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Research Article

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On-farm Tree Management Practices in Gondar Zuria District, Northwestern Ethiopia

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Abstract Agroforestry is a collective name for land-use systems and technologies where woody perennials are deliberately used on the same land management units as agricultural crops and/or animals via spatial sequence and arrangement. It has incredible benefits from socio-economic and environment. The study was carried out in Gondar Zuria district and the assessment was conducted to know the local people management practice on on-farm trees and the arrangement of on-farm trees on the farmer's farmland. The respondents were selected randomly and interview their experience about on-farm tree management practice and their importance for the livelihood improvement. Field assessment also conducted to visualize the arrangement and population density of on-farm trees. Excel micro soft word was used to analyze the data. On-farm scattered trees were increased as the farmers cultivated land increased and the reverse was true that on-farm trees were decreased on the small land size-holding farmers. There were limited species number of on-farm scattered trees that highly susceptible to diseases and insects and may disappear within a few times. Therefore on-farm scattered trees should be diversified by different species that good friendly relationships with cultivated crops. Moreover, the scattered tree should be well arranged on the cultivated land to be easy for cropping activities.

Keywords Agroforestry, Management practices, On-farm tree, Farmland

Introduction

The agroforestry system is an ancient practice and the farmer more recognized. It is a form of sustainable land-use systems that combine trees with crop or animal husbandry simultaneously and sequentially [1]. Agro-forestry is also a collective name for land-use systems and technologies where woody perennials are deliberately used on the same land management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In addition, it has both ecological and economical interactions between the different components [2]. An agroforestry and ecosystem-based approach to natural resource management presents itself as an effective strategy to resolve such a conflicting situation. By intercropping trees and woody perennials with crops on farms and rangelands, agroforestry diversifies and sustains production for increased socio-economic and environmental benefits for land users at all levels [3-6]. It is a common practice promoted in the world due to economic, social and environmental benefits. In addition, it is an instrument for diversifying production from a single land unit [7].

In Ethiopia, there are location-specific agroforestry practices, such as home garden, parkland and cash crop-based alley cropping agroforestry practice, and woodlots at the edge of crop fields. Furthermore, there are also fruit tree-based agroforestry practices [8]. In the drylands of northern Ethiopia, there are a number of indigenous agroforestry systems involving Agri-silvicultural, silvopastoral, and agro-silvo-pastoral systems, which have trees, shrubs, agricultural crops and livestock as components in a mixed pattern [9]. Due to its fact and incredible benefits through economic, social and environmental, almost all smallholder farmers are more

familiar with agro forestry system or agro forestry practice in Ethiopia [10-12]. Mixing trees with annual crops is an option for diversifying productions and increase the productivity of land, which in turn helps the farmer to overcome the crop failure due to climate change [13-14]. The economic feasibility of agro forestry and small-scale plantations, as well as their livelihood benefits, can be increased by their engagement in the carbon market [15].

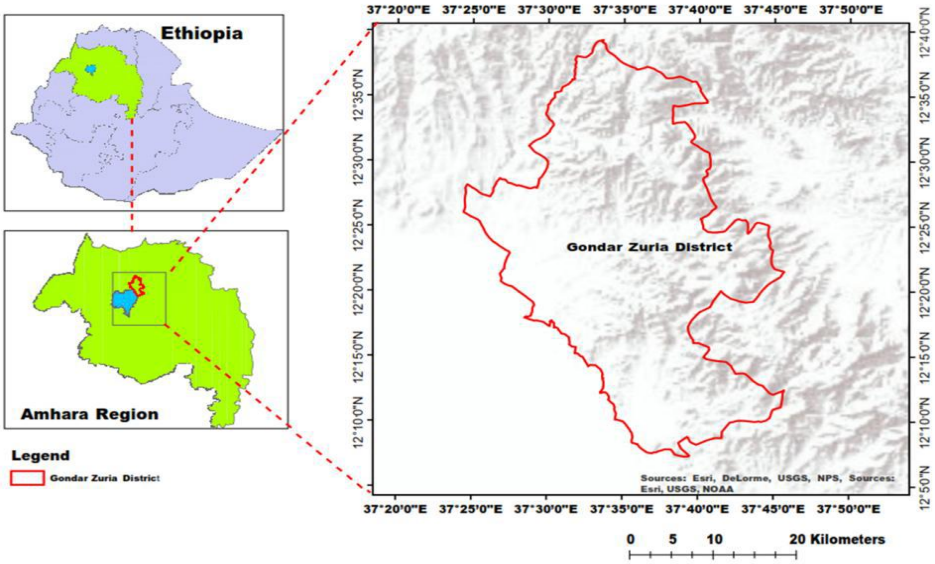

Figure 1: Gondar Zuria woreda Map

In the highlands of Ethiopia Agro forestry practices are one way of reducing deforestation problems especially the integration of trees with crops on farmlands has a great potential for enhancing land productivity. It can also provide food, fuel wood and fodder for the farm family on a sustained basis [16]. The other uses of agro forestry practices are important for domestic fuel; the substitutes may include farm byproducts such as dung cakes and crop residues, or commercial energy sources such as petroleum products [17]. Indigenous tree management practices are an expression of the indigenous knowledge concerning usefulness and harvesting techniques of trees, and the local livelihood strategies local tree utilization and management practices can be categorized into controlled utilization, purposeful regeneration and domestication [18]. The application of appropriate agro forestry practices is determined mainly by agro ecological diversity. Farmers allow some plants to grow in their croplands and practice some traditional management practices, which includes planting around the home garden, pruning, pollarding, fencing and preventing cutting of some plants by local culture in the lowland area [19]. High regeneration value species like *Ziziphus spina-christ* and *Balanites aegyptiaca* that grows in farmlands are commonly applied pruning management practices during the plowing period of lowland area. All most all livelihoods of the Ethiopian people are dependent on rain-fed agriculture in which agro forestry practice is footprint [7]. However, few or no studies examine the practices, role and management of agro forestry practices in different agro-ecological zones of Ethiopia. Therefore, this research aimed to assess the arrangement, management, experience and importance of agro forestry practices in, Gondar Zuria District, Ethiopia.

Methods and Materials

Description of the Study Area

Gondar Zuria woreda is one of the districts in the Central Gondar administrative zone. The study area shares borders with Wogera and West belesa districts in the North, West in Lay Armachiho, South Dembia district and Lake Tana and in the East LiboKemkem district. Gondar Zuria has about 35 rural kebeles and 3 urban kebeles. The district total area covers about 114,983 hectares. Gondar Zuria is divided into different topographic features that are 65% flat land, 25% hill and 10% valley type. The district area coverage is divided into different land use types that are 63% for cropland, 14.8% grassland and 9.6% is covered by forest, 7.5% by physical construction, 2.6% is considered as wetland and 2.5% for others. Based on the traditional agro-ecological classification, *Gondar Zuria* is described as 22 % *Dega* and 78% *Woina Dega*. The annual average rainfall of the district

ranges from 950 to 1035 mm. The yearly average temperature also ranges between 24 – 33 C0. The altitude of the District ranges from 1800 to 2700 m.a.s.l. (*Gondar Zuria* DOA, 2017). The District had a human population of 224,460 with 113,702 (or 50.6%) males and 110,758 (or 49.4%) females based on CSA projection [20]. In addition, 87.2% of *Gondar Zuria's* population lives in rural areas while the remaining lives in *Makisegnit, Enferaz* and *Degoma* towns [20].

Methods

Indigenous agro forestry practices in Gondar Zuria district were studied using the following approaches. Secondary information was collected from Gondar Zuria district agricultural office reports and manuals. The specific sites for the study were identified in collaboration of district forestry expertise, local people, and research teams. Reconnaissance and diagnostic surveys were undertaken to understand the actual ecosystem. A formal survey was carried out using a structured questionnaire to quantify and verify the informal survey findings. The formal survey involved direct field observations of the traditional agro forestry practices, discussions with individuals and group interviews, and key informant interviews. A total of 50-households were taken for this study. The households were selected randomly and visualizing the local area with transects walk and taking different photos. Further discussion with the district agricultural office of Natural resource experts, which used as an additional source of information to triangulate the information generated through the questionnaires and group discussion. An informal survey was conducted to gather qualitative information about traditional agro forestry practices and woody plant management practices in their selected farmer's land.

Figure 2: During interview at the farmer`s field

Data Analysis

The qualitative and quantitative data were analyzed as well as expressed using Ms-excel. The collected information from the respondents and key informants were elaborated and summarized by narrations.

Results and Discussion

Land holding size verses on-farm tree planting

The local farmers cultivated land size increased on-farm scattered trees also proportionally increases as shown in figure (3).

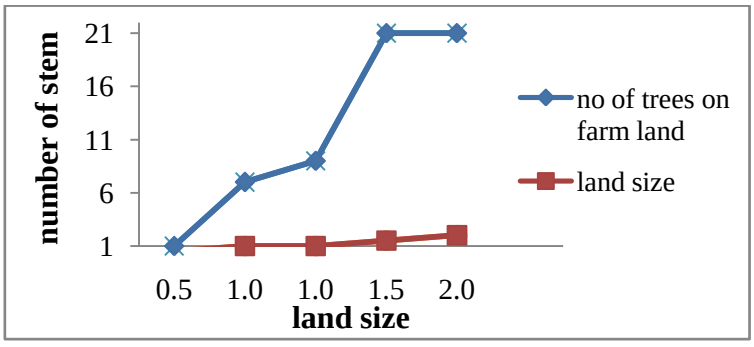

Figure 3: Cultivated land size verses number of on–farm trees

The size of the farm, the wealth status and age of the farmers are factors influencing tree-planting activities as are the environmental conditions influencing actual growth and survival of trees related to specific tree characteristics. The study supported by Kallio [21] that tree-planting farmers owned larger land areas compared to non-tree planters, a pattern found in other studies in the tropics.

Arrangements of on-farm trees

Scattered trees On-farm

The major on-farm scattered trees found on the study site were *Croton Macrostachys, Cordia Africana,* and *Acacia seyal.* Those scattered on-farm trees were deliberately left and managed by the local farmers to enhance the productivity of the cultivated land that yield increment contributor nutrients supplied by the scattered trees and on-farm scattered trees had the prominent feature for agricultural land escapes. They have been nominated as keystone structures because of their ecological importance relative to their low abundance. Scattered trees can be critical habitat for biota and contribute to the viability of wildlife populations in fragmented landscapes. Scattered trees provide a range of ecosystem services shade for stock or shade-tolerant crops a buffer against soil acidity control against erosion and desertification and insect control and are a cost-effective source of seed for re-vegetation. Only mature trees can provide many of the ecological functions and ecosystem services provided by scattered trees. Several animal species in South Africa prefer to use large Acacia species rather than saplings. Agricultural soils under large trees contain more soil moisture, carbon, and nitrogen than soils under small trees or away from tree cover [22]. This was the reason that the local farmers were used to scattered on-farm trees for their own cultivated land to have better crop products than none of the scattered on-farm trees on cultivated land.

Farmers agree that for a tree to qualify as good species for intercropping they should have the following qualities;

- Complementarily with the crop component of the farm(cereals), less negative effects
- Multipurpose tree species
- A tree species that improve soil fertility through nutrient cycling
- Tree species that have deep roots and do not compete for water and nutrients with cereals
- Tree species that improves moisture retention through enhanced infiltration
- Trees that have more vertical roots, than lateral roots
- Trees that have a light canopy, thus reducing the shading effect and trapping of rainwater during light rain [23].

Categories of tree integration in farm fields

- Trees on non-arable land: naturally regenerated trees on land without crops or grass
- Scattered trees in arable land: naturally regenerated trees on cropland
- Trees growing around homesteads: mainly planted trees around the homestead area
- Trees growing in boundaries: planted trees as boundaries for demarcation of farmland, or within, fields or to serve a protective purpose
- Intercropping of trees: planted trees on arable or cropland, together with crops
- Mono cropping of trees: planted trees on cropland, without crops (woodlots) [23].

On-farm trees as boundary plant and its importance

In the study area boundary plantation is practiced by the local communities for different purposes like separation of their cultivated lands from the neighbor one, to protect different properties from winds and other natural hazards as well as this plantation was important for soil enrichment and controlling flood to prevent damages on their cultivated land. In addition to this, the local farmers used boundary plantation as fuel wood consumption, farming tool, house construction, and other benefits.

On-farm tree boundary plantation, aside from their use as living fences, they are also used as shade trees in coffee plantations and pastures, fuel wood, fodder for livestock, flood control, soil enrichment (N- fixation), and lumber. Their widespread use, and especially their ability to tolerate and establish under the harsh conditions

found in pastures, are key factors that make them an attractive tool for tropical restoration. Living fence species are widely available, and cheap, ready-to-plant stakes can easily be purchased from local farmers [24].

The environmental and social benefits of boundary plantation are:

- Separate property boundaries
- Windbreak
- Hydrological benefit
- Biodiversity benefit
- NTFP beekeeping, medicines, fruits etc.
- Shading for humans and livestock
- Pruning and thinning material may be used as firewood

Management practices

In the study site, the local farmers were done different and frequent tending operations for the boundary plantations in the seedling stage like weeding, watering and protection from human and animal damage by fencing. Slashing and minimal weeding was done regularly especially during the early years of the establishment when weeds may suppress the growth of the young trees. As the local farmers said, the wedding cost was decreased when the boundary plantation age was increased that the plantation had the great competition potential with unwanted planting material by up taking of nutrients and available water. Prune side branches of timber trees to create clean boles of high value and to allow more sidelight to penetrate the homestead and farmland. No burning was allowed at any time and trees should be protected from fires through maintenance of firebreaks. Any foliage from farm boundary plantations was managed properly to be hums and organic matter to enhance the soil nutrition.

On- farm tree management activities in the study area

Three main on-farm tree management practices were accomplished in the study area as indicated in figure (4). From the 50 respondents 100, 33.3 and 16.7% of respondents were used pollarding, pruning and coppicing on-farm tree management practice respectively. Similarly, Agidie [16] in koga watershed, upper Blue Nile basin, Ethiopia, on-farm trees management activities and/or operations must accomplished (implemented) properly in order to harmonize their existence with crops and animals. Coppicing, pollarding, pruning, and lopping management practices with the most important trees are practiced in the area. Farmers had awareness about the importance of the different tree management activities for optimizing tree crop interaction and to derive benefits such as fuel wood, fodder, and soil fertility improvement from tree management activities. Despite, on-farm scattered trees had a great contribution as a source of animal forage production it was not measurable in the form of economic perspective [16].

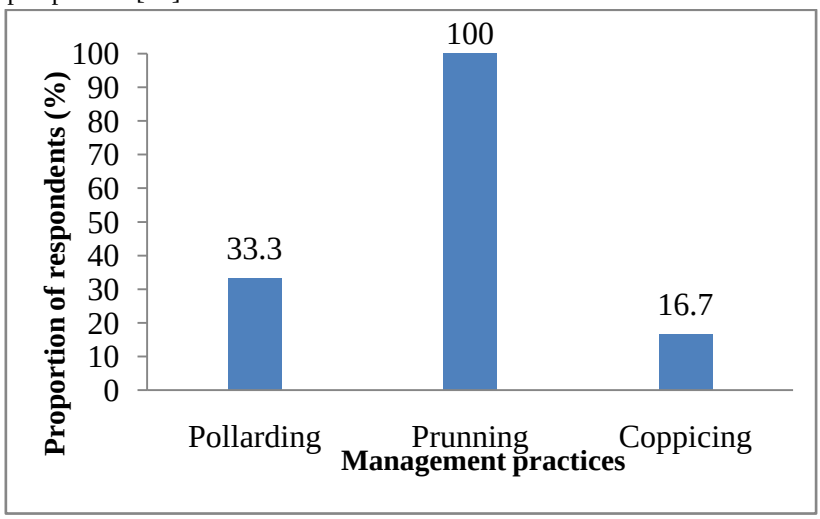

Figure 4: Types of On-farm tree management activities

Pollarding

Pollarding is a system in which the upper branches of the tree are removed, promoting a dense head of foliage and branches as indicated in figure (5). The local farmers were practiced pollarding management activities to restrict the growth and crown diameter size of the on-farm tree to protect the negative effect of on-farm trees on cultivated crops and having much biomass wood product for a different purpose. Like fence, fuel wood, charcoal, soil fertility, fodder and others. Primarily pollarding is practiced for protecting the shading effect on crops. As the respondents expressed that, this practice was accomplished in every year when the cropping season was started in May and June. Trees in any system can be pollarded by sawing through the main branches or the single trunk at shoulder height or higher (to prevent cattle browsing the early re-growth). Farmers carrying out pollarding should take a proper training course with forestry specialists before tackling the job themselves.

Figure 5: Farmers cultivated land with pollarding system

Pruning

The pruning practice was done at all woody plants shed branches in response to shading and competition for crops during the cropping time in the study area as indicated in figure (6). Pruning for safety involves removing branches that could fall and cause injury or property damage, trimming branches that interfere with lines of sight on streets or driveways, and removing branches that grow into utility lines. Safety pruning can be largely avoided by carefully choosing species that will not grow beyond the space available to them, and have strength and form characteristics that are suited to the site. The word pruning as trees mature, the aim of pruning will shift to maintaining tree structure, form, health and appearance. Proper pruning cuts are made at a node, the point at which one branch or twig attaches to another. In the spring of the year, growth begins at buds, and twigs grow until a new node is formed. The length of a branch between nodes is called internodes. In the study area pruning, the practice was done predominantly to protect their cultivated crops from shading and additionally they used pruning to improve the wood quality for different purposes. Different authors mentioned that time of pruning was varying due to the purpose of a tree most common time for pruning was late winter or early spring and just before the new growth emerges but in the study area it was practiced commonly in late winter . Because of the crop season was started in May and June. However, trees may be pruned at any time of the year, except when the wood is frozen. Pruning in the late winter or early spring, just before the new growth emerges, is good timing for many trees [25].

Figure 6: On-farm tree pruning management practice

Coppicing

The respondents of the study area mentioned that the landowner coppice on-farm trees every year during the cropping season to protect their crops from different competition with the on-farm trees as indicated in figure (7). This was due to the scarcity of cultivated land that short rotation of coppicing but the coppiced tree was used for fencing, fuel wood and other routine purposes. The shoots are left to grow about 2 to 4 years before being harvested with specialized machinery. The stool left in the ground and produces more shoots that grow for a further 2 to 4 years, until the next harvest year. Several 2 to 4-year cutting cycles take place before yield declines and the crop is replaced; the exact length of time the stools remain in the ground depends on their productivity and the wishes of the landowner [26].

The advantages of coppice for small farmer abundant harvests of straight poles for fencing, firewood, furniture, charcoal, poles for the hop growing, and other uses. Rapid re-growth from established (and mature) root systems, with repeat harvests along regular cycles, is needed for replanting.

Figure 7: Coppicing of on-farm tree management practice

Conclusions and Recommendation

Conclusions

The study showed that there were limited species of on-farm scattered tree distribution on the farmers cultivated land. This limited number of species was not advisable because, if the diseases and insects may happened in this area these limited species highly injured by the happened insects and diseases due to lack of diversification. Despite, these limited on-farm scattered trees were staggered arrangement on the cultivated land that imposed the farmers to do different farming activities during the cropping season. On-farm scattered tree population was increased as the farmers cultivated land size increased whereas the farmers cultivated land size becomes decreased the scattered on-farm trees also decreased. The local farmers were used different management activities of on-farm scattered trees like pollarding, pruning and coppicing to protect and decrease the scattered trees competition on cultivated crops from light, nutrient and other available things for the crops.

Recommendation

- The local communities should be diversified on-farm trees species on their cultivated land
- The local communities should make appropriate arrangement of on-farm scattered trees that is easy to farming practice and light penetration for cultivated crops
- There is a need to set up a strong institutional framework that enables farmers to plant on-farm trees on their cultivated and pasture land.
- There must be strong by law in the local area to stop free grazing because of free grazing damages on-farm trees in the seedling stage.
- The local communities must be select On-farm tree species that has to give diversified product and highly improved the soil fertility.
- Further studies should be conducted on scattered On-farm trees that which species is very crucial for farmers in order to have different products and from the perspective of soil fertility status.

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