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Livelihood options of landless rural households in Tigrai Region, Northern Ethiopia: evidence from selected districts

Teklay Negash*, Haftu Etsay, Metkel Aregay, Gidey Kidu and Zewil Machine

Abstract

Background The livelihood of rural households in Ethiopia, like in most developing countries, largely depends on land resource. However, nowadays most rural households are denied access to arable land in the highland of Ethiopia due to high population growth and shortage of arable land. Landlessness is, therefore, becoming a serious social and economic problem in the rural highland areas of Ethiopia in general and Tigrai region in particular. This study, therefore, intends to explore the choice of livelihood strategies of landless rural households and assess the challenges and opportunities of the livelihoods of landless rural households in selected districts of Tigrai region.

Methods This study is conducted in three randomly selected districts of Tigrai region, namely, *Kilte-Awlaelo, Degua-Tembien, and Hintalo-Wajerat* districts. For the purpose of this study, two *Tabias* were randomly chosen from each districts. Then, afterward, both primary and secondary data sources were consulted to address the specific objectives of this study. The primary data were collected from 258 randomly selected households and six focus group discussions. This study used Multivariate Probit and Negative Binomial Regression to analyze factors influencing the choice of livelihood strategies and the number of livelihood options adopted by the landless rural households, respectively.

Results This study finds that the livelihood sources of the landless rural households in the study area include farm (90%), non-farm (72%), and off-farm (41%) economic activities. The result of the Multivariate Probit regression indicates that household head characteristics, human capital, social capital, physical capital, financial capital, and institution-related factors were significantly influencing the choice of livelihood strategies of the landless rural households. The results of the negative binomial regression model, on the other hand, assert that household head-related factors, social capital, and institution-related factors were significantly influencing the number of livelihood options adopted by the landless rural households. This study affirms that stone or sand selling, dairy farming, poultry production, animal fattening, and bee keeping are the major opportunities to improve the livelihood of the landless rural households. Moreover, this study also identifies that shortage of arable land, youth unemployment, lack of access to infrastructure, poor land administration, and lack of access to financial capital were the major challenges facing the landless rural households.

Concluding remarks This study concludes that all stakeholders efforts to address the problem of landlessness need to be geared to enhance access of landless rural households to different livelihood capitals, such as human, social, financial, physical, and natural capitals. Moreover, rural township and village enterprises could enhance the access of landless rural households to market and job opportunities.

*Correspondence:
Teklay Negash
teklaynegash@gmail.com; teklay.negash@mu.edu.et
Full list of author information is available at the end of the article

Keywords Landless rural households, Livelihood strategies, Multivariate probit model, Negative binomial regression, Tigrai region

Background

The livelihood strategies of rural population in developing countries largely depend on natural resources, particularly, land [1–3]. Nowadays, diversifying the livelihood strategies has become common phenomenon as the carrying capacity of the agricultural sector to attain food and livelihood security is extremely declining from time to time [4]. This can be attributed to high population growth rate, land fragmentation, soil erosion, low soil fertility, and resulting low crop productivity. Some households diversify their livelihood strategies to reduce risk exposure, and maintain consumption requirements in the event of shocks, while others rely on one or few activities as sources of livelihood [5–7]. Study by Ref. [8] conducted in Humla, a remote mountain district in west Nepal, reported that rural livelihood diversification and well-being can be achieved when households pull high return livelihood portfolio from among various economic activities available to them. In Ethiopia, agricultural sector is the main economic pillar of the rural economy and the overall economic growth of the country is highly dependent on the success of this sector. It represents 42% of the Gross Domestic Product (GDP), more than 90% of foreign exchange earnings, and about 85% of the population gaining their livelihood sources directly or indirectly from the sector [9]. Thus, agriculture is still believed to remain a sector that plays an important role in stimulating the overall economic development of the country in the years to come [10].

Rural residents in Ethiopia have been guaranteed access to land through a law that provides them a right to obtain agricultural land for free. The constitution of FDRE[1] states that any citizen of the country who is 18 years of age or above and wanted to engage in agriculture for living shall have the right to use rural land for free [11]. Furthermore, children who lost their mother and father due to death or other situation shall have the right to use rural land through legal guardians until they attain 18 years of age [11]. Conversely, Ethiopia currently faces severe land scarcity in the highland part of the nation where population density has become very high and the per capita holding of farm lands has become very small [12]. For instance, study by Ref. [13] reported that about 43% of the people in the rural areas of Ethiopia are landless, and nearly 60% of the households do not have sufficient access to farm land to produce adequate food for their members. Thus, land as a safety net has been eroding and landlessness is emerging among the youth in most rural highlands areas of Ethiopia [12]. This has led to rise rural unemployment in most parts of rural highlands of the country [14]. Food insecurity, vulnerability, and land oriented poverty are the manifestation of the emergence of rural landlessness in Ethiopia [12].

Similarly, in Tigrai region agriculture is the mainstay of the rural population despite the sector is challenged by recurrent drought, erratic rainfall, and limited availability of farm land well below the national average. The share of agriculture in the Regional Gross Domestic Product (RGDP) was reported to be about 36.7% in 2018/19 [15]. The sector is the source of employment opportunity for about 80% of the rural population [16]. The zonal distribution of arable land in the region is reported to be uneven with western and north western zones having larger arable land per capita amounting to 3.36 and 1.36 hectare, respectively. However, southern, eastern, and central zones owned smaller arable land 0.82, 0.76, and 0.69 hectare, respectively [16]. On top of this, the regional government of Tigrai had ceased re-distribution of arable land since 1991 owing to limited availability of arable land. On the contrary, in Tigrai region the growth rate of population was reported to be 2.5% per annum which made the total rural population of the region around 3.847 million in 2017 [17]. This indicates that the demand for arable land is still increasing with escalating rural population. The growing number of the rural landless households and the limited availability of cultivable land initiated the regional government to handle the scarcity of cultivable land through the re-distribution of communal land to the landless rural households.

However, little is known about the choice of the livelihood strategies of landless rural households in Tigrai despite very few studies in some parts of the country. For instance, Ref. [18] accessed the diversification and livelihood sustainability in a semi-arid environment of southern Ethiopia. Ref. [4] identified the livelihood strategies and assessed the factors that influenced households' decision to choose among the alternative livelihood strategies in *Wolaita* zone of Ethiopia. Ref. [19] assessed the livelihood strategies among the *Borana* pastoralists in southern Ethiopia and Ref. [20] looked at the livelihood diversification of rural households to supplement their small-scale agricultural activities in east *Gojjam* zone. Similarly, study by Ref. [21] investigated households

[1] Federal Democratic Republic of Ethiopia.

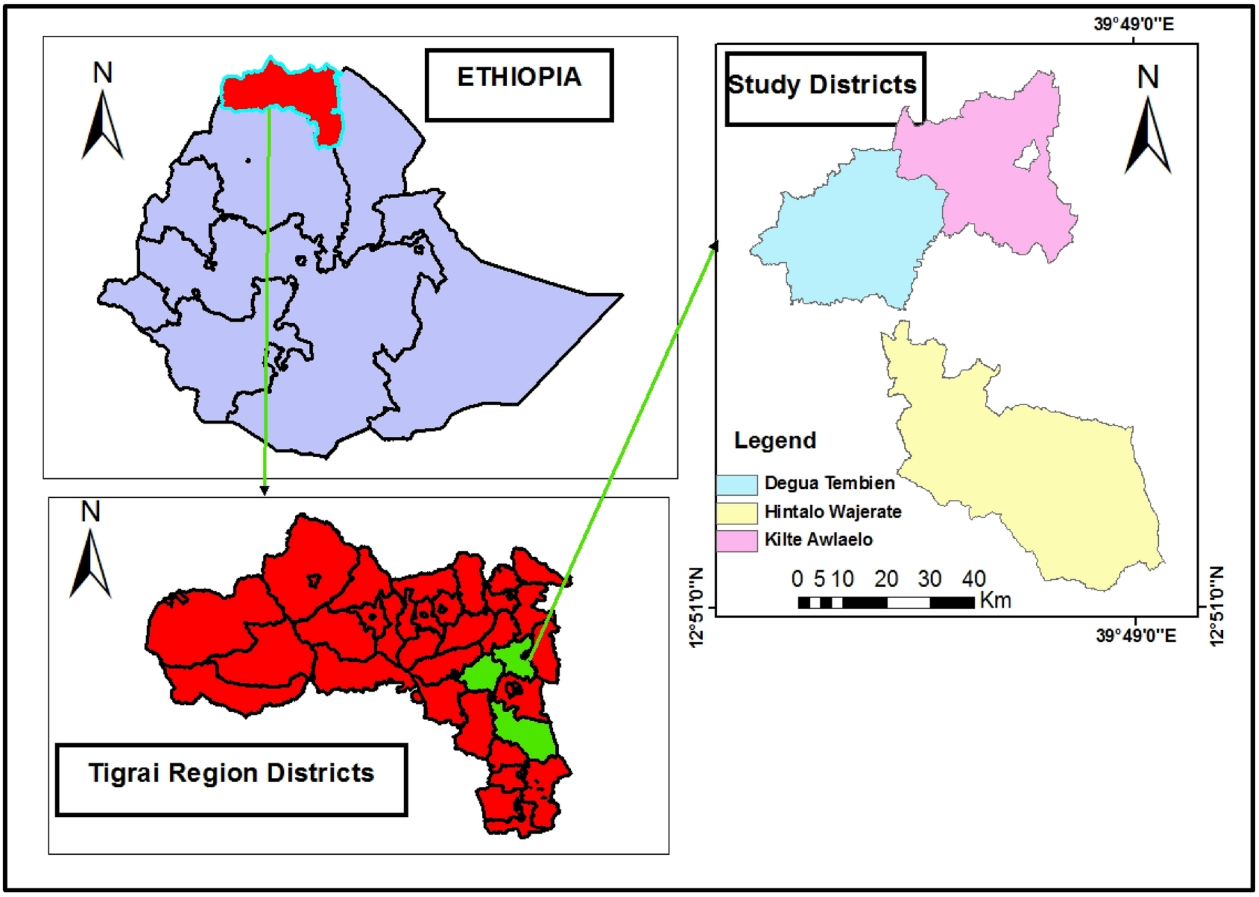

Fig. 1 Administrative map of study districts

livelihood diversification options and analyzed the determinants of livelihood diversification strategies in eastern Tigrai Region of Ethiopia. However, none of these studies investigated the livelihood options of landless rural households in Tigrai region. On top of this, the problem of rural landlessness and unemployment are crucial policy issues which need critical examination to alleviate rural poverty and food insecurity. Our study is unique from previous studies in two perspectives. First, this study focuses on the livelihood sources of the landless rural households in land scarce Tigrai region. Second, methodologically previous studies used Multinomial logit model to estimate the correlates of choice of livelihood options ignoring the fact that the choice of livelihood options could be simultaneously modeled. However, this study used Multivariate Probit model to estimate factors affecting the livelihood choice of landless rural households appreciating simultaneity of the livelihood options adopted by the landless rural households in the study districts.

This paper, therefore, aims at exploring the choice of livelihood strategies among rural landless households in three districts of Tigrai region, northern Ethiopia. More specifically, this study is designed to assess the livelihood sources of landless rural households, analyze factors influencing the choice of livelihood strategies, examine the major determinants affecting the number of livelihood strategies adopted by the landless rural households, and identify the major challenges and opportunities facing the livelihood of rural landless households in the study sites.

Data and methods

Description of the study area

This research was conducted in three randomly selected districts of Tigrai region, northern Ethiopia. The study areas include *Kilte-Awlaelo*, *Degua-Tembien,* and *Hintalo-Wajerat* districts (Fig. 1). Afterward, two *Tabias*[2] were randomly selected from each district. Accordingly, *Kihen* and *May-Kuiha* from *Kilte-Awlaelo*, *Debre-Nazret*

[2] *Tabia is the smallest local government administrative unit in the rural setting of Tigrai region.*

and *Mizan-Birhan* from Degua-Tembien, and Mesanu and *Alem-segeda* from *Hintalo-Wajerat* were randomly selected for the purpose of this study. Geographically, *Hintalo-Wajerat* is delimited by the *Emba-Alage* district on the south, *Seharti Samre* district on the west, *Enderta* district on the north, and the Afar Region on the east. *Degua-Tembien* is bordered on the south by the *Seharti Samre* district, on the west by *Abergele* district, on the northwest by *Kola-Tembien*, on the north by *Hawzen* district, on the northeast by *Kilte-Awlaelo,* and on the east by *Enderta*. Furthermore, *Kilte-Awlaelo* is encircled on the south by *Enderta* district, on the west by the *Hawzen* district, on the north and northeast by *Saesi Tsaedaemba*, and on the east by *Atsbi-Wenberta.* Mixed crop and livestock farming systems are the major economic activities practiced in the study districts. The dominant cereal crops grown in *Degua-Tembien* district include wheat, barley, *teff,* and pulses. Wheat, barley, *teff,* and pulses are the most staple crops grown in *Hintalo-Wajerat* districts. Similarly, wheat and barley are the major crops grown in *Kilte-Awlaelo* district. The major livestock populations in the study districts include cattle, goat, sheep, and donkey.

Data sources and collection methods

This study used primary and secondary data sources. The primary data were collected from randomly selected landless rural households using structured survey questionnaire. The structured survey questionnaire was prepared to collect relevant information on demographic characteristics, livelihood sources, capital assets ownership, like human, natural, financial, physical, and social capital, institutional factors, challenges, and opportunities of the landless rural households. Pre-testing of the questionnaire was undertaken in a randomly selected village within the study area to enhance the relevance and reliability of the data collection tool.

Focus Group Discussion (FGD) was also conducted to explore concepts, generate ideas, determine differences in opinion among stakeholders, and perceive challenges and opportunities of the livelihood strategies of landless rural households of each districts. Checklist was prepared to guide focus group discussions. The checklist was designed in a manner that was able to generate relevant information regarding the perception of discussants on the available livelihood strategies, sustenance of each livelihood strategy, as well as the challenges faced and possible opportunities of the landless rural households in each *Tabia.* Six FGD consisted of 8–10 participants each were conducted. By doing so, the authenticity of data collected using the household survey was verified and triangulated. Secondary data were gathered from reports and documents of the regional and local government administration to supplement the household survey and focus group discussion.

Table 1 Distribution of sample landless rural households in the selected *Tabias*

Districts	Tabia	Total landless Households	Sample selected
Kilte-Awlaelo	*May-Kuha*	141	50
	Kihen	118	42
Hintalo-Wajerat	*Mesanu*	107	38
	Alem-Segeda	124	44
Degua-Tembien	*Debre-Nazret*	110	39
	Mizan-Birhan	127	45
Total		727	258

Sampling technique and sample size

This study employed multi-stage sampling technique. In the first stage, three districts, namely, *Kilte-Awlaelo, Hintalo-Wajerat, and Degua-Tembien,* were randomly selected from Tigrai region, northern Ethiopia. In the second stage, two *Tabias* from each district was also randomly selected. In the third stage, sampling frame was prepared for each *Tabia*. The study applied [22] standard formula to estimate representative sample size as shown in Eq. 1. In the fourth stage, the representative sample size was distributed among the study *Tabias* in proportion to their representation of target population. Finally, respondents were randomly selected from the list of households obtained from respective local government administrations. The lists of study districts and *Tabias* along with the sample drawn are presented in Table 1.

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

where N stands for the total landless rural households found in six study *Tabias* (727) and e is the tolerable magnitude of error at 95% level of significance which is equal to ($e = 0.05$) and n stands for representative sample size (258).

Conceptual framework of the study

This study adopted sustainable livelihood approach which provides insight about the complex and comprehensive understanding of how rural household struggle to survive in resource deficient rural setting. The concept of livelihood can be seen from capabilities and entitlement perspectives [23–26]. The sustainable livelihood approach also considers natural resource management and use, and comprehensive capital ownership of rural households. The livelihood strategies practiced by the rural households are based on the five capital asset ownership [5,

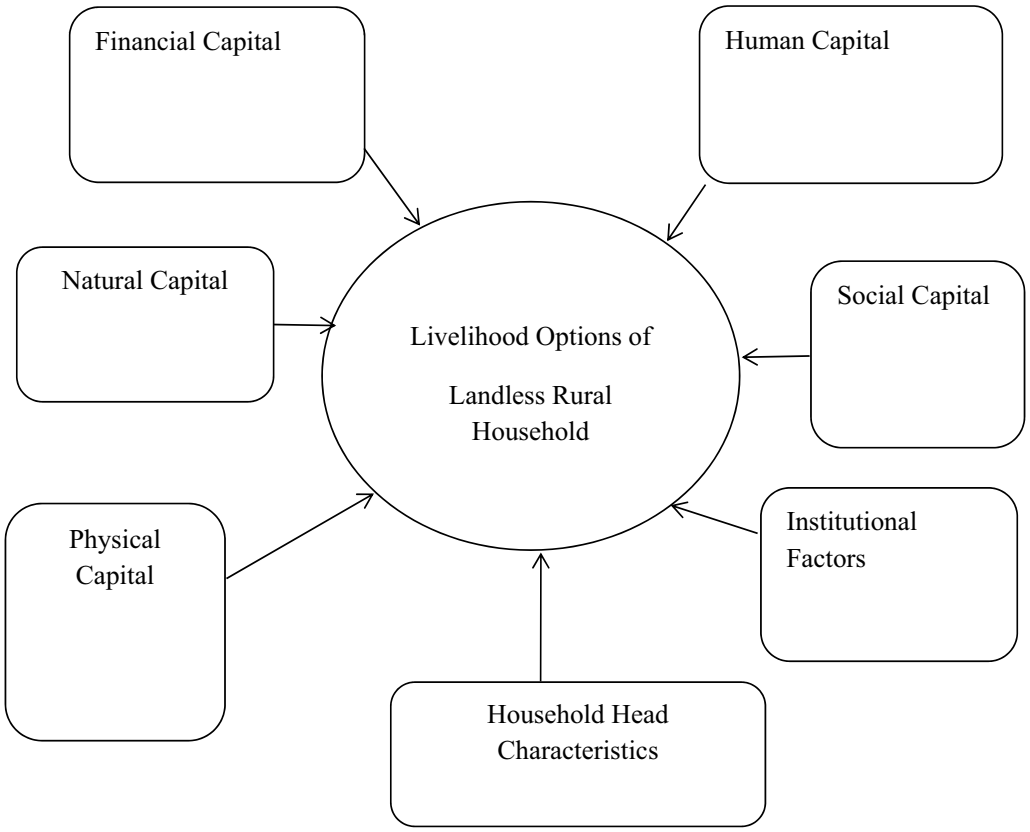

Fig. 2 Conceptual framework for choice of livelihood options of the landless rural household

27, 28]. These include human, natural, financial, social, and physical capital assets of households. Access to and ownership of these capital assets determine the choice of livelihood strategies adopted by the landless rural households [29]. Moreover, household head-related and access to institutional factors also significantly determine the livelihood choice of landless rural households. Livelihood strategies comprise the range and combination of activities and choices that people make in order to achieve their livelihood goals. In the rural setting of developing countries, the livelihood strategies of households can be categorized into farm, non-farm, and off-farm activities. The case is not unique in Ethiopia at large and in Tigrai region, in particular, where more than 80% of the population rely on the agriculture. The concern of this study is, therefore, to investigate on how the ownership of and access to different livelihood capitals along with household head and institutional factors influence the choice of livelihood strategies of landless rural households in the randomly selected districts of Tigrai region of Ethiopia. Moreover, this study also attempted to investigate whether or not the livelihood capital assets, institutional factors, and household-related factors influence the number of livelihood options adopted by the landless rural household in Tigrai region, northern Ethiopia. The detailed conceptual framework of the study is presented in Fig. 2.

Methods of data analyses

This research paper used both descriptive statistics and econometric techniques of data analyses. This study used descriptive statistics to summarize the demographic and socioeconomic attributes of the surveyed landless rural households. Particularly, frequency and percentage were also used to summarize the challenges and opportunities of the landless rural households in the study area. To analyze the major factors affecting choice of livelihood strategies and examine the major determinants influencing the number of livelihood options adopted by the rural landless households, this study used Multivariate Probit (MVP) and Negative Binomial Regression (NBR) models, respectively.

Multivariate probit model (MVP)

The livelihood options available to the landless rural households might not necessarily be mutually exclusive; rather a household can simultaneously adopt more than one option as the means of livelihood sources. That is, the

landless rural households may choose any one or combination of the available livelihood options to support their livings. For this reason, a multivariate modeling framework is needed to account for the interdependence and possibly simultaneous decision making characteristics of the landless rural households in the study districts.

Methodologically, MVP applies when the probability of choosing more than one option is simultaneously modeled against the explanatory variables [30, 31]. Therefore, this study used MVP to estimate factors affecting choice of livelihood options of the landless rural households. A system of simultaneous Multivariate probit model for the livelihood options of landless rural households was constructed as follows [32]:

$$y_{im}* = \beta_m X_{im} + \varepsilon_{im},\ y_{im} = 1 \text{ if } y_{im}* > 0 \text{ and } 0 \text{ otherwise.} \quad (2)$$

Equation 2 is based on the assumption that a rational ith landless rural households has a latent variable y^*_{im} which captures unobserved preferences associated with the mth choice of livelihood option ($m=3$; available livelihood options in the study districts); βm is the set of parameters that reflect the impact of changes in the vector of explanatory variables on the landless rural household's preference toward the mth livelihood option; x_{im} represents the vector of observed explanatory variables that are expected to explain the choice of each type of the livelihood option; and ε_{im} represents error terms of the model.

The dependent variables of the model are the livelihood options adopted by the landless rural households in the study districts. The dependent variable assumes the values of $Y=1$, if household is engaged in crop production and/or animal rearing activities on gifted, rented, or shared in land; $Y=2$, if the choice lies on non-farm[3] activities which include petty trade, sale of handicraft, sale of beverage, animals trading, stone sale, sand sale, carpenter, masonry, guarding, and sale of firewood or charcoal; and $Y=3$, if the choice lies on off-farm activities, such as land preparation, plow, weeding, harvesting, and threshing among others to earn farm wages.

Following Ref. [33] and the study area context, household head-related characteristics (like age, sex, and marital status of the household head), human capital-related variables (such as educational status of household head and labor force), physical capital-related asset (like private house ownership for residence and livestock holding in TLU[4]), financial capital-related variables (credit access, membership of *Equb*,[5] and remittance), social capital[6]-related factors (such as membership in *Edir*,[7] and traditional labor sharing[8]), and institutional factors (like participation in safety net program, distance to all-weather road, and distance to nearest market) of the rural landless households were included as explanatory variables in the MVP (Table 2).

Negative binomial regression

The number of livelihood options adopted by the landless rural household can be considered as a count variable. This observed count variable basically refers to the number of livelihood options adopted by the landless rural households. The dependent variable of the model (that is, number of livelihood options of the landless rural households) assumes non-zero positive integer values in which both Truncated Poisson Regression and Negative Binomial Regression (NBR) are possible candidates to estimate the major factors influencing the number of livelihood options of the landless rural households. The Truncated Poisson Model assumes equi-dispersion of the mean and variance of the dependent variable which is commonly violated in most applied researches. On the other hand, the Negative Binomial Model integrates the problem of over-dispersion into account while estimating the parameters of the model. To select which model is appropriate to apply between the two models, it is pertinent to conduct a Z test following Refs. [32, 35] given in Eq. 3:

$$pr(Y = y|\lambda,\alpha) = \frac{\Gamma(\alpha^{-1}+y)}{\Gamma(\alpha^{-1})\Gamma(y+1)}\left(\frac{\alpha^{-1}}{\alpha^{-1}+\lambda}\right)^{\alpha^{-1}}\left(\frac{\lambda}{\lambda+\alpha^{-1}}\right)^{y} \quad (3)$$

where λ and α are parameters in which α is the variance indicators.

The result of the Z test in Table 3 confirmed that there is statistically significant difference between the mean and

[3] In this study, the definition of non-farm and off-farm economic activities is based on Ref. [3]. Accordingly, the non-farm activities involve earnings from permanent and self-generated economic activities. However, off-farm activities are defined as economic activities mostly relying on selling labor to other farmers. Off-farm activities are, therefore, seasonal farm works by their very nature.

[4] It is an aggregation of livestock from various species and age as per convention factors given by Ref. [34]. It is given by calf = 0.5, Heifer = 0.75, cow = 1, Ox = 1, horse = 1.1,goat/sheep = 0.13, donkey = 0.70, camel = 1, and chicken = 0.013.

[5] Refers to traditional and informal way of saving practices where by each member can take credit based on the share he or she has contributed to it. So, this is considered as social capital in this study.

[6] Social capital refers to institutions, relationships, and norms that shape the quality and quantity of a society's social interactions.

[7] Refers to informal self-help group in which each member gets different benefits during mourning, wedding, and other social ceremonies. This is counted as social capital as it may improve the social network among members.

[8] This refers to labor sharing practice in building house, weeding, harvesting, and threshing activities.

Table 2 Explanatory variables included in the multivariate probit and negative binomial regression models

Variables	**Descriptions**
Dependent variables of multivariate probit (MVP)	
Household livelihood Options	1. If the choice of household is farm activities
	2. If the choice of household is off-farm activities
	3. If the choice of household is non-farm activities
Dependent variable of negative binomial regression (NBR)	
Number of Livelihood options adopted by the rural landless households	

Variable code	**Description of the explanatory variables**	**Nature**	**Expected sign in NBR**
Family size	Size of household	Continuous	
Age	Age of household head	Continuous	±
EduStatu	1 = if the educational status of household head is literate	Dummy	+
Gender	1 = if the gender of household head is male	Dummy	+
Marital Status	1 = if the marital status of household head is married	Dummy	
Labor force	Number of active labor forces of household (age between15- 64)	Continuous	
DISMKT	Distance to nearest market in kilometer	Continuous	−
DISdistrict	Distance to district center in kilometer	Continuous	−
DISFTC	Distance to farmers' training center in kilometer	Continuous	
TLU[a]	Number of livestock holding in Tropical Livestock Unit	Continuous	+
Farm size	Farm size of the household during the survey year in *Tsimad*[b]	Continuous	
Migrated	1 = if any household member is migrated	Dummy	
PSNP	1 = if the household participated in safety net program	Dummy	−
Residence	1 = if the household owned private house	Dummy	
Edir	1 = if the household participated in *Edir*	Dummy	+
Traditional Labor share	1 = if the household has shared labor in weeding, harvesting and other activities	Dummy	+
Equb	1 = if the household participate in *Equb*	Dummy	+
Credit	1 = if the household has credit access	Dummy	+
Remittance	1 = if the household received remittance during the survey year	Dummy	

[a] It is an aggregation of livestock from various species and age as per convention factors. It is given by *calf* 0.5, *Heifer* 0.75, *cow* 1, *Ox* 1, *horse* 1.1, *goat/sheep* 0.13, *donkey* 0.70, *camel* 1, and *chicken* 0.013 [34]

[b] 1 tsimad is equivalent to 0.25 hectare of arable land

Table 3 Z test of equi-dispersion of variance and mean

Regress zhat lambda, noconstant noheader						
Zhat	Coef	Std. Err	T	P > t	[95% Conf. interval]	
Lambda	− 0.0711	0.0232	− 3.06	0.002	− 0.1168	− 0.0254

variance value as the p-value of the coefficient that correspond the lambda is 0.0002. This implies that there exists problem of over-dispersion which indicates that Negative Binomial Model instead of Truncated Poisson Model is recommended for the purpose of this analysis.

The mathematical representation of the Negative Binomial Regression is given in Eq. 4:

$$\mu_i = \exp(\ln(t_i) + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki}), \quad (4)$$

where β_i are unknown parameters to be estimated from the data set, t represents the exposure time, and X_i stands for the explanatory variables included in the model (Table 2).

Table 4 Summary statistics of demographic and socioeconomic features of respondents

Variable	Mean	Standard deviation	Minimum	Maximum
Gender	0.80	0.40	–	–
Age	32.80	9.20	19	68
Edustatu	0.61	0.49	–	–
MartalSta	0.81	0.40	–	–
Family size	4.23	1.80	1	11
Labor	2.33	1.11	1	8
Farm size	2.79	1.98	0	10.25
Dismrod	4.03	4.37	0.17	20
Dismkt	4.98	3.44	0.10	15
DisTFC	2.28	3.28	0.17	22
TLU	2.19	1.89	0	9.2
Residence	0.62	0.49	–	–
PSNP	0.30	0.46	–	–
PSNPdep	0.40	0.49	–	–
Migrated	0.28	0.69	–	–
Remittance	0.10	0.30	–	–
Livelihood options	2.88	1.62	1	9

Results and discussion

Demographic and socioeconomic profiles of the surveyed households

The results of descriptive analyses of demographic and socioeconomic characteristics of the surveyed households are presented in Table 4. The result of this study shows that about 80% of the landless rural households were male headed and 81% of the surveyed household heads were married. The mean age of the landless rural household heads was about 32.8 years old. Furthermore, the mean household size, dependency ratio, and labor force of the surveyed landless rural households were also found to be 4.23, 1.90, and 2.33, respectively. With regard to educational status of household heads, about 61% of the household heads were literate. Concerning to livestock holding of the households, on average, the surveyed landless rural households owned 2.2 TLU.

About 62% of the surveyed landless rural households have private residential house, while the remaining live in rented houses, depending on their parents' house or in relatives houses. Concerning access to public institutions, the mean distance to all-weather road, nearest market, and farmers' training center were 4.03 km, 4.98 km, and 2.28 km, respectively. Furthermore, about 29% of the sampled landless rural households were beneficiaries of the safety net program either in food for work or direct support programs. A significant number of the landless rural households were not beneficiaries of the safety net program. This is because the local government administration believes that they [non-beneficiary] are relatively young and able to work elsewhere in the urban or sub-urban areas to smooth out consumption and ensure their food security. On top of this, respondents were asked about their perception regarding the dependency syndrome on safety net program. Accordingly, about 40% of the respondents reported that the safety net program created dependency syndrome due to entitlement for extended years. The participants of focus group discussion further confirmed that safety net program harms the self-reliance and work habit of the beneficiaries of the program. For instance, one of the respondent revealed that there are few number of safety net beneficiaries who always under report their earnings and went to the extent of selling their basic asset like livestock so that they remained entitled in the program. This result is in contrast to the empirical finding of Ref. [36] who reported that there were no indications that participation in productive safety net program-induced households to disinvest in livestock production or tree plantation.

This study found out that 27% of the surveyed households reported to have any member of their household migrated abroad looking for employment opportunity. However, this study finds out that only about 10% of the households received remittance. The result of the this study is similar with the empirical finding of Ref. [19] who reported that remittance is not an important source of household income in the *Borana* area, southeastern zone of *Oromia*, Ethiopia. Table 4 also reveals that, on average, the surveyed households relied on 3 livelihood options with minimum of 1 and maximum of 9 livelihood sources. This implies that most of the landless rural households did not diversify their livelihood options to mitigate their vulnerability to various risks and shocks.

Participation of landless rural households only on limited number of livelihood sources might influence their food security status adversely. That is, households who have limited livelihood sources might suffer from critical food shortage and hence food insecure. However, those who diversified their livelihood sources are more likely to be food secure. Moreover, the focus group discussant affirmed that households who diversified their livelihood sources are linked with food security status.

Factors affecting landless rural households' choice of livelihood strategies

Prior to running MVP regression, predicted probabilities and correlation matrix of the households' livelihood options were conducted to look at the overall significance of the model. The estimation result shows that the probability of choosing among the alternative livelihood sources by the landless rural households' was 90%, 72%, and 41% for farm, non-farm, and off-farm

Table 5 Predicted probabilities and correlation matrix of livelihood strategies

	Off-farm	Non-farm	Farm
Variables			
Predicted Probability	0.41	0.72	0.90
Estimated correlation matrix			
Off-farm	1.00		
Non-farm	0.14(0.03)**	1.00	
Farm	0.03(0.65)	0.01(0.87)	1.00

** Denotes for 5% significance level and the values in the parenthesis are *p*-value

activities, respectively (Table 5). That is, on average, about 90% of the surveyed landless rural households were engaged in crop and livestock farming activities. Most of them were involved in crop production activities on gifted, rented, and shared in land even if they did not own private farm land. Similarly, about 72% of the surveyed households also participated on non-farm activities, such as petty trade, sale of handcraft, sale of beverage, animals trading, daily laborer, carpenter, masonry, stone sale, sand sale, guarding, and in rare cases sale of firewood or charcoal. In this regard study by Ref. [37] indicated that non-farm income significantly contributed toward reducing the incidence, depth, and severity of household poverty in rural *Kedah* of Malaysia. This indicated that non-farm economic activities played a vital role in the livelihood of rural areas of developing countries. Ref. [21] also indicated that in the context of food inadequacy and drought, non-farm income played a significant contribution in eastern Tigrai region of Ethiopia. Similar results have also been reported by Ref. [12] in north west Ethiopia that next to crop farming, livestock rearing, daily labor, selling wood, and charcoal were the major livelihood options and strategies practiced by landless rural households. Furthermore, almost 41% of the sampled landless rural households were participating in different off-farm activities, like plow, weeding, harvesting, and threshing in others' farm land. Moreover, our study result is consistent with empirical findings of Refs. [38, 39] documented that landless people often rely on food aid, sharecropping, petty trading, and daily labor for survival or they migrate to urban areas in Loess Plateau, China, and west Bengal, respectively. This indicated that the only way to pursue an increase in households income is to enhance the employability of landless people in non-farm and off-farm job opportunities. Typically, the construction sector, including large infrastructure works, private housing, and urban infrastructure development, is capable of attracting labor force from agricultural sector, particularly, the landless rural youths.

The correlation matrix revealed that there is positive and statistically significant interdependence between off-farm and non-farm activities as livelihood sources at 5% significance level. This indicates that the landless rural households simultaneously choose both off-farm and non-farm sources of livelihood. In other words, this study asserts that off-farm and non-farm sources of livelihoods are found to be complementary to each other. That is, landless rural households tend to engage in off-farm and non-farm sources of income simultaneously to reduce the risk of falling into food insecurity and poverty.

The Wald test (Wald chi2 (45) = 135.28, Prob > chi2 = 0.0000) indicated that over all the model fits very well to the data set. That is, the explanatory variables included in the model significantly explained the livelihood choice of the landless rural households. Table 6 indicates that out of fifteen explanatory variables included in the MVP, four variables were significantly affecting the choice of farm activity as means of livelihood; three variables were significantly influencing the off-farm income generating activities as source of livelihood; and eight variables were significantly determining non-farm activities as source of livelihood of the landless rural households at different significance levels (Table 6). The next paragraphs present detailed discussions of the statistically significant variables into six basic categories, namely, household head-related characteristics, human capital, physical capital, social capital, financial capital, and institution-related variables.

Household head-related factors

Sex, age, and marital status of household head were significantly influencing the choice of the livelihood options of the landless rural households in the study districts. Specifically, this study confirms that sex of household head is positively and significantly influencing the likelihood of choosing non-farm activities as the source of livelihood for the landless rural households at 5% significance level. Table 6 indicates that landless rural households are more likely to rely on non-farm activities than female-headed households in the study area. The possible reason for such finding may be derived from the fact that males could have more spare time to move away from their residence to work and engage in different income generating activities than female counterparts. Besides, females, household head, have extra work burdens at home, such as food preparation and taking care of children and elderly. This is perhaps also related with some cultural barriers, which still keep women and aged household members engage in agricultural activities.

Table 6 Estimation results of multivariate probit on factors affecting landless rural households' choice of livelihood options

Explanatory variables	Livelihood options of rural landless households		
	Farm	Off-farm	Non-farm
	marginal effect (SE)	marginal effect (SE)	marginal effect (SE)
Age	0.0037 (0.03030)	− 0.0074 (0.0157)	− 0.05757 (0.0175)***
Gender(male = 1)	− 0.6752 (0.5514)	− 0.2025 (0.3160)	0.8498 (0.3435) **
Marital status (married = 1)	1.8132 (0.5715)***	0.2635 (0.3423)	− 0.2264 (0.3779)
Labor force	0.1406 (0.2141)	− 0.0498 (0.1142)	0.2726 (0.1209)**
Educational status (literate = 1)	0.5100 (0.4038)	− 0.6199 (0.1996)***	0.2279 (0.2134)
TLU	0.2815 (0.1668)*	− 0.1129 (0.0572)**	0.0879 (0.0666)
Private house ownership(yes = 1)	0.5674 (0.4033)	0.1184 (0.1973)	0.0886 (0.2159)
Credit access (yes = 1)	0.6608 (0.3641)*	− 0.0960 (0.1915)	− 0.4621 (0.2140)**
Remittance (yes = 1)	− 0.6984 (0.5154)	− 0.3822 (0.3242)	− 0.5293 (0.3127)*
Edir (yes = 1)	− 0.1674 (0.3929)	− 0.2034 (0.1848)	0.2304 (0.2081)
Traditional labor sharing (yes)	0.9646 (0.3840)*	0.8662 (0.2074)***	0.0730 (0.2166)
Equb (yes = 1)	− 0.3293 (0.5774)	− 0.3332 (0.2736)	0.5443 (0.3259)*
PSNP(yes = 1)	0.2468 (0.4499)	− 0.2211 (0.2273)	− 0.0929 (0.2451)
Distance to road in km	0.0084 (0.0519)	− 0.0097 (0.0259)	− 0.0532 (0.0289)*
Distance to market in km	− 0.0115 (0.0409)	− 0.0217 (0.0197)	− 0.0563297 (0.0221) ***
Model summary			
Number of observation = 258			Log likelihood = − 311.89149
Wald chi2(45) = 135.28			Prob > chi2 = 0.0000

*, **, and *** represent significance level at 10%, 5%, and 1%, respectively. SE stands for standard errors in parentheses

Furthermore, age of household head was negatively but significantly influencing the likelihood of choosing non-farm activities of the landless rural households at 1% significance level. Holding other factors constant, as the age of the household head increases by one year, the likelihood of choosing non-farm activities declines by 6%. Similar finding has been reported by Ref. [19] who studied about determinants of livelihood diversification strategies in *Borana* pastoralist communities of Ethiopia and found out that the age of household head was negatively but significantly affecting the of pastoralist choice of pastoral and off-farm combination, and pastoral and non-farm combination as livelihood sources. However, our result is against the empirical findings of Ref. [40] who reported that age of the household head complemented with the non-farm income generating activities. This is to mean as the age of the household head increases, the participation of household in non-farm income generating activities tend to rise. Moreover, the marital status of household head was also found to be positively and significantly related with the likelihood of choosing farm activities as source of livelihood at 1% significance level (Table 6). That is, married landless rural households were more likely to choose farming activities on gifted, rented, and shared in land as the sources of livelihood than others (divorced, widowed, separated, and single).

Human capital-related factors

Educational status of household head and labor force of households were significantly influencing off-farm and non-farm livelihood sources of the landless rural household, respectively. Educational status of household head was negatively but significantly related with the likelihood of choosing off-farm activity as the source of livelihood of the landless rural households at 1% significance level. This implies households with literate heads are less likely to engage in off-farm activities as the major livelihood source of the landless rural households than households with illiterate heads in the study districts.

Moreover, labor force was positively and significantly influencing households' likelihood of choosing non-farm activities as major livelihood sources at 5% significance level. Households with large number of labor force tend to engage in non-farm activities as major source of livelihood, holding other factors constant. This is perhaps due to the fact that households with large labor force could have more extra labor force so that they can engage in different non-farm activities to support their livings. The finding of this study is congruent with the empirical findings of Ref. [21] who underscored that productive

family size adds significantly to the share of total income received from farming by participating in different non-farm income diversification strategies. This result is also consistent with the empirical findings of Ref. [38] who asserted that household size is complement with non-farm income generating activities on top of farming activities.

Social capital-related factors

Membership in *Edir* and participation in traditional labor sharing were included in the model to account for the effect of social capital-related factors on the choice of livelihoods landless rural households. Accordingly, this study finds that participation in traditional labor sharing was positively and significantly influencing the decision of landless rural households to choose farm and off-farm activities. Specifically, participation in traditional labor sharing was positively and significantly related with the likelihood of choosing off-farm activities as sources of livelihood at 1% significance level. This result is in line with the prior expectation of this study. Traditional labor sharing may help households create linkage and network with which they can enhance their likelihood of getting off-farm job opportunities in their localities.

Moreover, traditional labor sharing was positively and significantly affecting landless rural households decision to engage in farm activities at 10% significance level. This is might be due to the fact that the social network could help them access land either in the form of rented and shared in land. This is an instrumental solution to access land for the land poor and to engage in crop production in land scarce Tigrai region. This result is similar with the empirical finding of Ref. [41] who revealed that the relationship between livelihood diversification and membership of a cooperative society was found to be positive and statistically significant. This in turn indicated that social capital has significant contribution toward livelihood diversification. Similarly, Ref. [42] reported that neighborhood attachment as social capital has a positive effect on household confidence in coping with food and income insecurity in the face of climate change. Thus, the empirical finding confirmed that rural households are more likely to rely on bonding social capital to cope with economic stress. Households who have a close connection with their neighborhoods can mobilize resources from their neighbors in order to cope with economic and non-economic challenges. Furthermore, the study by Ref. [43] also asserted that membership in cooperative promotes household livelihood diversification into off-farm and non-farm economic activities. Moreover, Ref. [40] asserted that social capital is as important as other livelihood capital assets physical, natural, financial, and human capital for coping with natural hazards and climate change. This literature supports our empirical result in the sense that social capital contributes to the livelihood choice of landless rural households.

Financial capital-related factors

This study used credit access, *Equb* membership, and remittance to capture the effects of financial capital on the choice of livelihood options of the rural landless households. The result of this study shows that credit access was significantly determining the choice of non-farm and farm activities of the landless rural households. Specifically, credit access was positively and significantly influencing the choice of farm activities of the landless rural households at 10% significance level. This means credit access contributes more to the farming activities of the rural landless households to produce crop on rented and shared in land. The reason could be credit services are available mostly for farming activities, such as purchase of farm inputs, daily production, production of shoat, and poultry production. Similar, results have been reported by Refs. [43, 44] who found that households with credit access focused on agricultural intensification to enhance productivity instead of diversifying their livelihood sources. This implies that households tend to concentrate their production decision on selected economic activities instead of engaging in various activities.

However, credit access was negatively but significantly affecting the choice of non-farm source of income as means of survival at 5% significance level. This is perhaps due to the fact that the amount of credit offered by the financial institution might not enough to engage in non-farm income generating activities, such as petty trade and animal trading among others. The other reason could be landless rural households could not access credit for non-farm due to lack of collateral. Furthermore, membership in *Equb* was also significantly and positively affecting the choice of non-farm income generating activities by the landless rural households at 10% significance level. That is, the money they got from *Equb* could be important seed capital to start up small business, like petty trade and animal trading. Surprisingly, remittance was negatively but significantly determining the choice of non-farm economic activities as income generating livelihood options at 10% significance level.

Physical capital-related factors

Livestock ownership (TLU) was significantly influencing landless rural households choice of farm and non-farm livelihood options. That is, households with large number of livestock were positively and significantly related with choice of farm activities at 10% significance level. This

Table 7 Estimation result of negative binomial regression on factors influencing the number of livelihood options adopted by landless rural households

Livelihood options	IRR	Robust Std. Err	*P*-value
Gender of household head (male = 1)***	1.4448	0.1665	0.001
Age square of household head***	0.9998	0.0001	0.009
Educational status of household head (literate = 1)	0.9003	0.0739	0.200
Family size of the households	1.0306	0.0297	0.297
Edir (yes = 1) *	1.1605	0.0933	0.064
Distance to road in km	0.9996	0.0093	0.964
Distance to district in km***	0.9806	0.0052	0.000
Credit access (yes = 1)	0.9288	0.0782	0.380
Distance to farmers training center in Km	1.0138	0.0112	0.213
Livestock holding in TLU	0.9868	0.0223	0.555
Safety net Participation(yes = 1)	0.9164	0.0932	0.391
Constant term	3.2629	0.5052	0.000
/lnalpha	− 53.6532		
Alpha	5.00e−24		
Model summary			
Negative binomial regression			Number of obs = 258
Dispersion = mean		LR chi2(11) = 50.35	Prob > chi2 = 0.000
Log pseudo-likelihood = −449.2308			Pseudo R2 = 0.053

is due to the fact that livestock is important farm input required to engage in farm activities, like providing draft power and hauling services. However, households with large number of livestock were negatively but significantly influencing the choice of off-farm economic activities by the landless rural households at 5% significance level. The results of this study is in line with the empirical findings of Ref. [4] who asserted that the livestock ownership was negatively and significantly affecting the diversification of livelihood sources into non-farm and off-farm in *Wolaita* Zone of southern Ethiopia.

Institution-related factors

Participation in safety net program, distance to nearest market, and all-weather road were included in the model to account for the effects of institutional factors on the choice of livelihood options of the landless rural households. Consequently, distance to all-weather road was negatively but significantly influencing the likelihood of choosing non-farm activity as major sources of livelihood at 10% significance level. This implies landless rural households whose residence is far from all-weather road have less likelihood of engaging in non-farm income generating activities. This is perhaps due to the fact that access to information and job opportunity is highly related with proximity to road where information about labor market and job opportunity are available.

Similarly, this study confirms that distance to nearest market was also negatively but significantly affecting the choice of non-farm livelihood option at 10% significance level. This means the further the distance from the residence area of the landless rural households to the market, the lesser the likelihood of choosing non-farm livelihood sources. Furthermore, similar finding has been reported by Ref. [22] who confirmed that diversifying livelihood beyond the agricultural practice is likely to reduce as the distance to nearest market place increases from their residence. This result is consistent with the findings of Ref. [31] who highlighted that labor markets offer non-farm job opportunities for income generating activities of the rural households.

Factors affecting the number of livelihood options adopted by landless rural households

The log likelihood ratio chi2(11) = 50.3 with ($p = 0.000$) is significant at the 1% significance level, which indicates that the subset of all coefficients of the model is jointly significantly explaining the dependent variable. Thus, the explanatory power of the independent variables included in the model is overall satisfactory. Table 7 indicates that out of eleven explanatory variables included in the Negative Binomial Regression model, four explanatory variables were significantly influencing the number of livelihood sources adopted by the landless rural households.

Particularly, gender of household head and membership of the household in *Edir* were positively and significantly affecting the number of livelihood options adopted by the landless rural household. Furthermore, age square of the household head and distance to the district center were negatively but significantly related with the number of livelihood options adopted by the landless rural households. The following paragraphs give detailed discussions of the statistically significant variables by grouping into household head, social capital, and institution-related factors.

Household head-related factors

The first statistically significant household head-related factor was age square of the household head. The age square of the household head was included as an explanatory variable in the Negative Binomial Regression model to account for the non-linear relationship between age of the household head and the number of livelihood options adopted. The result of this study finds that there is non-linear relationship between age of household head and the number of livelihood options adopted by households at 1% significance level. That is, at the early ages of the household head, the number of livelihood options adopted is expected to increase with the age of the household heads. But after reaching a certain years of age, as the age of the household head increases, the number of livelihood sources adopted is expected to decrease.

As shown in Table 7 at the later age of the household head, as age increases by one more additional year, the number of livelihood options adopted by the household is expected to decrease by a factor of 0.99, holding other factors constant. This is perhaps due to the fact that with age, the physical endurance and health status of the household heads will deteriorate, which adversely affects the decision and participation of landless rural households to engage more on diversified sources of income. This result is consistent with the empirical findings of Ref. [43] who reported that participation in economic activities declines with the age of the household head. Our finding is also consistent with Ref. [18] who documented that younger households with literacy and more exposure to the exchange system diversified more income portfolios in southern Ethiopia. Ref. [44] also revealed that age of the household head was negatively associated with improved natural resources management practices. That is, with increase in the age of the household head, the planning horizons will shrink, and thereby, the incentives to enhance future productivity will diminish. However, the result of this study is somehow against to Ref. [45] who investigated the relevance and impact of experience in participation of Italian crop insurance markets and documented that direct or indirect experience motivate farmers to engage in crop insurance market to reduce risk and ensure food security during crop failure. Moreover, our finding is also inconsistent with the empirical results of Ref. [40] who reported that households with experienced head are more likely to have the chance to diversify their livelihood sources than those with relatively younger or less experienced household head.

The second household head-related factor significantly affecting the number of livelihood options was sex of household head. Table 7 indicates that sex of household head is positively and significantly influencing the number of livelihood choices adopted at 1% significance level. Male-headed households are expected to have a rate of 1.45 times greater number of livelihood sources adopted than female-headed households, holding other factors constant. The result of this study implies that male-headed households are more likely to increase their livelihood sources than their female counter parts. This is perhaps due to the fact that male-headed households are more likely to have better opportunity to participate in various non-farm and off-farm sources of income than female-headed households. Besides, the cultural and social burdens that women are faced with could also partly explained the lesser number of livelihood options adopted by female headed households. Similar findings has been documented by Ref. [4] who found that sex of the household is negatively and significantly affecting the probability of diversifying livelihood sources into off-farm activities in *Wolaita* zone of south Ethiopia.

Social capital-related factor

Membership in *Edir* was included in the model to investigate whether it affects the number of livelihood options adopted by the landless rural households or not. This study found out that membership in *Edir* is positively and significantly influencing the number of livelihood options adopted by the landless rural households at 10% significance level. This result is in line with the prior expectations of this study in the sense that social capital could increase the social link and network among households. This in turn may enhance the opportunity to get access to various livelihood options in their localities. That is, membership in *Edir* is expected to raise the livelihood sources as it significantly increases the social network of the rural landless household.

Holding other factors constant, this study found that households who participate in *Edir* are expected to increase their livelihood sources by the rate of 1.16 times higher than those who did not participate in *Edir*. Similarly, Ref. [41] reported that neighborhood attachment as social capital has a positive effect on household confidence in coping with food and income insecurity in

Table 8 Major challenges and opportunities of the landless rural household

	Frequency	Percentage
Major challenges		
Shortage of arable land	247	95.74
Lack of land for residence	98	37.98
Youth unemployment	186	72.09
Lack of awareness on alternative livelihood sources	67	25.97
Lack of financial capital	121	46.90
Poor land administration	156	60.47
Lack of access to infrastructure (water, electrification, and road)	173	67.05
Lack of market linkage	76	29.46
Conflict of interest on communal land use	78	30.23
Management problem of rural cooperatives	31	12.02
Major opportunities		
Bee keeping	127	49.25
Animal fattening	195	75.58
Dairy farming	186	72.09
Stone or sand selling	193	74.80
Poultry production	178	68.99
Hillside distribution program	82	31.78

the face of climate change or flooding. Thus, the study indicates that rural households are more likely to rely on bonding social capital to cope with economic stress. That is, households having a close connection with their neighbors can mobilize resources from their neighbors to expand their range of livelihood options. This result is also somehow similar with empirical findings of Ref. [40] who revealed that the relationship between livelihood diversification and membership in cooperative society was found to be positive and statistically significant. The implication of the study result is that social capital has significant contribution toward livelihood diversification of the landless rural households.

Institution-related factors

Table 7 shows that distance to district center was found to be negatively but significantly influencing the number of livelihood options adopted by the landless rural household at 1% significance level. This means as the distance between the residence area of the landless rural households and the district center increases by one more kilometer, the number of livelihood sources would expect to decrease by factor of 0.982, holding other factors constant. This result seems to some extent similar with the empirical finding of Ref. [40] who reported that the scope for livelihood diversification gets boosted when there is better proximity to urban or district centers. Furthermore, similar finding has been documented by Ref. [19] who affirmed that diversifying livelihood beyond the agricultural practice was likely to reduce as the distance to market place increases from their residence area. This is due to the fact that individuals who live near the market center have higher opportunity to engage in different livelihood options.

Unfortunately, access to credit was also found to be negatively related with the number of livelihood options adopted by landless rural households. That is, holding other factors constant, households with credit access are expected to have less number of livelihood sources by the rate 0.889 times compared to those who have not taken credit from any financial institutions. The result is statistically significant at 10% significance level. This result is in line with the empirical findings of Ref. [19] who studied factors affecting of livelihood diversification strategies in *Borana* pastoralist communities of Ethiopia and revealed that the level of credit access and use was significantly but negatively impacted livelihood diversification of households.

Major livelihood challenges and opportunities of landless rural households

The result landless rural households were asked to list out and rank the major challenges and opportunities of their livelihood options and the results are summarized in Table 8. In the same fashion, focus group discussants were requested to list out the major challenges that landless rural households are faced in their localities. Even if there were few district and *Tabia* specific challenges, the following are the common challenges specified by the focus group discussants and surveyed households:

shortage of arable land, youth unemployment, lack of access to infrastructure (like water, rural electrification, and road), poor land administration, and absence of collateral to take credit for the landless household were identified to be the top five major challenges faced with the landless rural households in the study area. Moreover, the surveyed landless rural households were also asked if there are any unexploited opportunities in the rural area which they could rely on as livelihood sources and their responses are summarized in Table 8. This study identifies that the major opportunities in the study area include stone or sand resources, dairy farming, poultry production, hillside distribution, animal fattening, and bee keeping. Similarly, the participants of the focus group discussion also highlighted that if the local government administration makes significant supports and follow-ups, the aforementioned activities can be helpful to rely on as sources of livelihood by the landless rural households in the study districts.

More specifically, the focus group discussant in *Kilte-Awlaelo* stressed that stone resources and bee keeping are the two most underutilized livelihood options for the landless rural households. The focus group discussant in *Degua-Tembien* also identified that bee keeping, dairy farming, shoat fattening, and stone selling could be the potential livelihood options for the landless rural households. Similarly, the focus group discussant in *Hintalo-Wajerat* identified that diary farming and stone selling could be the potential livelihood sources for the landless rural households.

Concluding remarks

This study was conducted in randomly selected districts of Tigrai region to explore the livelihood strategies, the number of livelihood options adopted, and identifying the major challenges and opportunities of the landless rural households. This study concludes that the major livelihood source of the landless rural households is farm (90%) followed by non-farm (72%) and off-farm (41%) economic activities. This study finds that household head-related characteristics, like age, sex, and marital status of the household head, and human capital-related factors, such as educational status of household head and labor force, were significantly determining the choice of livelihood sources of landless rural households. This study also reveals that social capital-related variables, like traditional labor sharing and membership in *Edir,* and financial capital-related factors, such as remittance, credit access, and membership in *Equb,* were also significantly influencing the choice of livelihood sources by the landless rural households. Moreover, physical capital-related factors, like livestock holding of households, and institution-related factors, such as distance to all-weather road and distance to nearest market, were also found to significantly affect the livelihood of choice the landless rural households.

The result of the Negative Binomial Regression also indicates that the number of livelihood options of the landless rural households depends on sex and age square of household head, membership in *Edir*, and distance to district center. This paper also concludes that the current way of government intervention to address the problem of landlessness in the study area needs to take into account the interest of the landless rural households. Furthermore, all stakeholders effort to address the problem of landlessness has to be geared in such way that can boost the access of landless rural households to the different livelihood capitals, such as human, social, financial, and physical of the rural landless households. Moreover, concerned bodies has to focus on rural township to enhance job opportunities and access to nearest market for the landless rural households.

Abbreviations

CSA	Central statistical agency
FDRE	Federal Democratic Republic of Ethiopia
FGD	Focus group discussion
GDP	Gross Domestic Product
KM	Kilometer
MoFED	Ministry of finance and economic development
MVP	Multivariate probit
NBR	Negative binomial regression
PSNP	Productive safety net program
TLU	Tropical Livestock Unit
WRI	World Resources Institute

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Author contributions

TN participated in supervision, data collection, data analysis, description, drafting, and revising the manuscript. HE, MA, GK, and ZM were also involved in data analysis, data collection, and commenting the draft and revised versions of the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

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Declarations

Ethics approval and consent to participate

Prior to starting the work, the study design was explained to officials of agriculture and Administrative of the study districts for their permission and support. The nature of this study was fully explained to respondents to obtain consent. No false promise, such as remuneration or per diem, was given. Information was collected after securing consent from study participant. Data

obtained from each study participant were kept confidential, and all people who participated in this study were acknowledged.

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Competing interests
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Author details
[1]Department of Agricultural and Resource Economics, Mekelle University, P. O. Box. 231, Tigrai, Ethiopia.

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