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Research Article

Views and Attitudes of Local Farmers towards Planting, Growing and Managing Trees in Agroforestry System in Basona Worena District, Ethiopia

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ABSTRACT

Agroforestry is a dynamic ecological-based natural resources management practice that integrates food crops, trees, and livestock in an agricultural landscape where the components may have ecological, economical, and social impacts. This study aimed at examining the views and attitudes of local farmers towards 'planting, growing, and managing trees in agroforestry system' in Basona Worena District, Ethiopia. As there was already a traditional agroforestry adopted by the farmers, the study kebele was purposely selected. A structured questionnaire was developed by accounting different socioeconomic variables. A total of 94 respondents were randomly contacted to collect the questionnaire data. Multiple linear regression technique was employed to analyze and interpret the data. Contrary to expectation, the findings showed that a greater proportion (about 60%) of the respondents did not practice agroforestry. However, those farmers who used to practice traditional agroforestry mainly exercised it to meet their household wood demands. Based on their economic values, the most commonly preferred tree species planted and grown by the farmers in descending order, included eucalyptus species, *Acacia abyssinica*, *Croton macrostachyus*, *Sesbania sesban*, *Cupressus lusitanica*, and *Olea africana*. The results also suggested that the farmers had conscious perceptions to determine the negative and positive effects of tree species on food crops, soils, and water. Generally, a greater proportion of the farmers strongly agreed (73.33%) that they had developed positive attitudes towards 'planting, growing, and managing trees in agroforestry system'. Moreover, the multiple linear regression model showed that different socioeconomic variables significantly influenced the attitudes of farmers towards 'planting, growing, and managing trees in agroforestry system'. Generally, the regression model explained about 36% of the variance in attitudes of the respondents towards 'planting, growing, and managing trees'. Hence, providing improved agroforestry extension services, including incentives (e.g., seeds, tree seedlings, technical supports, and credits) may help increase the active participation of the farmers to adopt plant, grow, and manage trees in agroforestry system. Moreover, provision of adequate technical trainings on agroforestry technologies and establishing demonstration site is indispensable to increase the awareness level of the local farmers and thereby promote the adoption of agroforestry technologies in Basona Worena District and elsewhere.

Keywords: Adoption; Agroforestry; Extension services; Managing trees; Technical training

INTRODUCTION

Resulting from various factors, the natural vegetation in Ethiopia is being degraded rapidly. Some of the main reasons for the decline in the vegetation coverage in the country include unwise utilization of the forests for fuelwood, construction materials, charcoal burning, urbanization, large scale investment, fast population growth, and illegal farming inside forested areas [1]. As a result, the forests in the country have steadily declined in coverage, species composition, structure, and richness [2,3].

To overcome the aforementioned deriving factors, agroforestry is an optimal solution by which the degraded vegetation in Ethiopia can be restored to provide sustainable multipurpose values which in turn enhance the livelihoods of the indigenous people [3-10] and also reduce the anthropogenic pressure on the remnant forest resources in the country. Moreover, agroforestry can help

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increase the agricultural productivity through maintaining soil fertility either through litterfall and/or retrieving back the leached nutrients with the help of the deep root system [6,9] and also reducing the adverse effects of erratic climate [6] which ultimately leads to ensure the green economy that Ethiopia is striving to achieve in its long term development goal. Hence, agroforestry helps diversify and sustain production to increase social, economic, and environmental benefits [11,12]. Agroforestry does not only provide multiple benefits to mankind, but also it helps restore the degraded environment, including biotic and abiotic natural resources [4,6,8,13]. In fact, agroforestry could provide vital ecological security at local, regional, and national levels [14]. With this tremendous role in mind, agroforestry has an essential contributions to improve the livelihoods of the agrarian society who lives especially in the developing countries [4,12].

On top of promoting the products obtained from annual crops, deliberately growing trees with annual crops in agroforestry system can increase total productivity, reduce land degradation, and improve nutrient cycling, while producing fuelwood, fodder, fruit, and timber [5-7]. However, the higher productivity and improved sustainability secured in agroforestry land use compared with mono-culture cropping are the outcome of a complex set of interactions among the different components of the system [14]. For example, Asfaw [4] noted that various traditional management practices, including spatial and temporal arrangements can be mentioned to enhance or maintain soil fertility and crop production in agroforestry land use. An important aspect of the interactions may, however, also include the increase in dominance of trees as they mature and compete with food crops for light, water, and nutrients [4,15].

In southern Ethiopia (e.g., Sidama and Gedeo Zones), various traditional agroforestry land use exists where trees and shrubs are found as important components [4-7,9,13]. Those traditional management practices without any extension input have developed over time to select the effective mixture of agroforestry components [4]. Nair also noted that maintaining and integrating the various components in agroforestry system is intentional and carried out under levels of low technical inputs [14]. Therefore, agroforestry contributes to ensure food security and poverty alleviation where adopted and practiced [4,6,8,9].

Rural people are usually prosperous in their traditional views towards natural resources management [15]. However, the exclusion of the direct participation of the people in natural resources management can lead to environmental degradation resulting from the unsustainable resources utilization [16,17]. For instance, shortage of knowledge, adverse attitudes, and lack of benefit-sharing scheme from forests to the surrounding people has aggravated the degradation of forests in various developing countries, including Ethiopia [18-20]. Attitude is positive or negative outlook of a person towards an event, including tree planting, growing, and managing in agroforestry system [19-21]. Therefore, forest conservation is affected by the attitude of the person who is unavoidably linked with the forests and through his/her active involvement in forest management [18-20]. Behavior of a person can be affected by his/her views towards agroforestry. Attitude of the person in turn can be influenced by his/her manners [22]. Hence, appreciating how manners influence the attitudes of people is critical for the management and sustainable utilization of the forests through initiating agroforestry land use, where majority of the inhabitants are entirely reliant on forests to meet their basic needs [18-20].

Studies to characterize the existing traditional agroforestry practice and how the local communities manage the different components of agroforestry system are lacking in Basona Worena District, Ethiopia [23]. To understand and increase our insights on the traditional agroforestry practice and thereby forward plausible remedial solutions, this study aimed at examining the views and attitudes of farmers towards 'planting, growing, and managing trees in agroforestry system' in Basona Worena District, Ethiopia. This study is relevant to: (1) characterize the existing traditional agroforestry practice and how the local communities manage the different components of agroforestry system; (2) identify the most commonly preferred agroforestry tree species planted, grown, and managed by famers; (3) investigate farmers' views on the impacts of tree species planted and grown in agroforestry system on food crops, soils, and water; (4) explore the attitudes of farmers towards 'planting, growing, and managing trees in agroforestry system' in Basona Worena District, Ethiopia. Therefore, the findings of this study may provide crucial scientific highlights for policy- and decision-makers, researchers, and other stakeholders who have direct or indirect responsibility to conserve the biodiversity through practicing agroforestry technologies (i.e., because expanding pure plantation forestry is a difficult task due to the scarcity of vacant land in most parts of Ethiopian highlands, including Basona Worena District) and thereby achieve the goal of restoring the biodiversity through reducing adverse environmental impacts [23].

MATERIALS AND METHODS

Study area

The study was conducted in Basona Worena District, Ethiopia. The study kebele (i.e., Gudo Beret Kebele) was purposely selected because there was already a traditional agroforestry practiced by the farmers. Kebele is the lowest governmental entity in the country. The study site is positioned on 10°41ə50" north and 39°47'03" east at a distance of 162 km northeast of Addis Ababa and 32 km in the same direction from Debre Berhan town on the street running to Dessie (Figure 1). The altitude varies between 2828 to 3700 meters above sea level [23]. The total area of the study site is about 7,054 hectares among which 1,418 ha are plantation forests, 923 ha of grazing land, and the other 4,713 ha are assigned for crop production. The total population size is estimated to be

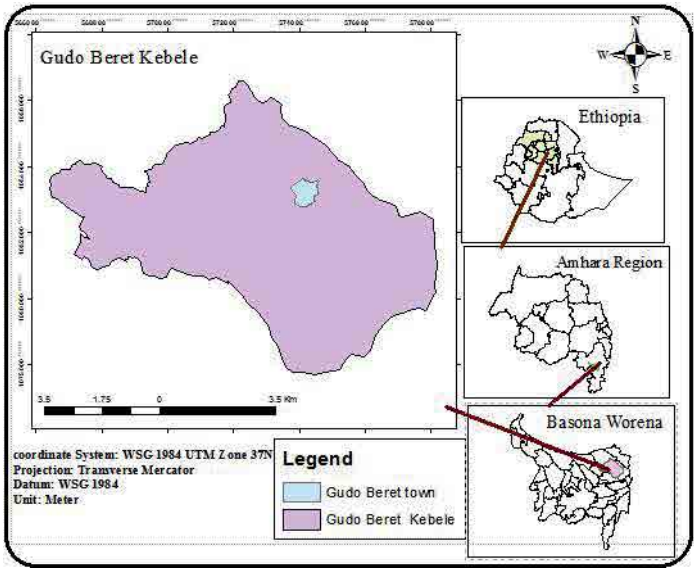

Figure 1: Location map of the study area.

4,550 people with a density of 90.03 individuals/km^2. The total number of households is 1052. Most of the residents practice mixed agriculture. The climate of the area is mainly "Dega", i.e., temperate type cool climate. The mean annual rainfall ranges between 950-1200 mm while the average yearly temperature is about 10-20°C (Personal contact with North Shewa Administrative Zone of Agriculture and Rural Development Department, March 20, 2018).

Study approach

A reconnaissance study was conducted to visualize the study area and identify the essential information to be gathered. A structured questionnaire was developed [17,20] which probably influence the views and attitudes of farmers towards 'tree planting, growing, and managing in agroforestry system'. Majority of socio-economic, experience, and knowledge determining questions were quantified in nominal rates with a scale of 3=yes, unsure=2, and 1=no. Greater values suggested better outlooks on planting, growing, and managing trees in agroforestry system. Distance between the nearby access road and the respondents' land where they practiced agroforestry, age, and family size, length of residence, annual income, land size and level of education were measured in continuous numbers. To complement the structured questionnaire, the participants qualitatively discussed their ideas on planting, growing, and managing trees in agroforestry system. To measure the attitudes of the participants towards 'planting, growing, and managing trees in agroforestry system', Likert scale was used with a scale of 5=strongly agree, 4=agree, 3=unsure, 2=disagree and 1=strongly disagree [24,25]. Greater values suggested positive attitudes towards 'planting, growing, and managing trees in agroforestry system'.

Data collection

A household survey was conducted by developing and administering a structured questionnaire consisting of closed- and open-ended questions. The questionnaire was prepared by accommodating socioeconomic variables, such as sex, age, family size, annual income, educational status, length of stay in the study site, livestock ownership, land ownership, land size, labor, market, local bylaws, incentives, accessibility to various forestry extension services, and the like. The questionnaire was managed with a sum of 94 randomly selected households. The total sample size was determined according to Israel [26]. The households were randomly selected through a lottery system based on their house identification numbers. The enumerators collected the questionnaire data via house-to-house visits in March 2018.

Independent variables

The independent variables included the followings:

- Sex
- Age
- Family size
- Educational level
- Annual income
- Livestock ownership
- Had adequate grazing land
- Needed to have more livestock than had at present
- Had a shortage of forage for their livestock
- Length of stay in the study site (in years)
- History of settlement in the area
- Intention to live in the study site in the future
- Private land ownership
- Land size
- Had a scarcity of fuelwood
- Had practiced agroforestry
- Planted and grew tree seedlings in agroforestry system
- Distance between the nearby access road and their land where they planted and grew trees in agroforestry system (km)
- Had enough labor to manage trees/seedlings planted and grown in agroforestry system
- Got incentives (e.g., seeds, tree seedlings, technical supports, and credits) to plant and grow trees in agroforestry system
- Had sufficient market to sell their products (e.g., wood, fruit, etc.) obtained from agroforestry system and
- Had any traditional bylaws that restrict people and/or livestock from illegally destroying the tree seedlings planted and grown in agroforestry system.

Dependent variable

The dependent variable, i.e., attitudes of the farmers towards 'planting, growing, and managing trees in agroforestry system' was derived from a statement 'agree that the agroforestry in the study site is environmentally friendly, economically feasible, and socially acceptable'.

Data analyses

Quantitative statistical method was employed to analyze and interpret the results. For example, descriptive statistics, including mean, standard deviation, frequency, and percentage were quantified to infer the characters of the respondents on the most commonly preferred tree species planted, grown, and managed in the study site. Multiple linear regression model with α=0.05 was employed to predict the attitudes of farmers towards 'planting, growing, and managing trees in agroforestry system'. However, before running the model, the household survey data were checked for assumptions, including linearity, singularity, multicollinearity, homoscedasticity, heteroscedasticity, homogeneity of variance, and normality [17,27]. There were no shortcomings with the entire independent variables to meet the aforementioned assumptions. Considering multiple comparisons (i.e., 22 tests per dependent variable) with a Bonferroni correction, $P \leq 0.002$ was judged significant. The Bonferroni correction was calculated by dividing 0.05 to 22 which is equal to 0.002 [17,27]. SPSS version 16 was used to perform the data analyses.

RESULTS

A sum of 94 respondents reacted to the questionnaire survey. A larger percentage (65.26%) of the respondents was males, and the mean age of the participants was about 42.6 years with a SD of 13.4. A mean of about 6 persons were found to live in a household. Greater than half of the respondents (54.74%) went to primary

school. A larger proportion (73.68%) of the respondents practiced mixed agriculture, and the mean annual income was about 14,336 Ethiopian Birr (ETB) (Table 1).

About three-fourth (75.79%) of the households had livestock. However, a larger proportion (60%) did not have sufficient grazing area. In contrast, the greater percentage (72.63%) of them wanted

Table 1: Sample characteristics and descriptive results of the study area.

Variables	Descriptive results	Percentage (%)
Sex	Male	65.26
	Female	34.74
Age	Mean=42.6 years; SD=13.4	
Family member	Mean=6.02 persons; SD=6.75	
	Illiterate	28.42
	Primary	54.74
Level of education	Secondary	8.42
	Diploma	3.16
	Degree	5.26
	Crop cultivation	17.89
	Livestock rearing	3.16
Occupation	Mixed farming	73.68
	Government employee	5.27
	Other	0
Annual income in ETB	Mean=14,336; ETB; SD=7,882	
Livestock ownership	Yes	75.79
	No	24.21
Had enough grazing land for their livestock	Yes	40
	No	60
Wanted to keep more livestock than had at present	Yes	72.63
	no	27.37
	Prestige	0
Reason to keep more number of livestock than had at present	Insurance during crop failure	63.59
	Enough grazing land	16.84
	Other	0
	No	19.57
Had a shortage of fodder for their livestock	Yes	46.32
	No	53.68
	Free range grazing	7.37
	Cut and carry system	24.21
Methods used by the respondents to manage the satisfaction of forage requirement	Transhumance	0
	Purchasing additional fodder	12.63
	Crop residue	23.16
	Other	0
Length of residence in the area (years)	Mean=37.07 years; SD=14.12	
History of settlement in the area	Inherited land from my ancestor	53.69
	Bought land	14.74
	Settled by own interest	4.2
	Settled by the state	27.37
	Other	0
Had the plan to stay in the area in the future	Yes	65.26
	Unsure	32.63
	No	2.11
Land ownership	Yes	92.63
	No	7.37
Land size (ha)	Mean=0.88 ha; SD=0.49	
Shortage of fuelwood	Yes	20
	No	80
Practiced agroforestry in Gudo Beret Kebele	Yes	38.95
	No	61.05
	Lack of knowledge on agroforestry	17.89
	Lack of technical support	7.37
	Shortage of the supply for agroforestry tree seedling	4.21
Reason not to practice agroforestry system in Gudo Beret Kebele	Shortage of land	34.74
	Lack of awareness about agroforestry	10.53
	Lack of appropriate knowledge about tree management	11.79
	Lack of incentive	0
	Lack of market	10.53
Planted and grew tree seedlings in agroforestry system	Yes	38.95
	No	61.05
	Three- four	0
The amount of land that the respondents allocated for agroforestry practice	Half	15.78
	Quarter	24.21
	All	0
	None	59.44
The estimated distance between the access road and the land of the respondents where agroforestry was practiced (km)	Mean=2.55 km; SD=1.29	
	Alley cropping system	0
The type of agroforestry system practiced in Gudo Beret Kebele	Inter cropping system	48.66
	Home garden	51.34
	Park line or scattered tree species	0
	Shelter belt	0
	Appropriate tree species selection	29.47
	Appropriate spacing	0
	Pollarding	0
	Pruning	1.05
Management practice used by the respondents to reduce the negative impacts of trees	Fertilizing	15.79
	Thinning	4.21
	Fencing	0
	Watering	21.05
	Composting	35.79
	Other	0
Had enough labor to manage the seedlings/ trees planted and grown in agroforestry system	Yes	49.47
	No	50.53
Got incentives	Yes	9.47
	No	90.53
The organization that provided incentives to the respondents	Government	100
	NGO	0
	Other	0

Had sufficient market to sell their agroforestry products	Yes	75.79
	No	24.21
Knew any traditional by laws that restrict people and/or livestock from illegally destroying the tree seedlings planted and grown in agroforestry system	Yes	7.37
	No	62.1
	Unsure	30.53
The specific kind of bylaw used in the study site	Punishment by money	100

to have additional number of livestock than had at moment. More than three-fifth of the households (63.59%) marked that having more heads of livestock used to guarantee as insurance during crop failure. However, more than half of them (53.68%) claimed that they had a scarcity of forage. Thus, about one-fourth of the respondents (24.21%) used to exercise cut and carry system to manage the shortage of forage (Table 1).

On average, the contacted participants had lived in Gudo Beret Kebele for about 37 years. With respect to the settlement history, about 53.69% participants underlined that they had succeeded land from their ancestors. Similarly, about 65.26% and 92.63% of them planned to live in Gudo Beret Kebele in the future and marked that they had their own private lands, respectively. The mean land size which belonged to the residents was about 0.88 ha. More than three-fourth of the households (80%) underlined that they did not have a scarcity of biomass fuel (Table 1).

Contrary to expectation, majority of the households (61.05%) noted that they did not practice agroforestry system. More than one-third of the participants (34.74%) noted that one of the main reasons that restrained the respondents not to practice agroforestry in Gudo Beret Kebele was shortage of land. Hence, majority of the households (61.05%) did not plant and grow tree seedlings in agroforestry system. The results implied that more than half of the farmers (61.05%) did not allocate their landholdings for agroforestry practice. The average estimated distance between the access road and the land of the respondents where they practiced agroforestry was about 2.55 km. About half of the contacted participants (51.34%) practiced home-garden agroforestry.

More than one-third of the farmers (35.79%) used composting to manage and reduce the negative impacts of trees on food crops and soils. However, half of them (50.53%) underlined that they had a scarcity of labor to handle the seedlings/trees planted and grown in agroforestry system. On top of this, most of the households (90.53%) complained that they did not get any incentives to practice agroforestry. Amazingly, all of the participants (100%) commented that the incentives were provided by the government. In contrast, about three-fourth of the respondents (75.79%) noted that they had sufficient market to sell their agroforestry products (e.g., wood, fruits, etc.). More than three-fifth of the participants (62.1%) noted that farmers lack knowledge on the presence of any traditional bylaws that restrict people and/or livestock from illegally destroying the tree seedlings planted and grown in agroforestry system. Surprisingly, 100% of the participants underlined that the only bylaw known and being implemented in study site was monetary punishment (Table 1).

The most commonly preferred, planted, grown, and managed tree species in agroforestry system by the local farmers in descending order, included eucalyptus species, *Acacia abyssinica*, *Croton macrostachyus*, *Sesbania sesban*, *Cupressus lusitanica*, and *Olea africana*. The farmers planted and grew those tree species mainly for charcoal, fuelwood, fencing, construction material, sale, aromatic material, soil fertility management, fodder, farm implements, timber, and wind break purposes (Table 2).

The farmers perceived that eucalyptus species have various negative effects on food crops, soils, and water. This was attached to the reality that eucalyptus trees may out complete the food crops for light, nutrients, moisture, and also make tillage practice difficult with their massive root system. As a result, farmers did not want to plant and grow eucalyptus tree species on their farmlands for fear that the species have allelopathic effects on food crops. As a result, the farmers mostly planted and grew eucalyptus tree species around their home-gardens and farm boundaries. In contrast, the farmers believed that *Acacia abyssinica*, *Croton macrostachyus*, and *Sesbania sesban* have positive effects on food crops, soils, and water. This is because the farmers consciously observed through their intuitive experience that *Acacia abyssinica*, *Croton macrostachyus*, and *Sesbania sesban* trees can fix nitrogen, increase soil fertility, and thereby make nutrients readily available for food crops grown in association with those trees in agroforestry system. Moreover, the farmers believed that the aforementioned tree species can reduce soil erosion caused by rainwater and thereby conserve the water in the soil system (Table 3).

About three-fourth (73.33%) of the participants strongly agreed that they developed positive attitudes towards 'planting, growing, and managing trees in agroforestry system' are environmentally friendly, economically feasible, and socially acceptable in the study site (Table 4).

The multiple linear regression model showed that numerous socioeconomic variables significantly influenced the attitudes of farmers towards 'planting, growing, and managing trees in agroforestry system because they believed that agroforestry land use is environmentally friendly, economically feasible, and socially acceptable. As detected from their slopes, family size (ß =0.20),

Table 2: The most commonly preferred, planted, grown, and managed tree species by the farmers in agroforestry system together their main purposes in Gudo Beret Kebele.

No	Tree species	Number of respondents	Main purposes of the tree species grown
1	Eucalyptus species	34	Charcoal, fuelwood, fencing, construction material, for sale, and windbreak
2	Acacia abyssinica	28	Charcoal, fuelwood, soil fertility management, and farm implements
3	Croton macrostachyus	28	Charcoal, fuelwood, soil fertility management, shade, and farm implements
4	Sesbania sesban	27	Fodder, fuelwood, and soil fertility management
5	Cupressus lusitanica	24	Charcoal, fuelwood, construction material, timber production, fencing, for sale and windbreak
6	Olea africana	2	Charcoal, for sale, aromatic material, farm implements, and shade

Table 3: The views of farmers on the six commonly preferred, planted, grown, and managed tree species in agroforestry system with respect to their main effects on food crops, soils, and water. The number of respondents was shown in the table.

No	Tree species	Effects on food crops		Effects on s oils		Effects on water	
		+ve	-ve	+ve	-ve	+ve	-ve
1	Eucalyptus species	0	13	0	12	0	10
2	Acacia abyssinica	28	0	27	0	11	0
3	Croton macrostachyus	21	0	20	0	5	0
4	Sesbania sesban	18	0	21	0	10	0
5	Cupressus lusitanica	0	0	0	0	0	0
6	Olea africana	0	0	0	0	0	0

Table 4: Descriptive results for item measuring the attitudes of the farmers towards 'planting, growing, and managing trees in agroforestry system' in Gudo Beret Kebele

Belief statement	Strongly Agree (%)	Agree (%)	Unsure (%)	Disagree (%)	Strongly Disagree (%)	M (SD)*	Factor loading score
Agree that planting, growing, and managing trees in agroforestry system is environmentally friendly, economically feasible, and socially acceptable.	73.33	9.7	4.24	12.73	0	4.44 (1.05)	0.75

*Scale values (Strongly agree = 5 through strongly disagree = 1) were used to calculate mean (M) and standard deviation (SD) values, where higher values indicate more positive attitudes towards 'planting, growing and managing trees in agroforestry system is environmentally friendly, economically feasible and socially acceptable'.

Table 5: Multiple linear regression model to predict the attitudes of the farmers towards 'planting, growing, and managing trees in agroforestry system'

Variable	Attitudes towards 'planting, growing, and managing trees in agroforestry system''		
	ß	t	P value
Intercept	4.15	17.79	-
Sex (Male=1; Female=2)	-0.07	-0.64	0.526
Age	0.02	0.17	0.865
Family size	0.2	3.18*	0.002
Level of education	0.24	3.69*	0.001
Annual income	-0.04	-0.37	0.716
Livestock ownership (Ye =3; No=1)	0.07	0.7	0.485
Had enough grazing land (Yes=3; No=1)	0.02	0.2	0.84
Needed to keep more livestock than had at present (Yes=3; No=1)	0.35	3.57*	0.001
Had a shortage of fodder for their livestock (Yes=3; No=1)	0.17	3.34*	0.002
Length of residence in the area (in years)	0	0.02	0.994
History of settlement in the area	0.08	0.79	0.43
Had the plan to stay in the area in the future (Yes=3; Unsure=2; No=1)	0.25	3.74*	0.001
Had private land ownership (Yes=3; No=1)	0.3	4.08*	0.001
Land size (ha)	0.06	0.5	0.616
Had a shortage of fuelwood (Yes=3; No=3)	0.05	0.52	0.601
Had practiced agroforestry (Yes=3; No=1)	0.04	0.35	0.728
Planted and grew tree seedlings in agroforestry system (Yes=3; No=1)	0	0.04	0.971
Distance between the nearby access road and the respondents' land where they planted and grew trees in agroforestry system (km)	-0.11	-1.1	0.274
Had enough labor to manage the trees/seedlings planted and grown in agroforestry system (Yes=3; No=1)	0.16	1.62	0.109
Got incentives (e.g., seeds, tree seedlings, technical supports, and credits) to plant and grow trees in agroforestry system (Yes=3; No=1)	0.22	3.32*	0.002
Had sufficient market to sell their products (e.g., wood, fruit, and other products) obtained in agroforestry system (Yes=3; No=1)	0.03	0.31	0.756
Knew any traditional bylaws that they used to restrict people and/or livestock from illegally destroying the tree seedlings planted and grown in agroforestry system (Yes=3; Unsure =2; No=1)	-0.3	-3.18*	0.002
b. + indicates a positive change in attitude and - a negative change in attitude. A Standardized coefficients were reported; * represents significance at the 95% confidence level; bAdj. R2 = 0.36, df = 21; F = 12.73, overall P = 0.001.			

educational status (ß =0.24), needed to have more number of livestock than had at the moment (ß=0.35), those who had a scarcity of forage to livestock (ß =0.17), had the plan to live in Gudo Beret Kebele in the future (ß =0.25), had private land ownership (ß =0.30), and those who got incentives (e.g., seeds, tree seedlings, technical supports, and credits) to plant and grow trees in agroforestry system (ß =0.22) significantly had positive attitudes towards 'planting, growing, and managing trees in agroforestry system'. In contrast, those who had knowledge on the traditional bylaws that restrict local people and/or livestock from illegally destroying the tree seedlings planted and grown in agroforestry system (ß =-0.30) significantly had negative attitudes towards 'planting, growing, and managing trees in agroforestry system'. Generally, the regression model explained about 36% of the variance in attitudes of the respondents towards 'planting, growing, and managing trees in agroforestry system' (Table 5).

DISCUSSIONS

The present study investigated the views and attitudes of farmers towards 'planting, growing, and managing trees in agroforestry system' in Basona Worena District, Ethiopia. In contrast to expectation, the present study demonstrated that majority of the farmers did not practice agroforestry land use in the study site. One of the plausible causes for such surprising outcome is explained by the shortage of land to grow seedlings in agroforestry system. For example, due to the shortage of land, most of the farmers planted and grew trees around their home-gardens. Previous studies also noted that farmers in eastern and southern Ethiopia were not voluntary to plant trees on their farmlands when they had a shortage of land, but they used to plant trees along roadsides and around their homesteads [28-30]. Moreover, lack of technical knowledge on agroforestry system and its values (e.g., ecological, economic, and social), lack of appropriate knowledge on tree management in agroforestry system, shortage of awareness about agroforestry technologies, lack of technical support, and shortage of input (e.g., tree seeds and seedlings) are also believed to hinder people not to actively practice agroforestry land use. Similarly, previous studies noted that farmers' decision to plant and grown trees in the highlands of Ethiopia is mainly affected by labor availability, presence of market to forest products, access to tree seeds and seedlings, technical knowledge, provision of extension services, farmland ownership and size [23,31].

However, those farmers who practiced traditional agroforestry in Gudo Beret Kebele mainly exercised it to meet their household wood demands. For example, based on their economic benefits, the most commonly preferred tree species planted and grown by the farmers in agroforestry system in descending order, included eucalyptus species, *Acacia abyssinica*, *Croton macrostachyus*, *Sesbania sesban*, *Cupressus lusitanica*, and *Olea africana*. Moreover, the results suggested that the farmers planted and grew those tree species mainly for wood-based products, including charcoal, fuelwood, fencing, construction material, sale, fodder, farm implements, and timber. Other studies also noted that farmers mostly practice traditional agroforestry to earn wood-based products [4,6,7,32].

Regardless of its attractive economic benefits, farmers did not want to plant and grow eucalyptus trees on their farmlands for fear that the trees have allelopathic effects on food crops. Farmers also thought that eucalyptus trees have negative effects on soils and water. Moreover, the farmers complained that planting and growing eucalyptus trees with food crops may increase competition for water, nutrients, and light. Various research findings also claimed that soil acidification, nutrient depletion, and allelopathic effect [33-37] as well as excessive water utilization [36,38,39] are the typical negative environmental effects of eucalyptus trees especially when it is planted and grown together with food crops [38-40]. In addition, the farmers learned from their visual experience that the massive root system of eucalyptus trees makes tillage very difficult if eucalyptus is grown on farmlands. Other studies suggested that the roots of eucalyptus trees make plowing hard when they are grown on farmlands [35,41]. As a result, farmers mostly used to plant and grow eucalyptus trees around their homesteads and farm boundaries. In addition, to control the adverse effects of tree species in agroforestry system, the farmers in Gudo Beret Kebele used different management techniques, including composting, appropriate tree species selection, watering, and fertilizing. Similarly, other research findings suggested that the negative effects of trees in agroforestry system can be managed if proper tree management operations are put in place [35,41-43].

In contrast, the farmers believed that *Acacia abyssinica*, *Croton macrostachyus*, and *Sesbania sesban* have positive effects on food crops, soils, and water. This is because the farmers observed through their conscious experience that *Acacia abyssinica*, *Croton macrostachyus*, and *Sesbania sesban* trees can fix nitrogen, increase soil fertility, and thereby make nutrients readily available to food crops grown in association with those tree species in agroforestry system. Several previous studies also supported these contextual argumentations [4,6,9,10,35,41,44]. In addition, the farmers believed that those tree species can reduce soil erosion caused by rainwater and thereby conserve the water in the soil system. However, the farmers believed that *Cupressus lusitanica* and *Olea africana* had neither positive nor negative effects on food crops, soils, and water. Nevertheless, this may need further experimental studies to test whether the intuitive beliefs of the farmers is scientifically true or not.

Generally, the results showed that farmers had positive (87.5%) rather than negative (12.5%) attitudes towards 'planting, growing, and managing trees in agroforestry system'. As a result, the farmers had developed the beliefs that planting, growing, and managing trees in agroforestry system is environmentally friendly, economically feasible, and socially acceptable.

The multiple linear regression models showed that different socioeconomic variables significantly influenced the attitudes of the farmers towards 'planting, growing, and managing trees in agroforestry system'. As shown in their slopes, family size, educational level, needed to have more livestock than had at the moment, scarcity of forage, planned to live in the study site in the future, land ownership, and those who got incentives (e.g., seeds, tree seedlings, technical supports, and credits) to plant and grow trees in agroforestry system significantly had positive attitudes towards 'planting, growing, and managing trees in agroforestry system'. Similarly, other findings suggested that farmers' attitudes towards growing and managing trees were positively influenced by various socio-economic variables [20,23,37,45-50]. In contrast, those respondents who knew any traditional bylaws that restrict people and/or livestock from illegally destroying tree seedlings planted and grown in agroforestry system significantly had negative attitudes towards 'planting, growing, and managing trees in agroforestry system'.

One of the possible reasons for the increase in positive attitudes towards 'planting, growing, and managing trees in agroforestry system' with the increase in family size revealed that respondents

with greater number of family members may have more labor available to practice agroforestry in Gudo Beret Kebele. In addition, as the management practices for most of agroforestry technologies are labor intensive, households with large labor forces have more probability to accept agroforestry land use practice than those with low number of labors. The increase in the positive attitudes of farmers towards 'planting, growing, and managing trees in agroforestry system' with the increase in level of education suggested that educated people may be more aware of the various values of agroforestry technologies. On top of this, previous studies noted that educated people would able to effectively manage trees in agroforestry system through implementing appropriate tree species selection and tending operation [4,51]. As one of the benefits of agroforestry is to make fodder available for livestock, the positive attitudes of the farmers towards 'planting, growing, and managing trees in agroforestry system' may be explained by the demands of fodder, shelter, and shade for livestock when the livestock numbers increases with time. Moreover, when the farmers had a scarcity of forage, they would be more interested in planting, growing, and managing trees in agroforestry system because trees provide forage [4,6]. So, the farmers would likely develop positive attitudes towards 'planting, growing, and managing trees in agroforestry system' when they have a scarcity of forage to feed their livestock.

The increase in positive attitudes of farmers towards 'planting, growing, and managing trees in agroforestry system' with the increase in those who had the plan to live in Gudo Beret Kebele in the future could be explained by the fact that people who will live in the study site in the future may be more conscious about their environment as compared with those who don't have the plan to live in the area in the future. On top of this, those farmers who had the vision to live in the study site in the future may believe that agroforestry land use could be environmentally friendly, economically feasible, and socially acceptable technology. Several research findings also suggested that agroforestry is essential for conserving biodiversity, keeping ecological integrity, enhancing soil nutrients availability, regulating local weathers, and also source of income [4,6-8]. The positive correlation between the attitudes of the farmers towards 'planting, growing, and managing trees in agroforestry system' with private land ownership suggested that those farmers who had private land ownership could be much interested in practicing agroforestry land use [29-31]. Moreover, the positive correlation between the attitudes of farmers towards 'planting, growing, and managing trees in agroforestry system' and access to incentives (e.g., seeds, tree seedlings, technical supports, and credits) could be explained by those who got incentives may be more attracted to adopt and practice agroforestry technologies.

In contrast, the negative correlation between the attitudes of farmers towards 'planting, growing, and managing trees in agroforestry system' and knowledge on the presence of traditional bylaws that restrict people and/or livestock from illegally destroying the tree seedlings planted and grown in agroforestry system is reasoned out by the monetary punishment. Other findings also suggested that the attitudes of farmers towards growing and managing trees were negatively related to the practice of traditional bylaws that restrict people and/or livestock from illegally destroying the tree seedlings planted and grown in an area [20,46,47]. As a result, those farmers may develop negative attitudes towards practicing agroforestry land use.

CONCLUSIONS

Contrary to expectation, the present study demonstrated that a greater number of farmers did practice agroforestry in Gudo Beret Kebele. One of the main reasons for such surprising outcome is attributed to the shortage of land to plant trees in agroforestry system. For example, due to the shortage of land, most of the farmers planted and grew trees around their home-gardens and farm boundaries. The preference of farmers to plant and grow trees was mainly determined based on the economic importance of the tree species. Based on their economic benefits, the most commonly preferred tree species planted, grown, and managed by the farmers in descending order, included eucalyptus species, *Acacia abyssinica*, *Croton macrostachyus*, *Sesbania sesban*, *Cupressus lusitanica*, and *Olea africana*. The findings revealed that farmers planted, grew and managed trees in agroforestry system mainly for wood-based products, including charcoal, fuelwood, fencing, construction material, farm implements, and timber.

The present findings showed that the farmers had good views on the positive and negative impacts of tree species on food crops, soils, and water. For example, the farmers did not want to plant and grow eucalyptus trees on their farmlands for fear that they have allelopathic effects on food crops. Farmers also thought that eucalyptus trees have negative effects on soils and water. Moreover, the farmers complained that planting and growing eucalyptus trees on the same plot of land with food crops may increase competition for water, nutrients, and light. As a result, farmers mostly planted and grew eucalyptus trees around their home-gardens and farm boundaries. In addition, to reduce the negative impacts of tree species in agroforestry system, the farmers used different management techniques, including composting, appropriate tree species selection, watering, and fertilizing. In contrast, the farmers had developed the beliefs that *Acacia abyssinica*, *Croton macrostachyus*, and *Sesbania sesban* have positive effects on food crops, soils, and water. This is because the farmers observed through their intuitive experience that *Acacia abyssinica*, *Croton macrostachyus*, and *Sesbania sesban* trees can fix nitrogen, increase soil fertility, and thereby make nutrients readily available for food crops grown in association with those tree species in an agroforestry system. The regression model suggested that a number of socioeconomic variables significantly affected the attitudes of the farmers towards 'planting, growing, and managing trees in agroforestry system'. Overall, the findings suggested that the farmers had positive attitudes towards 'planting, growing, and managing trees in agroforestry system' in the study site.

To resolve the prevailing challenges identified in the study site, the followings were recommended:

- In contrast to expectation, majority of the farmers in Gudo Beret Kebele did not practice agroforestry land use. Therefore, providing improved agroforestry extension services, including incentives (e.g., seeds, tree seedlings, technical supports, and credits) may help increase the active participation of the farmers to adopt plant, grow, and manage trees in agroforestry system.
- The district's forestry office should ensure that improved agroforestry extension services are provided to the farmers in the study site. This in turn will help increase the awareness level of the farmers towards 'planting, growing, and managing trees in agroforestry system'.
- Provision of adequate technical training to the farmers on

agroforestry technologies is mandatory. This in turn assists the farmers to have their own tree nurseries by which they can raise their preferred tree seedlings to practice agroforestry. So, government, non-governmental organizations, and forestry experts should be the active stakeholders to initiate and exercise the provision of both formal and informal technical trainings to the farmers.

- Farmers' cooperative groups should be encouraged to form formal cooperation so that they can practice agroforestry in group.
- Establishing agroforestry demonstration site is essential to promote the adoption of agroforestry technologies in Basona Worena District and elsewhere.

Ethics approval and consent to participate

Not applicable in this section.

Consent for publication

Please contact author for data requests.

Author's contributions

SAT conducted the study, analyzed the data, interpreted the results, and wrote the manuscript.

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COMPETING INTERESTS

The author declares that he has no competing interests.

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