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The role of agro forestry practices in soil and water conservation mechanism in case of Bahir Dar Zuria Woreda, northwest Ethiopia

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Abstract

Land degradation and soil erosion present major ecological, social, and economic challenges to agricultural sustainability in the Ethiopian highlands. This study assessed the role of traditional agroforestry practices in soil and water conservation in Bahir Dar Zuria, located within the Bahir Dar Zuria Woreda of the Amhara Region, Ethiopia. It specifically investigated existing TAF types, active constraints, and local farmer attitudes toward these systems. A simple random sampling technique was utilized to select a sample size of 50 households from a total population of 1,782 households within the kebele. Primary data were gathered through semi-structured interviews, focus group discussions, and direct field observations. Quantitative and qualitative metrics were evaluated using descriptive statistics, including frequencies and percentages. The study identified home gardens as the predominant traditional agroforestry practice. TAF as a powerful tool for environmental mitigation, noting its primary roles in reducing soil erosion (58%) and improving soil fertility (24%). Despite these benefits, physical SWC methods remain more widespread (66%) than pure agronomic/agroforestry applications (20%). The expansion of TAF is severely restricted by critical bottlenecks, most notably a lack of community awareness (48%) and financial constraints (20%). Generally Traditional agroforestry plays an indispensable biological role in mitigating land degradation and protecting localized topsoil in Bahir Dar Zuria. To optimize its potential, it is recommended that the government and non-governmental organizations (NGOs) initiate targeted awareness campaigns, deliver robust institutional extension support, and secure a reliable supply of seedling materials to alleviate physical and economic barriers for smallholder farmers.

1. Introduction

Cultivating trees and agricultural crops in intimate combination with one another is an ancient practice that farmers have used throughout the world. Tracing the history of agro forestry king (1987)states that in Europe, until the middle ages, it was the general custom to clear-fell degraded forestry, burn the slash, cultivate food crops for varying periods on the cleared area and plant or sow trees before, along with, or after sowing agricultural crops. This farming system is no longer popular in Europe, but was wildly practiced in fine land up to the end of the last country and was being practiced in a few areas in Germany as late as the 1920.

In tropical America many societies have simulated forest condition to obtain the beneficial effects of the forest ecosystem. For example, in Central America, It has been a traditional practice for long time for farmers to plant an average of two dozen species of plants on plots larger than one-tenth of a hectare. A farmer would plant coconut or papaya with a lower layer of bananas or citrus, a shrub layer of coffee or cacao, annuals of different stature such as maize, and finally a spreading ground cover such as splash. Such an in time mixture of various plants, each with a different structure, imitated the layered configuration mixed tropical forestry (Wilken 1977).

In Asia, the Hanunoo of the Philippines practices a complex and somewhat sophisticated type of shifting cultivation. In clearing the forest for agriculture use, they deliberately spared certain trees which, by the end of the rice-growing season, provided a partial canopy of new foliage to prevent excessive exposure of the soil to the sun. Trees were an indispensable part of the Hanunoo farming system and were either planted or preserved from the original forest to provide food, Medicines, construction wood and cosmetics (Conklin 1957). Similar farming systems have also been common in many other parts of the humid low land tropics of Asia.

The situation was little different in Africa. In south Nigeria, yoms, maize, pumpkins and beans were typically grown together under a cover of scattered trees (Forde, 1937). The Yoruba of western Nigeria, who have long practiced an intensive system of mixing herbaceous, shrub, arid, tree crops, claim that a system is a means of conserving human energy by making full use of the limited space from the dense forest. The Yoruba also claim that this system is an expensive means of maintaining the soil fertility, as well as combating erosion and nutrient leaching (ojo, 1966). There are innumerable examples of traditional land use practices involving combined production of trees and agriculture species on the same piece of land in many parts of the world. These are some examples of what is known as agro forestry. By the end of the nineteenth century, however, establishing forestry agriculture plantation had become an important objective for practicing agro forestry (king, 1987).

Ethiopians also a new days, practiced agro forestry to control erosion because agro forestry has always two or more output and the systems has both ecological and economical interactions between different components and taken as best measurement for environmental protection. Even if our country are falling for full practices for agro forestry, due to lack of technology, awareness of the society etc. but, those practices are very important for soil water conservation, providing energy, fuel wood, fencing and animal forage(fodder) (Arnold, 1997).

Similarly in Amhara region, since most areas are seriously affected by land degradation due to population numbers, which result deforestation, complete removal of crop residuals, affect soil and water. So, there are some observable practices of agro forestry (ZKAO, 2018).

In the last time there was no that much practices of agro forestry because of lack of awareness, proper management and other relate constraints, but now there is an indicator for practicing of agro forestry in the local communities of Bahir Dar Zuria because from time to time they understand the role of agro forestry for the conservation of soil, fuel, animal fodder, fencing, shading etc. The major indictors are reduction of erosion, reduction of degradation and some peoples have little knowledge about agro forestry practices.

Agriculture is the oldest activity in Ethiopia. It is the major source of food, industrial row material and export it’s more than 85% of the country population is engaged in agricultural activists. About 56% of the land is suitable for farming economy, over 90% of the country export Coffee from this sector. However this vital economic sector has man problems of whit soil erosion is critical for the country (Getachew Tadesse, 2005).

The natural resource is placed under extreme degradation that causes a serious environmental, social and economic problem across all over the world, due to the increment of population number which leads to deforestation and degradation of land. Degraded lead is one of the major ecological issues of the world. I.e. loss in the capacity of a given land to support growth of useful plants on sustained basis. It is also the result too many factors combination factors that damage the soil and there is an impact of food security and environmental quality. All these indicated that there is no incorporation of crop with trees to conserve soil and water to make as a productive land. In addition there no much more advancement of agro forestry practices in our country. There for this study was conducted to assess the role of agroforestry practice on soil and water conservation in Bahir Dar Zuria Woreda.

2. Research methodology

2.1 Description of the study area

Bahir dar zuria woreda is one of the woreda in West Gojjam zone of Amhara region; Ethiopia. The district is surrounded by Woreba kebele in south, Lake Tana in the west, Robit kebele in the north and Tana kirkos in the east. It consists of three sub-kebeles namely Sesaber, Gedro and Micaelnius kebeles. The study area is geographically located at 15^{o} 38' north latitude and 37^{o} 10' east longitude with an altitudinal range 1917 above mean sea level. The area has 4135 ha (zenzelm kebel agricultural office; 2026). The total population of the study area is 10614 of which 5381 female and 5233 male. In percentage 49.4% male and 50.6% are female. The Keble has totally 1782 households i.e. 1494 households lead by men and 288 households lead women. The dominant religion in the study area is orthodox-Christian (ZKAO, 2026). The climatic zone of the study area is weynadega and mean annual temperature in the area is 18^{o} c with mean annual maximum at 25^{o} c and minimum 11^{o}c .The mean annual rain fall reach 1400mm refried with long period of summer rain (ZKAO, 2026). The soil types of Zenzelma Keble are vertisol that have color red, brown and dark. This typical soil is rich inorganic and organic materials which are used for different crop productions (ZKAO, 2026). The total study area is 4135 ha of these agriculture land (37.96%), irrigated land (19.84%), forest land(8.68%), shrub land(12.52%), grazing land (10.72%),other land use type: like quarry land, and others (10.28%).(ZKAO, 2026).

2.2. Data collection

The data was through both primary and secondary data. The primary data was collected from interviews, semi structure interview schedule, field observation and focus group discussion. I.e. prepare the question for the local people and translate English to Amharic language, prepare open and close ended question distributed to the people and then discussed with the kebele key stakeholders and peasant association as well as with development agent. Whereas, secondary data was obtained from different documented materials, published data, unpublished data, reports etc.

2.3. Sample technique and sample size

In this study was selected simple random sampling techniques because these sampling techniques and much cheaper and required lesser time, less bias as well as give equal chance for the local peoples. From Bahir Dar Zuria Woreda is select this is because of it is near to the university and we were determine the sample size of the total 1782 household. But, because of limitation of time, budget and other constraints we cannot collect data from all households. We were taken of the 50 household randomly.

2.4. Data analysis

The data collected through semi structured interview schedule, field observation, interview, documented material and focus group discussion and about traditional agro forestry practices and it contribution in SWC measure and analyzed by using descriptive statics like percentage and frequency of some qualitative data and quantitative data, then the result will be show by using tables.

2.5. Sampling Design

Since the study is concerned with describing contribution of agro forestry practice on soil and water conservation in Bahir Dar Zuria. The study will be to investigate the role of agro forestry practice on soil and water conservation mechanism by collecting data from respondents. The simple survey design will be selected to collect data from the sample population at specific point in time and beside on results to make generalizations.

3. Result and discussion

3.1. Demographic and social characteristics of respondents

The above table shows that most of the house holds about 46% are between 26–35 years old. This helps to get about changes in the past and in the future with in the area. The rest 4%, 16%, 22% and 12% of the respondents are found with age range of 15–18, 19–25, 36–45 and > 45 respectively. Hence, half of the respondents have awareness about traditional agro forestry practice and most of them are practicing it because of their age.

3.1.1 Age distribution of respondents

Table 1
age distribution of respondents

Age range	Frequency	Percentage (%)
15–18	2	4
19–25	8	16
26–35	23	46
36–45	11	22
Above 45	6	12
Total	50	100

Source; field survey, 2026

The above table indicates that about 74% the respondents were male and the rest 26% are female. From this we can conclude the most of the respondents are male headed households in the study area. As the respondents told females have good attitude than men about it.

3.1.2 Sex distribution of respondents

Table 2
sex distributions of respondents

Sex	Frequency	Percentage (%)
Male	37	74
Female	13	26
Total	50	100

Source; field survey, 2026

The above table shows that about 40%of the respondents have land size of 0.5-1Ha. This shows that there is shortage of land for practices and development of agro forestry. The rest 44% and 16% of the respondents of have a land size of 1Ha-2ha and above respectively. As a result, land sizes of the respondent are insufficient for agricultural land to produce their consumption. Consequently it leads to intercrop to produce different types of crops with in a plot of land.

3.1.3 Land size of the respondents

Table 3
size of the respondents land

Land size	Frequency(F)	Percentage (%)
0.5ha-1ha	20	40
1ha-2ha	22	44
2ha and above	8	16
Total	50	100

Source; field survey 2026

From the above table the majority of respondents have a family size between3-4 which is 42%. On the other hand, the rest 32%, 22% and 8% of respondents have a family size between1-2, 5–7 and above 8 respectively. Hence, above 42% of the respondents have above 3 family sizes. Consequently, they practice agro forestry to fulfill different needs with small plot of land.

3.1.4 Family size of respondents

Table 4
; family size of the respondents

Family size	Frequency(f)	Percentage (%)
1–2	16	32
3–4	21	42
5–7	11	22
> 8	2	4
Total	50	100

Source; 17 field survey, 2026

Are married which are 78%. This helps to work together in the practices of agro forestry rather than working alone. The rest 16%, 2%and 4% of the respondents are single, divorced and widowed respectively because there will no coordination.

3.1.6 Marital status of the respondents

Table 6
; marital status of the respondents

Marital status	Frequency	Percentage (%)
Single	8	16
Married	39	78
Divorced	1	2
Widowed	2	4
Total	50	100

Source: - own field survey, 2026

According to the above table significant proportions 16(32) of respondents were unable to read and write. About 40% of the respondents were able to read and write. They have indigenous knowledge about traditional agro forestry. The percentages of respondents who attended elementary school (grade 1–8) were 10%. The percentage of respondents who attended secondary school were 4% and those who are at college/ university were low but they have good awareness about traditional agro forestry 14% and respectively.

3.1.7 Educational status of the respondents

Table 7
; Educational status of the respondents

Educational level	Frequency	Percentage (%)
Unable to read and write	16	32
Read and write but not formal	20	40
Primary (1–8)	5	10
Secondary (9–10)	7	14
College/ university/	2	4
Total	50	100

Source: - own field survey, 2026

The above table indicates that the majority of the people livelihood income is agriculture. The rest 14%and 2% of the respondents are involved in workers and business respectively. Therefore, based on the response of the households we can conclude that most of society income is agriculture which is 84%. So agriculture is closely related with traditional agro forestry.

3.1.8. Household income of the respondents

Table 8
; Household income of the respondents

No	Alternatives	Frequency(F)	Percentage (%)
1	Agriculture	42	84
2	Workers	7	14
3	Business	1	2
4	Others	-	-
5	Total	50	100

Source; field survey, 2026

According to the above table about 64% of the household are living in the Bahir Dar Zuria has used tree in combination of crops i.e. traditional agro forestry (home garden). And some extent about 12% of the household have Village forest garden with the traditional agro forestry (home garden). Even through its extent is small about 24% of the household used Village forest garden agro forestry practices such as wood lot alley cropping and hedgerows. According to respondent's interview, mostly maize and other crops are integrated with chat in the study area.

3.1.9 Types of agro forestry practices

Table 9
; types of agro forestry practices

Types of agro forestry practices	Frequency(F)	Percentage (%)
Home garden	32	64
Village forest	6	12
Wood lot	7	14
Hedge row inter cropping(alley cropping)	5	10
Total	50	100

Source; field survey 2026

The above table shows Farmers understanding towards on the role of TAF practice is to reduce soil erosion, improve soil fertility, Reduce velocity runoff and Increase infiltration respectively. According to the respondent's response, agro forestry practices have a major role on soil and water conservation in the study area listed as follows.

3.2. Reduce soil erosion

According to respondents answer, TAF practices reduce soil erosion by serve as a shelter belt protects the soil from wind erosion; reduce the power of raindrops by intercepting on their leaves. Not only that, but also, by trapping the soil in its root it maintained soil structure. As a result, it reduces the extent of erosion.

3.2.1. Improve soil fertility

According to the respondent's interview, TAF practices have a major on SWC by improve soil fertility. The decays of the trees increase the fertility of the soil and serve as mulching. As a result, it reduces water erosion by increase water infiltration capacity of the soil.

3.3. Farmers understanding towards on the role of TAF practice

Table 10
; farmers understanding towards on the role of TAF practice

Role	Frequency	Percent (%)
Reduce soil erosion	29	58
Improve soil fertility	12	24
Reduce velocity runoff	5	10
Increase infiltration	4	8
Total	50	100

Source field survey, 2026

As indicates above table 32% of the farmers have get benefit on agro forestry practice by income generation 50% of the household have to high soil conservation 4%,8%,and 6% have to get benefit recreational value, market value and control runoff & erosion and respectively. When we study in the Bahir Dar Zuria about the benefits of the traditional agro forestry farmers give same information about the benefits of agro forestry when we see some are agroforestry used as a food for the cows and goats and also used as shadow the house and for the purpose of for animal feeding and used as can get in come buying the wood lots. Generally agro forestry gives benefit for the farmers in the Bahir Dar Zuria.

Table 11
; benefits of traditional agro forestry

No	Benefits of traditional AF	Frequency	Percentage
1	Income generation	16	32
2	Recreational value	2	4
3	High soil conservation	25	50
4	Market value	4	8
5	Control run off & erosion	3	6
Total		50	100

As below table indicates in the study area farmers are used mechanisms of soil and water conservation methods 66% of the farmers are use physical methods which means conserving by tracing by check dams and other used physical methods in the study area 14% of the farmers use biological SWC which means by planting the trees or reforestation in the study area 20% of the farmers use agronomic SWC by practicing agro forestry.

Table.12 mechanisms of soil and water conservation measures

No	Mechanism of soil & water conservation	Frequency	Percentage
1	Biological SWC	7	14
2	Physical SWC	33	66
3	Agronomic SWC	10	20
	Total	50	100

3.4. Determinant factors of TAF practices

Based on the present study, there were different constraints to practices AF in the study area. According to the respondent, some of them are related with house hold economy, small land size and insufficient extension intuitional support. According to the respondent's response, we were concluded the constraints very high, high, and medium.

According to the respondent's information 20%of the farmers are lacks of financial economy, 12% farmers have small land size in the area it is the major tackles for development TAF practices in the study area. But it does not mean that other factors have no value for constraints, rather they have little degree as compares to the above one. However, 10%insufficient extension an institutional support, and 10% lack of seedling material supply. Where there is AF practices problem there has contribution on erosion (more exposed to erosion).

Table 13
; Determinant factors of TAF practices

No.	Constraints of TAF practices	Frequency	Percent (%)
1	Financial economy	10	20
2	Lack of awareness	24	48
3	Lack of seedling material	5	10
4	Small land size	6	12
5	Insufficient extension and institutional support	5	10
Total		50	100
Source; field survey.2026			

As the below indicates about Classification of farmers attitude toward on traditional agro forestry in the study area 52% of the farmers are a medium attitude, 48% of the farmers are it have positive attitude generally more than half of of the farmers have positive or good attitude about the agroforestry in the study area that means in the Bahir Dar Zuria.at the time of interviewing farmers the farmers are rise so many questions about the problems of the agro forestry for example when the farmers are combine tree with crop or maize with chat at that time the maize affect the chat by covering the crop at the shadow time so some farmers fill generally agro forestry is important for all by increasing soil fertility and also reducing soil erosion.

Table 14
, Classification of farmer's attitude toward on traditional agro forestry

No	Classification farmers attitude toward traditional agro forestry	Frequency	Percentage
1	Positive attitude	24	48
2	Medium attitude	26	52
3	Negative attitude	-	-
	Total	50	100%

5. Conclusion and Recommendation

5.1 Conclusion

Soil erosion is one of the aggregations and also has physical constraints to crop production in Ethiopia this leads to land degradation lowering soil fertility and the productivity (young, 1989). In order to reduce this problem several studies has been conducted to design appropriate structures and to find better practices whether physical or biological in Ethiopia. However still there has been little work done on the assessing of the role of the existing practices in soil and water conserve action like traditional agro

forestry practices. In south was, there are several traditional agro forestry practices used farmers particularly home gardens. However, there is little done in identifying the potential of this traditional agro forestry practices in soil and water conservations. The data was collected through interview etc with Bahir Dar Zuria stakeholders in the area. The result indicates that several socio-economic practices as well as for environmental protection such as soil and water conservation the study reheated that area suffers little by erosion this is due to agro forestry practices and the presence different soil water conservation measure, traditional agro forestry practices has a great role (very high) in conserving soil and water. The present study also identified that there are a number of constraints that hinder the development of TAF in the study area such as financial economy, lack of seedling material, small land size and insufficient extension and intuitional support.

5.2. Recommendation

- Based on the research finding the following suggestion has been forwarded:
- As far as our research knowledge considers, there is no research has conducted to identify and characterized traditional agro forestry practices in the study area. Therefore we recommended an applied research must be conduct in this area.
- The present study has found that there are a number of constrains that limit the development as well as introduce of agro forestry practices in the study area, thus government and other NGOS are expected to do some important things such as, supply of seeds and materials.
- Crate awareness for the community about the value traditional agro forestry practices for soil water conservation.
- Supporting extension activates to encourage the farmer to introduce agro forestry practices which has contribution for soil water conservation.
- The community should more participate on agro forestry practices to conserve soil and water.
- The government should encourage the community to introduce traditional agro forestry.

Limitation of the study

The study was conducted in Bahir Dar Zuria. The limitations that were faced during the study are, mainly in the collection of data which are relevant to our study. In collecting data, absence of relevant, Shortage of time, Lack of financial support, accurate and specified secondary and primary data, and lack of knowledgeable person (key informants'), in the study area will its own obstacle to analysis.

Declarations

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Author contributions

Ayele Mengstu: The author was responsible for all aspects of the research process. This includes the conceptualization of the study, data curation, formal analysis, investigation, and development of the methodology. The author also provided the necessary resources, prepared the original draft of the manuscript, and handled the writing, review, and editing of the final version. Melaku Asresu : Contributed to supervision, reviewing and editing of the manuscript.

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Data availability

The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request.

Ethics approval and consent to participate

The study followed the Declaration of Helsinki and was conducted after obtaining approval from the Institutional Ethics Committee (IEC) of Sekota Dryland Agricultural Research Center Agricultural Research Review Committee (SDARC-ARRC/18/01/2025).

Consent to participate

Informed consent was obtained from all participants prior to data collection. For participants below 16 years of age, written informed consent was obtained from their parents or legal guardians, and assent was obtained from the participants. The study objectives, data collection procedures, potential risks, and benefits were clearly explained to the participants and their parents or legal guardians in a language they understood. Participation was voluntary, and participants and their parents or legal guardians were informed of their right to withdraw from the study at any time without consequence. All information provided by the participants was treated confidentially and used solely for research purposes.

Consent to publication

Not applicable.

Competing interests

The authors declare no competing interests.

Conflict of interest

The authors have no conflict of interest.

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