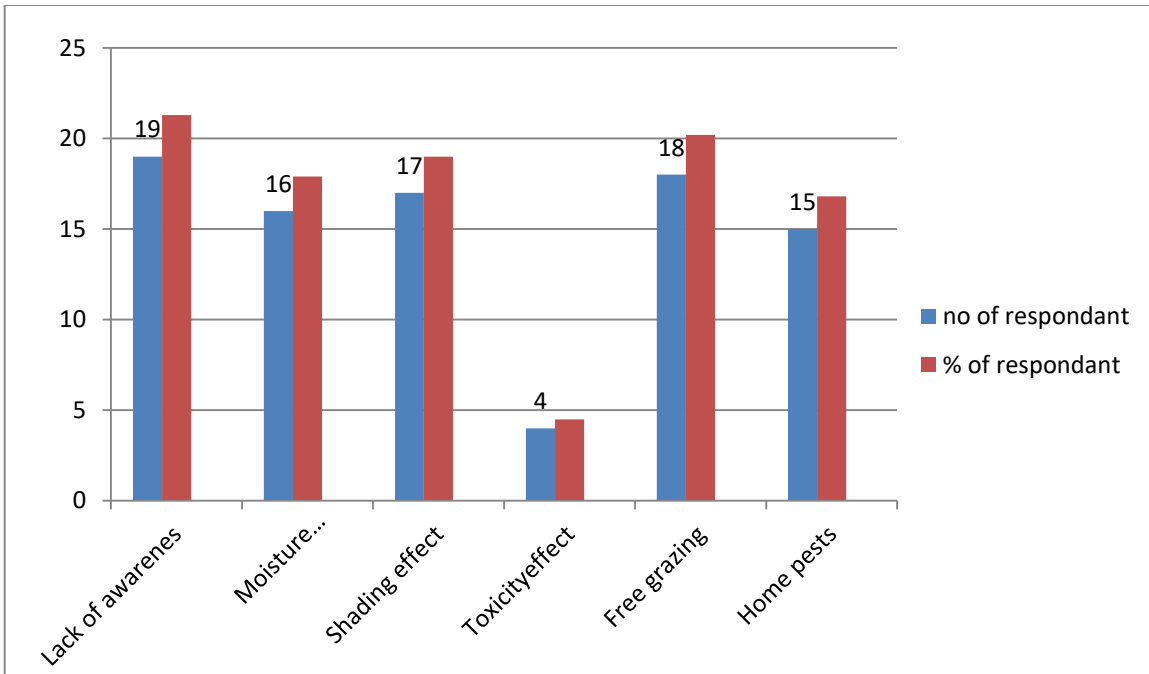


Fig4.4. Main problems that hinder AF practices

As shown In figure, the challenges depicted in the figure have hindered the adoption of agroforestry (AF) practices. These issues stem from various factors, with the most common problems are lack of awareness 19 (21.3%) of respondents identified as a primary barrier. The second most significant obstacle was free grazing, reported by 18 (20.22%) respondents. Other challenges included toxicity (4.49%) and home pests (16.8%). Additionally, 17 (19%) and 16 (17.9%) respondents pointed to shading effects and moisture scarcity as major hindrances to AF practices.

While these difficulties were acknowledged, it is important to note that the lack of technical training emerged as a critical issue. Despite understanding the challenges, many farmers may not know the best ways to address them. The lack of awareness is particularly concerning, as it suggests that many farmers may not fully recognize the potential benefits of agroforestry for soil and water conservation, biodiversity, and overall productivity. Schroth *et al.* (2004) emphasize that increasing awareness and knowledge about agroforestry systems is essential for their successful adoption. Without sufficient information, farmers may hesitate to implement practices that could improve their livelihoods and environmental sustainability.

Free grazing is another significant challenge affecting the viability of agroforestry systems. Uncontrolled grazing can damage young trees and prevent the establishment of beneficial vegetation. This can lead to soil degradation and reduced plant diversity, ultimately undermining the ecological benefits that agroforestry systems aim to provide. Effective livestock management is, therefore, essential for protecting agroforestry initiatives.

Although less frequently reported, issues like toxicity and home pests also pose serious concerns. Pests can damage both crops and trees, negatively affecting yields and discouraging farmers from investing in agroforestry practices. This highlights the need for integrated pest management strategies to mitigate these risks.

The challenges hindering agroforestry practices in the study area are multifaceted, arising from a lack of awareness, free grazing, pest problems, and environmental factors such as shading and moisture scarcity. Addressing these challenges requires a comprehensive approach that includes education on the benefits of agroforestry, improved livestock management, and effective pest control strategies. By equipping farmers with the necessary knowledge and tools, the adoption of agroforestry can be significantly improved, leading to enhanced environmental sustainability and agricultural productivity.

4.6. Mechanisms to make the best AF practices.

Table 4.10: Best solutions for the problems of AF practice that was found from respondents.

Parameter	No of respondent	% of respondent
Awareness raising	34	38.2
Experience sharing	25	28
Introduce better technology	17	19
Finding alternative water source	23	14.6
Total	89	100

Source: field Survey 2025

As shown in the Table 4.11 to improve the AF practices in the area, 38.2% of the respondents said that; giving awareness was the best alternative; 28.% of them said, through experience sharing ; 19.% of them said, through introduce better technology ; and 14.6% of them also said, through finding alternative water source were the best methods to develop AF practices as the researcher asked them about their perceptions' on agro forestry practice and they had putted their answers voluntarily, that was why the respondents have good perception on agro forestry practice.

4.6.1. Best options to make the best AF practices

To address the challenges facing agroforestry (AF) practices in Cheha Woreda, Yeferezye Kebele, Gurage Zone, it is essential to implement strategies that prioritize farmer education and awareness. Educational initiatives can empower farmers by providing them with knowledge about the benefits of agroforestry, such as improved soil health, enhanced biodiversity, and water conservation. According to Kumar and Nair (2004) emphasize that effective education programs are crucial for the successful adoption of agroforestry systems. By understanding these benefits, farmers are more likely to embrace AF practices, leading to increased productivity on their land.

The integration of modern technologies into agroforestry systems can further improve their effectiveness and sustainability. Techniques such as precision agriculture, soil moisture

monitoring, and advanced irrigation methods can optimize resource use, leading to increased productivity. Ong *et al.*(2015) note that combining modern technologies with traditional practices can create more resilient agricultural systems. This synergy not only maximizes yields but also promotes sustainable land management, essential for long-term agricultural viability.

To combat moisture scarcity—a significant barrier to successful agroforestry finding alternative water sources is crucial. Implementing rainwater harvesting systems, promoting groundwater recharge, and utilizing drought-resistant crops are effective solutions to ensure an adequate water supply. Lal (2004) advocates for integrated approaches to water management, which can enhance water availability and support agroforestry initiatives.

Addressing free grazing through sustainable livestock management is also vital for protecting agroforestry systems. Implementing controlled grazing practices and establishing designated grazing areas can help prevent damage to young trees and promote healthy growth. Kumar and Nair (2004) suggest that integrating livestock management with agroforestry can optimize land use and enhance overall productivity, creating a more sustainable agricultural environment.

The existing problems were expected to be solved by using the alternatives because if the farmers aware of about the AF practices and their management technologies as well as the productive increase ability of those practices on a plot of land; and also if there was wide experience sharing in association to finding alternative water sources they could introduce the modern technologies of using AF practices, then the extent of AF practices, increased and then the income source as well as soil and water conservation was increased.

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

In the study area, traditional agroforestry (AF) practices are widely observed, with common systems including home gardens, boundary planting, trees integrated into soil conservation structures, and combinations of three or more AF practices alongside common crops. Traditional methods such as alley cropping, shifting cultivation, and improved fallows are also practiced. The study confirms that agroforestry is a viable land management strategy, offering significant benefits to both the environment and local farmers by enhancing soil quality, improving water infiltration, reducing surface runoff, and helping to mitigate the impacts of water scarcity.

Despite these benefits, the widespread adoption of agroforestry in the area remains limited due to several key challenges. These include a lack of technical knowledge, insecure land tenure, and insufficient policy support. While farmers generally have a positive perception of agroforestry and understand its potential contributions, their knowledge remains largely theoretical. Due to the absence of formal training or experience-sharing opportunities, most farmers have relied on personal experience rather than structured learning. As a result, they struggle to apply their awareness practically on the ground.

The major challenges hindering the expansion of agroforestry practices in the area include a lack of awareness, limited land availability, tree toxicity, damage from home pests, shading effects, moisture scarcity, and free grazing. During community discussions, participants identified key solutions such as raising awareness, facilitating experience-sharing among farmers, introducing improved technologies, and developing alternative water sources to support agroforestry systems.

5.2. Recommendation

To support the successful adoption and sustainability of agroforestry in Yeferezye Kebele, several strategic recommendations should be implemented;

- ✓ Strengthening policy support is vital to create an enabling environment for agroforestry. Local governments should formulate and enforce policies that offer financial incentives, subsidies for seedlings and tools, as well as consistent technical support.
- ✓ Increasing awareness and education is crucial for agroforestry practice on soil and water conservation
- ✓ Furthermore, there is a pressing need to increase financial and technical support for farmers. Access to affordable credit, grants, and other financial services can help farmers make the necessary investments in agroforestry.
- ✓ Agroforestry should also be integrated into broader sustainable land management practices. Combining agroforestry with techniques such as crop rotation, conservation tillage, and organic farming can enhance soil health, improve productivity, and build climate resilience.
- ✓ To ensure long-term success, it is important to enhance monitoring and evaluation systems. Regular assessment of agroforestry practices will help track progress, measure impact on soil and water conservation, and identify areas for improvement.
- ✓ Lastly, encouraging community-based agroforestry initiatives can significantly enhance participation and ownership.

By implementing these recommendations, agroforestry can be more effectively adopted in Yeferezye Kebele.

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6. Appendix (annex)

6.1. Questionnaires

This questionnaire was prepared to collect information about the farmer's perception and response towards Agroforestry practice in SWC in yeferezye kebele, Cheha Woreda, Gurage zone, central Ethiopia regional state, Ethiopia.

Respondents Name _____ Woreda _____ Kebele _____ village _____

Section A: Demographic Information

1. Sex:

- Male
- Female

2. Age:

- <20
- 21–35
- 36–40
- 41–50
- >51

3. Educational Status:

- Cannot read and write
- Can read and write
- Primary education
- Secondary education
- Higher education

4. Landholding Size:

- <0.5 ha
- 0.6–1 ha
- 1.1–1.5 ha
- 1.6–2 ha
- >2 ha

5. How many years have you been farming?

- <5 years

- 5–10 years
- 11–20 years
- >20 years

6. Do you have access to agricultural extension services?

- Yes
- No

Section A :Major Research questions

Q1. What are the types of AF Practice in this area?

- -----
- -----
- -----
- -----
- -----
- -----
- -----

Q2.List the advantages of AF practice in this Kebele

- A,-----
- B,-----
- C,-----
- D,-----
- E,-----
- F,-----

Q3. What is the function of SWC practice?

- -----
- -----
- -----
- -----
- -----

Q4, what is the function of wind break and shelter belt practice?

A, reduce wind erosion

B, to manage snow

C, improve irrigation efficiency

D, improve aesthetic value

E, provide shelter for livestock

F, all of the above

G, a and d are answers

Q5, which part of plant is most use full in SWC/

A, Leave

B, Root

C, Stem

D, All