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ORIGINAL RESEARCH

Determinants of Smallholders' Commercial Plantation Establishment: Challenges and Opportunities to Promote Tree-Based Livelihood in Ethiopia

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Abstract

Small-scale plantations for commercial purposes bring a variety of benefits, including increased revenue, employment, and improved household livelihood. However, empirical research on the factors that affect smallholders' decisions to establish commercial plantations is lacking. This study aimed to discover the factors that influence smallholder farmers' commercial tree-planting decisions in Ethiopia's central and southern regions. Cross-sectional data were collected from 255 households using structured, semi-structured questionnaires. The Heckman two-stage selection model was used to examine smallholder farmers' participation in commercial tree planting and land allocated for tree planting. The results of the regression analysis revealed that education level of the household head, distance of the plot from home, distance of the plot to the market, size of livestock holdings, and frequency of contact with extension agents had a significant impact on the probability of participation in commercial tree planting by a household. In addition, the move to tree-based livelihoods was hampered by lack of capital and scarcity of land. Because trees take a long time to generate income for tree planters, it is critical to focus on creating alternative income-generating opportunities for smallholders until the trees reach harvest age.

Keywords Commercial plantation · Participation in tree planting · Tree-based livelihood · Tree planting

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Introduction

Over the next 20 years, the demand for all forms of wood products in Ethiopia is anticipated to increase by around 27%, reaching 158 million cubic meters annually by 2033 (EFCCC 2020). To meet the needs of Ethiopia's expanding economy over the next 20 years, 4.4 million cubic meters of industrial round wood will need to be filled (EFCCC 2020). Due to the growing demand for forest products and the escalating import costs of wood products, the necessity to develop forests is becoming more and more important (Busha 2021). Given that smallholder woodlots are currently the primary source of round wood, this challenge creates a significant investment opportunity for Ethiopia, which can fill the gap through the establishment of plantations, sustainable management of forest resources, and expansion of the forestry sector's industrial base (EFCCC 2020). At present, smallholder woodlots are the main source of round wood. As a result, Ethiopia is expanding its small-scale plantations, showing how well accepted they are as a viable source of income for smallholder farmers (Abebe et al. 2019).

Small-scale plantation forestry, owned and managed by smallholder farmers in rural communities, is vital for the survival of forestry and wood production industries in various African, Asian, and South American countries (Nambiar 2021). Small-scale forestry systems provide smallholders with subsistence products and revenue as well as a variety of environmental functions (Versteeg et al. 2016). Due to their size, ownership of forest land parcels, and potential openness to tree management techniques, smallholder farmers play a significant role in the supply of wood (Vallesteros 2016). Empirical research suggests that small-scale plantations for commercial purposes bring a variety of benefits, including increased revenue, employment, and improved household livelihood (Das 2012). However, small-scale tree growers and poor households still reap only a small portion of the commercial benefits from plantation-derived wood and processed wood products (Nawir et al. 2007). For smallholder tree cultivation to be effective, farmers must overcome various challenges (Rahman et al. 2017). Previous research has indicated that locally and nationally recognized systems of secure access to land, supportive policies and legislation, and reliable and stable markets have contributed significantly to the establishment of private, farm-based plantation forestry (Nawir et al. 2007).

In Ethiopia, small-scale tree plantations are believed to play a role in solving problems associated with the sustainable use of agricultural land, reversing the adverse effects of lost forests, and fulfilling the livelihood and energy requirements of the ever-increasing population (Keneni et al. 2021). However, smallholder farmers who own land have a variety of internal and external influences on the growth and maintenance of smallholder tree plantations (Abate and Yohannes 2022). Several studies examined the importance of smallholder plantations in Ethiopia (Mitiku 2020; Wubalem et al. 2019; Yilebes and Mandefrot 2019; Fentahun et al. 2016; Berhan et al. 2016; Abrham et al. 2015). However, empirical research on the factors that affect smallholders' decisions to establish commercial plantations is lacking. This study aimed to evaluate the factors that influence smallholder farmers' decisions to establish small-scale commercial plantations using survey data from central and southern Ethiopia. This study identified existing concerns about planting, managing, developing, and using farm forests sustainably, which could aid legislators, land-use planners, environmental analysts, forest conservationists, and management experts in considering the demographic, socioeconomic, biophysical, and institutional factors that influence smallholders' establishment of commercial plantations.

Materials and Methods

Description of the Study Area

Welmera district is located in the Oromia Special Zone. It is located 40 km west of Addis Ababa. Geographically, the district is located between 90 04′02″N−90 12′55″N latitude and 380 29′ 18″ E−380 34′ 00″ E longitude with an area of 775 km^2 (Tokuma 2018). On the other hand, the Chorso District is a newly established district located in the Gedeo zone of the Southern Nations, Nationalities, and Peoples Region (SNNPR). Geographically the district is located between 50 58′ 35″N − 60 2′ 14″N latitude and 380 16′51″E − 380 12′50″E longitude. It is located 420 km south of Addis Ababa. (DANRO 2021) (Fig. 1).

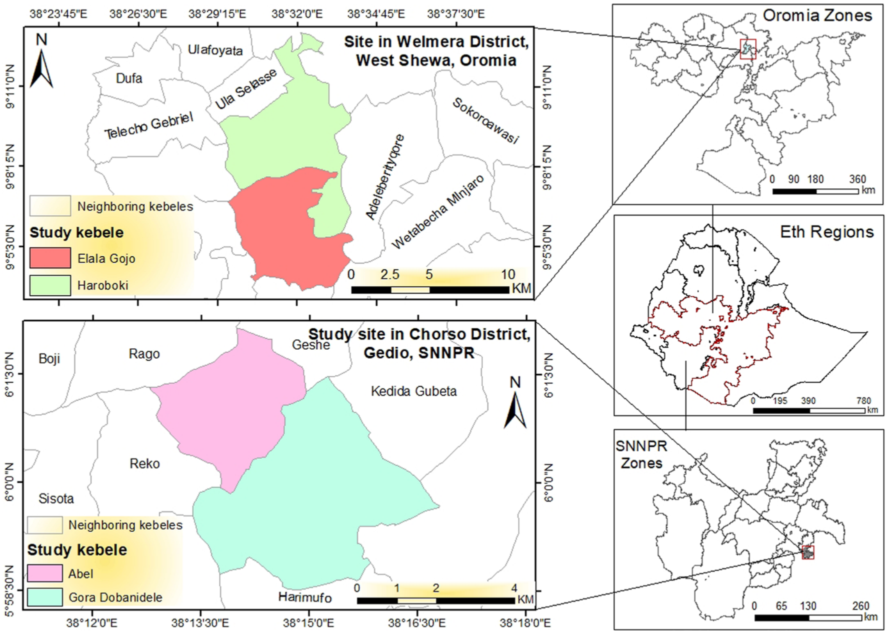

Fig. 1 Map of study areas

Sampling Procedure and Sample Size Determination Technique

In this study, a multistage sampling strategy was used. First, the two districts were chosen based on their access to all-weather roads and tree-based livelihood practices in the Oromia and SNNP regions. Second, using stratified random sampling, two kebeles from each district were chosen based on their dominance in terms of tree coverage. Two strata of kebeles were identified: those with high and those with low tree coverage. Haro Boki and Welmera-Choke/Elala Gojo/ kebeles in the Welmera district and Abel and Gora Dibandibe kebeles in the Chorso district were studied based on this. A simple random sampling technique was used to select the 255 households (Table 1). Sampling rate was determined proportionately based on household size in each kebele. In this study, the formula provided by Yamane (1967) was used to determine the required sample size at the 95% confidence level.

$$N = N/1 + N\,(e)^2 \tag{1}$$

where n is the sample size, N is the total household size (four kebeles of two districts), and e is the level of precision, which was e = 6% because of the time and budget constraints.

Methods

Primary and secondary data were also collected. Primary data were collected through household surveys, focus group discussions, key informant interviews, and direct field observation.

Household Survey

Semi-structured questionnaires were used to obtain data from households in the survey. The household questionnaire included demographic, institutional, socioeconomic, and biophysical questions that influenced smallholders' decisions to plant trees and their livelihood options. Before the actual survey, the questionnaire was pretested on ten households from each district to collect input from enumerators, and modifications were made depending on the information gained. Face-to-face interviews were conducted to gather information directly from the 255 households. The researcher developed the surveys and four enumerators administered the surveys in the local language (Amharic, Afan Oromo, and Gediogna).

Table 1 Sample size for the study

S/no.	District	Kebele	Total households	Sample size
1	Chorso	Abel	450	36
		Gora Dibandibe	1538	123
2	Welmera	Elala Gojo	738	59
		Haro Boki	462	37
Total			3188	255

Focus Group Discussion, Key Informant Interviews, and Field Observations

Focus group discussions (FGDs) were held in two kebeles each with ten participants. Members of the FGD were chosen based on their participation in woodlot management and willingness to offer their opinions. The main topics of the focus group discussion were challenges and opportunities to promote tree-based livelihoods.

On the other hand, six key informants from each kebele were chosen using snowball method of non-probability sampling technique. The first key informant was intentionally selected in consultation with experts from agricultural and rural development offices, local administrators, forestry supervisors, and development agents. Following the first key informant interview, the second key informant was selected based on the recommendation of the first key informant and so forth. The key informant interviews focused on different land use practices, livelihood strategies, wealth ranking, and the growing transition to plantation land use in the study areas.

Field observations on the situation in the area and prospective opportunities to promote tree-based livelihoods were conducted in the field, with photographic material acquired as a backup. Secondary data were also collected from District Agriculture and Natural Resource office to gain information regarding list of households participating in commercial tree plantation.

Data Analysis

Quantitative data from the household survey were analysed using descriptive statistics. The effects of various demographic, socioeconomic, institutional, and biophysical factors on smallholder decisions regarding commercial plantation establishment were studied using Heckman's two-stage model. Data were analysed using Stata version 14.2.

To identify the factors affecting smallholders' tree-planting decisions, the Heckman two-step model was used. Because participation in tree planting is represented by a binary variable, those who decide to participate might not plant a sufficient number of trees, implying that the decision to participate in tree planting and the decision to plant more trees are two separate decisions. If both decisions are involved in the participation and land allocated for tree planting in hectare, Heckman's (1979) two-step estimation procedure is appropriate.

The first stage of the Heckman model attempts to identify the factors affecting participation in smallholder tree planting (the participation equation). This equation was used to construct a selective term, known as "the Inverse Mills Ratio," which added to the second stage "outcome equation" which explains the factors affecting the intensity of tree planting (land allocated for tree planting in ha). The inverse Mills ratio was used to control for sample selection bias (Heckman 1979). The second stage involves the Mills ratio to the intensity of the tree planting equation and estimating the equation using Ordinary Least Squares (OLS).

The structure of the sample-selection model consists of two systems of equations. The first equation is the selection equation, defined as.

$$Y1i = \begin{cases} 1, & Yi^{*} > 0 \\ 0, & otherwise \end{cases} \quad (2)$$

$$Y_{1i}{}^{*} = X_{1i}\beta_{1i} + \epsilon_i \quad (3)$$

where Y_{1i} is the probability of participation in smallholder tree planting; which is a dummy variable that assumes a value of 1 for participants, and 0 otherwise. i = 1, 2, 3, 4 … n. $Y_{1i}{}^{*}$ is a latent variable; X_{1i} are the variables determining participation in the Probit model; β_{1i} is an unknown parameter to be estimated in the Probit regression model; and ε_i is a random error term.

The second equation is a linear model of interest. The ordinary least squares regression method was used to estimate the factors affecting the intensity of tree planting (land allocated for tree planting in hectare).

$$Y_{2i} = X_{2i}\beta_{2i} + \mu_i\lambda_i + \varepsilon_i \quad (4)$$

where Y_{2i} is land allocated for tree planting in hectare; X_{2i} is the independent variables determining land allocated for tree planting in hectare; β_{2i} is an unknown parameter; μ_i is a parameter that shows the impact of selectivity bias on the general role, and ε_i is the error term.

$$\lambda i = \frac{f(Xi\beta i)}{1 - f(X1i\beta i)} \quad (5)$$

where f (Xiβi) is a density function and 1−f (X i βi) is a distribution function.

The coefficient of the inverse Mill's ratio indicates a selection bias. If the coefficient of the "selectivity" term is significant, the hypothesis that an unobserved selection process governs the participation equation is confirmed.

Definition of variables

The major variables expected to influence smallholders' decision to participate in establishing commercial plantations are explained in this section (Tables 2, 3).

The variable "livestock size" is notably included in the selection equation but not in the outcome equation. Livestock considered as an important variable in defining participation decision due to its contribution to farmer's wealth. It might not, however, necessarily define the intensity of tree planting (land allocated for tree planting in hectare). Livestock is used as a selectivity term (instrumental variable) to ensure that the coefficients in the outcome equation are identified.

Table 2 Summary of hypothesized explanatory variables

Code	Variables	v/type	Sing
Dependent variables			
DECP	Participation in commercial plantation (1 = yes; 0 = no)	Categorical	
LATP	Land allocated for tree planting in hectare	Continuous	
Independent variables			
SEXHH	Sex of the household head (1 = male; 0 = female)	Dummy	+
EDUSHH	Educational status of the household head	Continuous	+
LIVHSIZE	Livestock holding size (TLU)	Continuous	+ /–
AEXTSER	Extension service (1 = frequently visited; 0 = otherwise)	Dummy	+
DISFHOM	Distance of the plot from home (Km)	Continuous	
DISFMRKT	Distance of plot from the market (Km)	Continuous	
AINCOM	Annual income of household	Continuous	+
SLOLA	Slope of land (1 = moderate-steep; 0 = flat)	Dummy	+
LODS	Location of districts (Welmera = 1)	Dummy	+
ACTQS	Access to quality seedlings (1 = yes 0 = no)	Dummy	+
Kebele	Kebele (1 = kebeles having high tree coverage)	Dummy	+

Table 3 Households' socio-economic characteristics

No.	Variables	Participants (n = 164)		Non-participants (n = 91)	
		Mean	STD	Mean	STD
1	Age (year)	47.09	11.72	34.97	7.53
2	Education (year)	6.60	2.77	1.48	1.84
3	Family size (number)	6.80	2.37	5.95	2.34
4	Land size (Hectare)	1.66	1.05	1.09	1.00
5	Income (Birr)	12,286	12,131	7252	8201
6	Distance of plot from home (km)	1.9	2.13	4.15	3.25
7	Distance to market (km)	3.70	3.28	8.53	3.54
8	Livestock size (TLU)	2.96	1.74	1.63	1.43
9	Farming experience (Year)	24.69	10.12	13.96	5.84

Results and discussion

Households' Characteristics

Of the total survey households, 14.5% were female and 85.5% were male. The average ages of tree planters (tree managing smallholder farmers) and non-planters were 47.09 years and 34.97 years, respectively. This means that the tree-planting participants were older than the non-planting participants were. The average family size of the participants was 6.8, whereas that of the non-participants average family size was 5.95. The educational levels of the participants and non-participants were approximately 6.6 and 1.48 years of schooling, respectively. One of the most essential aspects of the output of any investment, especially in a rural location, is the size of land. In the study area, participants had an average landholding of 1.66 ha, whereas non-participants had an average landholding of 1.09 ha in the study area. The participants' average annual gross income was 12,286 Ethiopian Birr ($279.2), whereas non-participants' average annual gross income was 7252 Ethiopian Birr ($164.8). The average livestock holding sizes of participants and non-participants were 2.96 and 1.63 Tropical Livestock Unit (TLU), respectively. The average farming experience of tree planters' and non-planters' was 24.69 and 13.96 years, respectively. This demonstrates that heads of households with extensive farming knowledge play an active role in tree-planting initiatives.

Tree Planting and Commercialization

In Chorso, 52.20% of the respondents planted trees on perceived infertile or degraded farmlands, whereas in Welmera, 60.42% planted trees on perceived infertile or degraded farmlands. According to the survey data, 60.42% of respondents in the Welmera district planted trees for commercial purposes. This is because of the district's competitive advantage in terms of infrastructure, such as all-weather roads, and its significant market demand. A total of 35.38% of the respondents in the Chorso district planted trees for commercial purposes. A minor percentage of respondents in both districts said that they also planted trees for fuel wood use (26%) and as live fences (23%).

In the previous year, 57.77% of the Chorso district households and 73.96% of the Welmera district households sold trees and tree products. Trees and tree products were the principal sources of income for 42.14% of Chorso district respondents and 60.42% of Welmera district respondents. In the Chorso district, trees and tree products contributed 45.5% of the total annual income, whereas in the Welmera district, they contributed 49.84%.

Dominant tree Species in the Study Areas

The most dominant tree species in the study sites was eucalyptus globules, which was reported by approximately 70% of the respondents in the two districts. Although eucalyptus species have a detrimental effect on ecological balance and a negative allelopathic effect (Wasihun 2012), farmers have favored planting eucalyptus trees on their farmland. In contrast to other crops, FGD participants stated that eucalyptus benefited their livelihoods by providing a high income and serving as collateral to gain credit. Because eucalyptus has a low input cost, there is a good chance of making a profit. Another benefit of smallholder tree growers in the study area is that they are adaptable to fragile landscapes. The survey also revealed that indigenous trees such as Juniperus procera (Yeabesha Tid) in both districts, waterberry (Dokima) in Chorso district, Acacia decurrence (Girar), and Olea africana (woira) in the Welmera district were the other most abundant tree species in the study area. The difficulty with these trees is that they do not regenerate after being cut down and do not grow as quickly as Eucalyptus species (DANRO 2021).

Determinants of Farmers Participation Decision on the Commercial Plantation

The results of estimating the drivers of smallholder commercial plantation establishment using a first-stage probit model for the sampled households are shown in Table 4. At a probability level of less than 1%, the overall goodness of fit of the probit model was statistically significant. Among the 11 explanatory variables included in the model, six factors in the selection equation were statistically significant.

Participation in smallholder commercial plantations was positively and significantly associated with respondents' educational attainment at less than 1% level of significance. When other parameters were held constant, as schooling increased by one unit, the probability of participating in tree-planting decisions increased by 10.5%. This is because the educational attainment of the household head may diversify household earnings and boost livelihood status. This study is similar to that of Berhan et al. (2016), who discovered that literacy encourages people to participate in land recovery tree planting. Miller et al. (2016) found that the adoption and land allocation to fruit trees and tree cash crops increased with the education level of the household head.

The distance between the plot and home had a significant negative relationship with the decision to participate in smallholder commercial plantations at a significance level of less than 1%. When all other parameters were held constant, the marginal effect verified that a kilometer increase in the distance between the plot and the farmer's home reduced the likelihood of farmers participating in tree planting by 3%. This implies that the smallholder's incentive to participate in tree planting

Table 4 Maximum likelihood estimates of first-stage Probit estimation

Variables	Participation			
	Marginal effects	Coeff.	Std. error	*P*-value
Education	0.105***	0.775	0.161	0.000
Ln Income	0.078*	0.578	0.318	0.069
Distance of plot	– 0.030**	0.220	0.095	0.021
Distance from market	– 0.032***	0.235	0.077	0.002
Location of districts	0.017	0.133	0.525	0.802
Livestock size	0.065**	0.478	0.186	0.010
Sex	0.810***	2.878	0.811	0.000
Extension service	0.383***	1.924	0.566	0.001
Slope of land	0.077	0.522	0.476	0.272
Kebele	0.143	0.814	0.495	0.100
Access to seedlings	0.032	0.223	0.476	0.624
_Cons		– 11.22	3.359	0.001

*, **, and *** stand for statistical significance at 10%, 5%, and 1% probability levels respectively

decreases as the plot becomes farther away from home. This finding is similar to that of Ashraf et al. (2015), who discovered that farmers are less likely to participate in tree-planting when their homes are far from the farm.

Smallholder commercial tree plantations were inversely associated with plot distance from the nearest market. When all other conditions were equal, the likelihood of participation in tree planting decreased by 3.2% when the market distance was increased by one kilometer. This implies that tree planters with plots far from the market are subject to time delays and knowledge asymmetry, and are unable to obtain market benefits as easily as smallholder tree growers with plots closer to the market. This finding is in line with that of Abay (2014), who claimed that forest users living far from the market incur transportation costs, time delays, and information problems.

Farmers' tree-planting decisions were positively and significantly associated with access to extension services. The marginal effect found that households with access to extension services had a 38.3 times higher chance of participating in tree-planting activities than their counterparts, when all other variables were held constant. Forest extension programs are frequently credited with pushing farmers to adopt tree-planting and other natural resource management practices. Farmers who maintain regular contact with development agents are more likely to obtain new technological information in a timely and convenient manner. This finding is consistent with that of Kyaw et al. (2018) and Edosa (2018).

Farmers' tree-planting decisions were positively and significantly influenced by their livestock holdings (TLU). While all other variables remained constant, the chance of participation in tree-planting decisions increased by 6.5% as the number of animals grew by one TLU. One possible explanation is the contribution of livestock to farmers' wealth. In terms of household wealth contribution, Zeleke (2009) discovered that livestock had a favorable and significant impact on the chance of planting trees.

The sex of the household head has a positive relationship with a household's decision to participate in a commercial plantation. Male-headed households had an 81 times higher chance of participating in tree planting than female-headed households, when all other variables were held constant. This implies that tree planting is highly dominated by men. According to studies by Zeleke (2009) and Musyoki et al. (2013), the low chance of female-headed households producing trees may be a reflection of the agricultural division of labor (a cultural factor) that exists in research areas and elsewhere in the country.

Determinants of Intensity of tree Planting

The overall goodness of fit of the model was significant at less than 1%, indicating that at least one of the explanatory variables differed from zero. The annual income of the household, location of the districts, sex (having a male household head), slope of the land, access to quality seedlings, and inverse Mills ratio had a significant impact on the intensity of tree-planting (land allocated for tree planting in hectare). Mills' lambda (inverse Mills ratio) estimates are statistically significant at a less than 5% significance level, indicating the presence of selectivity bias and hence necessitating the employment of Heckman's two-stage approach. The IMR's negative sign indicates the presence of unobserved factors that have a negative impact on both participation decisions and land allocated for tree planting. Furthermore, rho was negative, indicating that the unobservable variables were negatively correlated with the amount of land allocated by smallholder farmers for tree planting (Table 5).

Land allocated for tree planting in hectare was positively and significantly associated with the total gross income of households at the 1% significance level. Assuming that all other factors remain constant, a one-birr increase in annual gross household income is likely to increase the amount of land dedicated to tree planting by 0.22 hectares. Our results corroborate those of Versteeg et al. (2016), who found that in Isabel Province, the Solomon Islands, household income per adult equivalent unit was significantly positively related to plantation size. Similarly, Zeleke (2009) noted that increased household income is likely to increase smallholder farmers' risk-bearing ability and willingness to wait for long-term investments such as trees to pay off.

The district dummy variable has a significant impact on the intensity of tree-planting, suggesting the importance of location in smallholders' tree-planting decisions. Holding the other factors constant, a household in Wolmera District allotted 0.112 ha more land than a comparable household in Chorso District. Due to different geographical locations, access to training, availability of forests, and other reasons, there was significant variation in the intensity of tree-planting among districts in the research areas. This finding is similar to that of Abay (2014), who discovered that households near a regional town (Mekele) were more

Table 5 Determinants of the intensity of tree planting

Variables	Intensity of tree planting		
	Coeff.	Std. errors	*P*-value
Education	0.005	0.009	0.477
Ln income	0.220***	0.027	0.000
Distance of plot	− 0.007	0.009	0.422
Distance from market	− 0.002	0.006	0.672
Location of districts	0.112**	0.047	0.017
Sex	0.286***	0.101	0.005
Extension service	0.021	0.045	0.645
Slope of land	0.091**	0.087	0.018
Kebele	− 0.058	0.048	0.222
Access to seedlings	0.215***	0.038	0.000
_Cons	− 1.566	0.302	0.000
Mills lambda	− 0.184**	0.091	0.043
rho	− 0.807		
sigma	0.228		

*, **, and *** denote statistical significance at 10%, 5%, and 1% probability levels

likely to participate in forest management activities. Versteeg et al. (2016) found highly significant differences in the proportion of households in each village, owing to proximity to different services.

Regarding the gender of the household head, having a male head has a positive and significant effect on land allocated for tree planting, suggesting that male-headed households allotted more land to tree planting than female-headed households do. This finding is in line with that of Abriham et al. (2015), who found that tree planting by female-headed households is much lower than that by male-headed households. Similarly, Miller et al. (2016) discovered that female-headed households were 5% points less likely to adopt tree cash crops and allocate land to them.

The survey found that the slope of the land had a significant influence on land allocated for tree planting. Keeping all other factors constant, the results show that increasing the slope of the land by 1% increases the intensity tree-planting by 9.1%. This indicates that farmers with steep slopes are more likely to understand soil erosion issues and execute tree-planting. These findings are similar to those of Kinuthia (2010), who discovered that farmers living near mountains and steep slopes assign their land to flat land for tree planting.

Access to high-quality seedlings positively affected the intensity of tree planting. While all other variables remained constant, land allocated for tree planting increased by 21.5% when access to high-quality seedlings increased by one unit. This implies that the intensity of tree-planting will be aided by the availability of sufficient seedlings for farmers. According to Bertin (2012), improving the genetic and physical quality of planting materials can result in yield gains of up to 40% and considerable benefits for agricultural production and food security, especially if farmers replace their planting material stock.

Opportunities to Promote tree-based Livelihood by Smallholders

Smallholder farmers in Ethiopia have started to benefit from various opportunities associated with planting commercial trees (Fig. 2). One reason for this is the rapidly growing local demand for trees and tree products, driven by increasing population size and economic growth. Between 2010 and 2030, the demand for fuel wood is expected to increase by 65% (UNEP 2016). Apart from fuel wood, there is a growing demand for commercial tree planting in Ethiopia from the country's construction, furniture, utility poles, pulp, and paper subsectors (MEFCC 2017). Interestingly, the smallholder farmers surveyed in the present study also perceived these surging demands. For instance, nearly 85% of respondents in Chorso and 60.4% in Welmera reported a rapidly expanding demand for trees and tree products (Fig. 2). As stated earlier, the underlying drivers of the rising demand for wood and other forest products have increased urbanization, population growth, and a growing middle class. In addition to the rising demand for trees and tree products, Ethiopia's access to markets and infrastructure has improved in recent years. This situation in turn can help improve smallholder farmers' decisions to engage in tree-based livelihoods. In this regard, 57% of the sample respondents in Chorso and 72% of the respondents in Welmera also perceived improved market access and reported that this was

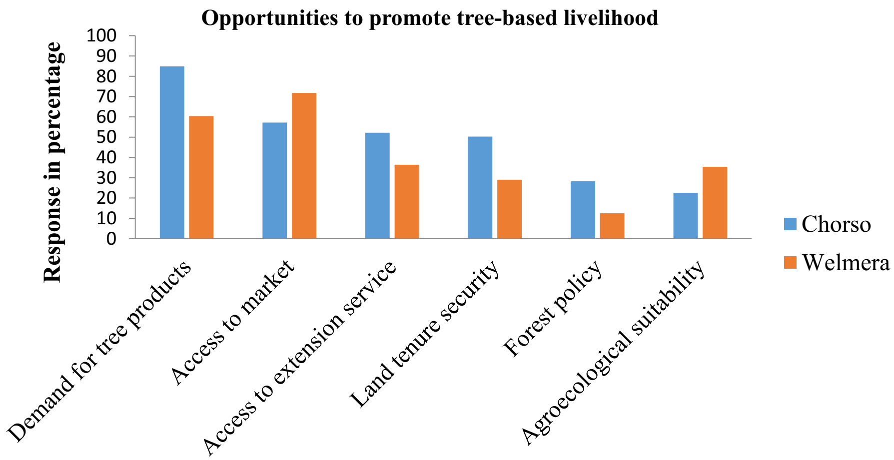

Fig. 2 Opportunities to promote tree-based livelihoods by smallholder farmers

the main reason for attracting farmers to engage in plantation establishment in their areas. The focus group participants also noted that because of improved access to infrastructure, buyers came directly to the farm gate to buy trees and tree products. According to our key informants, the country's current forest policy encourages smallholder participation in tree plantations to diversify income and employment among the rural people. The security of tenure encourages farmers to invest in tree-planting. However, according to the FGD participants, there is still concern over the loss of land due to development, especially in the Oromia region of the Welmera district. Our sample respondents also reported that their agro-ecologies were conducive to planting trees.

Challenges to Promote tree-based Livelihoods

Despite the growing opportunities for commercial tree plantations in Ethiopia in general and in the study areas in particular, the sample respondents noted several challenges to this possibility (Fig. 3). The main challenge is delayed returns on tree investment. The research locations had considerable problems in nurturing small-scale commercial plants, which was reported by 98.7% of the respondents in Chorso and 61.4% of the respondents in Welmera (Fig. 3). Even the fastest growing and most dominant tree, Eucalyptus globules, takes at least 5 years to harvest. The other commonly reported challenge faced by small-scale tree growers is the scarcity of high-quality seeds and seedlings. Plantation types in the study area are vulnerable to various pests and diseases, and there is a demand for disease-resistant varieties that the agricultural office and its partners cannot meet. According to key informants, disease management is given less attention, and the types of illnesses that affect tree plantations are not well understood. Pests are another important issue that require the attention of development actors and resource conservationists. The most persistent problem in the study area, notably in the Chorso District, was land shortage.

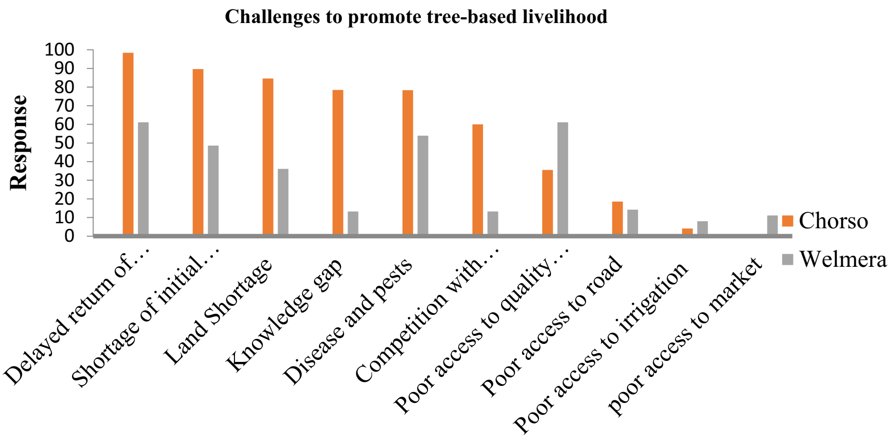

Fig. 3 Challenges to promote tree-based livelihoods by smallholder farmers

According to available evidence, 157 residences in Welmera and 200 houses in Chorso are located within the one-square-kilometer study area (Chorso and Welmera District Office of Agriculture, 2020 report). Another impediment to expanding tree-based livelihoods was a lack of capital (89.9% in Chorso and 48.9% in Welmera acknowledged this as a challenge). Despite the rising demand for trees and tree products, smallholders' confidence in planting trees is negatively affected by unpredictable and fluctuating prices. One reason for this state of affairs is the lack of tree market linkages with end buyers and the lack of market information for smallholder tree growers to negotiate prices for their products. Rivalry with other crops: 60.3% of the Chorso respondents and 13.5% of the Welmera respondents both reported the competitive behavior of trees, particularly eucalyptus, with nearby crops as a challenge (Fig. 3). Farmers claimed that Eucalyptus plantations and woodlots should be managed because of their detrimental effects on soil and water, shading, allelopathic influence on other crops, and cross-boundary effects on neighboring crops. Poor access to roads and irrigation networks has been reported to be an obstacle to tree planting.

Concluding Remark

For smallholder farmers in the study area, commercial planting is a vital source of revenue and subsistence. Eucalyptus globules were the most dominant tree species in the study area. Although eucalyptus competes with nearby crops, farmers prefer to plant eucalyptus trees in their fields because it is a fast-growing tree, has a short gestation period, and is also seen by many as a more profitable tree cultivation. The Heckman two-step selection model was used to examine the primary determinants of smallholder farmers' commercial plantation establishment decisions. The likelihood of a household's decision to participate in establishing small-scale commercial plantations was significantly influenced by the education level of the household head, distance of plot from home, distance of plot to market, livestock holding size of household (TLU), sex of household head, and frequency of extension service. The intensity of tree planting (land allocated for tree planting in hectare) was significantly influenced by the annual income of the household, location of the districts, sex of the household head, the slope of the land, access to quality seedlings, and Inverse Mills Ratio (IMR). On the other hand, this study attempted to identify the challenges and opportunities to promote tree-based livelihoods. The transition to tree-based livelihoods was challenged by delayed returns on investment, lack of capital, and land shortages. Meanwhile, increased demand for trees and tree products, market access, agro-ecological suitability, and the availability of extension services have all been recognized as enhancers of tree-based livelihoods.

The following policy implications are proposed based on the findings of this study: Because trees take a long time to generate income for tree planters, it is critical to focus on creating alternative income-generating opportunities for them to support their families with food and other expenses until trees reach harvest age. To promote tree-based livelihoods in the study area, it is critical to provide fast growing and less competition with surrounding plants at a subsidized price. Furthermore, providing credit and direct financial assistance to tree planters helps promote commercial tree planting.

Finally, capacity-building support for smallholder farmers through, for instance, forest extension services and training and creating market linkages is necessary to promote sustainable commercialization of trees in the study areas. As the FAO (2017) points out, sustainable commercialization by smallholder farmers also calls for financial support (small grants or subsidies) to invest in plantations, technical support and training to raise seedlings, and study tours to learn from the experiences of effective tree plantations.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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