

## Research

# Exploring income diversification strategies for rural households across three selected agro-ecological zones in the Dawuro Zone, southwestern Ethiopia

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## Abstract

This paper investigates income diversification and its determinants among rural households via data collected from 203 rural households located in lowland, midland, and highland agro-ecological zones in Ethiopia. A multistage sampling procedure was employed to select sample households. The study utilized primary data, which are qualitative and quantitative in nature. The collected data were analyzed via descriptive statistics and a two-limit Tobit model. To estimate the degree of income diversification among rural households, the Simpson index of diversity was used in this study. The results indicate that the degree of income diversification significantly varied among the rural households in the study area. These variations were explained mainly by differences in resource availability and farmers living in agro-ecological zones. Compared with lowlands, farm households located in highlands and midlands agro-ecological zones had a greater degree of income diversification in the study area. Moreover, the gender of the household head (male), the education level, and the possession of draught power were negatively correlated with the degree of income diversification in the study area, whereas agro-ecological zones, livestock possession, local leadership participation, participation in agricultural extension programs and access to credit services were positively correlated with income diversification. Thus, rural households' income diversification strategies should be promoted through more investment in pull factors in lowlands rather than in highland and midland agro-ecological zones.

**Keywords** Agroecology · Dawuro Zone · Income diversification · Rural households · Simpson index of diversity

## 1 Introduction

Agriculture is an important sector for the livelihoods of the majority of rural populations, as it is a source of income, employment and foreign exchange in developing countries [1]. In the Horn of Africa, the majority of people rely on agriculture as a means of living [2]. Similarly, agriculture is the principal source of food and income in Ethiopia, which employs approximately 75–85% of the population [2, 3] and contributes to more than 41% of GDP [4].

Despite its high contribution to overall economic activities in rural Ethiopia, the sector is characterized by dependence on rainfall, dominated by small-scale agriculture and still predominantly subsistence agriculture with traditional farming systems [5, 6]. Hence, agricultural productivity has remained very low, and most rural households in the country

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are exposed to food insecurity and chronic poverty [7]. Abera et al. [4] clearly state that dependence on the agricultural sector alone cannot be relied upon as a means of improving livelihoods and reducing poverty.

Livelihood diversification is believed to be a solution and an effective strategy for reducing poverty and food insecurity in rural Ethiopia [4, 8]. Livelihood diversification is a process by which household members construct a diverse portfolio of activities and social support capabilities in their struggle for survival and to improve their standards of living [9]. Diversifying households' income has become the custom, particularly in an agro-based economy [10], in which they have adapted their asset-building strategies to various techniques, either intensifying the extensity of agricultural production or diversifying their portfolio of economic activities in the non-farming sector [9].

In Africa, a small number of farm households have changed in terms of income diversification, and half of the farms have stagnated [11]. Thus, understanding and promoting rural household income diversification has substantial economic, environmental, and health impacts in rural areas. It can solve seasonal income gaps, reduce climate risk and market failure, increase income, improve assets, reduce dependency on natural resources, reduce gender inequality by improving women's capabilities, improving children's care and nutritional status, and reducing food insecurity [8, 12]. Thus, agrarian households should engage in off- and non-farm activities [13] because diversifications of income sources could help them overcome the difficulty of threats and suspicions [14]. Rural income diversification is an effective strategy to cope with adverse effects that emanate from changes in ecological services [8, 15].

In Ethiopia, there is growing evidence that households participate in diverse livelihood strategies toward non/off-farm activities that are undertaken to generate additional income for survival and cope with different livelihood shocks, trends and seasonality associated with agricultural production [16, 17]. However, their participation is determined by various factors, such as local settings, resource endowments or assets owned by households. Moreover, the determinants vary at different locations according to the context, local setting and asset holding of households [18, 19].

Accordingly, local livelihood knowledge is relevant for identifying the determinant factors for designing suitable development policies and interventions to increase household income diversification. Agro-ecological variations have a significant effect on farmer livelihoods in Ethiopia [20]. However, such effects have not been clearly investigated and promoted by past studies. Thus, this paper fills the existing gap by investigating the degree of income diversification and its determinants among rural households located in lowland, midland and highland agro-ecological zones in the study area.

## 2 Conceptual framework of the study

Income-based household income diversification analysis was applied in this study. Using this approach would offer several advantages, including accounting for the end outcome of income-generating activities and easier conversation of in-kind payments into money [21]. Income is closely related to the concept of absolute poverty and in measuring household wealth [21]. However, the asset-based approach has several shortcomings: for example, because of market failure, it is difficult to assign some useful assets to specific activities and determine their true market values [21]. Using the activity-based approach also has several drawbacks: for example, it is difficult to value all activities, and it ignores unearned income sources. Currently, the income earned from each activity may be used to analyze diversification. The income-based approach was used in different empirical works on income diversification, and this approach was also applied in this study because it reduces the above shortcomings.

The extent of household income diversification is measured by using different income diversification indices, including the number of income sources (share of non-farm income into total income) [22] and the level of income diversification (income diversity), which are known as Simpson's index and Herfindahl diversification index [23, 24]. Herfindahl Hirshmanand index equals the sum of the shares across each possible income source [21]. A value of 1 indicates complete dependence on a single income source, whereas a value of  $1/k$  represents perfectly equal earnings across income sources, where there are 'k' different income source categories. To estimate the degree of income diversification among rural households, the Simpson index of diversity (SID), which was adapted from biodiversity studies [23], was used in this study because the SID considers both the number of income sources and how evenly the distributions of the income between the different sources are [25, 26]. This justifies the choice of the SID as applied in this study over the remaining measures of diversification, such as the Herfindahl and Shannon indices. The SID ranges between zero (0) and one (1). In this method, the index value equal to 0 denotes specialization, and 1 is the extremity of diversification.

### 3 Materials and methods

#### 3.1 Study area

This study was conducted in the Loma district of the Dawuro Zone, located in southwestern Ethiopia, in 2019. The study area is geographically coordinated at 6° 42' 13"–6° 53' 48" N latitude and 37° 00' 20" E–37° 15' 48" E longitude. The agro-ecosystems of the study area cover highland to lowland areas and receive 1400 mm to 1600 mm of rainfall annually, with an average temperature of 21 °C, which ranges from 15.1 to 27.5 °C. The district's elevation ranges from 700 to 2600 m above sea level. The study district comprises 36 rural *kebeles* and has three agro-ecological zones: highland, midland, and lowland areas. The livelihoods of households are based mainly on rain-fed agriculture in the study area: rainfall shortages and variability impact the food security situation of the rural households in the study area [27]. As a result, most households are experiencing chronic food insecurity.

#### 3.2 Data sources and methods of data collection

The study utilized primary data which are qualitative and quantitative in nature. A well-structured questionnaire was used to collect data from 203 randomly selected sample household respondents.

#### 3.3 Sampling techniques

A multistage sampling technique was used to select the study Woreda (District), *kebeles*, and households. In the first stage, out of ten Woredas in Dawuro, Loma (including Disa) was selected purposively under the close guidance of agricultural and rural development experts in the Dawuro Zone; in the second stage, on the basis of agro-ecological differences, total of 36 rural *kebeles*, six were selected for this study. These selected *kebeles* include "Fulassa Bale and Gato Guffo" from the highlands, "Tulama Tama and Gessa Chare" from the midlands, and "Ella Bacho and Zima Waruma" from lowland areas. In the third stage, 203 households were randomly selected on the basis of their proportion of the target population size in each selected *kebele*.

#### 3.4 Data analysis

Both descriptive statistics and a two-limit Tobit model were used to analyze the data collected from smallholder farm households. The main descriptive statistics that were employed were frequency, percentage and mean. In addition, the chi-square test ( $\chi^2$ ) was used to determine whether there are significant differences among the different livelihood strategies in relation to the following variables:

The two-limit Tobit model was used to identify the determinants of farmers' income diversification. The model specifications and descriptions of the study variables are presented below.

The dependent variable used to estimate the two-limit Tobit model is the Simpson index of diversity (SID) index, which is computed as follows:

$$SID = 1 - \sum_{n=i}^R \frac{ni(ni - 1)}{N(N - 1)} \quad (1)$$

where SID is the Simpson Index of Diversity, R is the number of activities of ith for household, N is the total income, and n is the number of income sources. The dependent variable obtained from the SID was a proportion with non-integer values and bound in an interval between 0 and 1. Tobit coefficients were interpreted as coefficients of a linear regression model. The equation for the model was constructed as follows:

$$Y^* = X_i\beta_i + \varepsilon_i \quad (2)$$

where  $Y^*$  is unobserved for values less than 0 and greater than 1 (called a latent variable). It represents an index for sources and intensity of income diversification among farming households;  $X_i$  represents a vector of explanatory variables;  $\beta_i$  is a vector of unknown parameters; and  $\varepsilon_i$  is the error term.

Assuming that  $y_i$  is the observed dependent variable, the two-limit Tobit model can be specified as:

$$y_i = \begin{cases} 0 & \text{if } y_i^* \leq 0 \\ y_i^* & \text{if } 0 < y_i^* < 1 \\ 1 & \text{if } y_i^* > 1 \end{cases} \quad (3)$$

The values between 0 and 1 indicate the income diversification level within the Tobit Model Limit range. In this study, income diversification was the dependent variable, measured in SID and estimated from the number of annual income sources, including on-farm, off-farm, and non-farm activities. The SID index ranges between 0 and 1. The index indicates that household income diversification decreases as the SID approaches zero and increases as the SID approaches one. The results from the model used to examine the factors influencing household income diversification strategies are presented in Table 1.

## 4 Results and discussion

### 4.1 Degree of income diversification

The results of the descriptive statistical analysis revealed that the sociodemographic characteristics of rural households and the degree of income diversification were significantly interconnected (Table 2). Accordingly, gender, age, family size, farm size, livestock, draught power owned, farmland quality, participation in local leadership, access to seasonal roads, market access, participation in agricultural extension programs, access to credit, and transfers/remittance are important sociodemographic and institutional factors affecting the extent of income diversification among rural households.

Gender, educational level, age, and family size constitute human capital and significantly influence rural household income diversification. With respect to gender, the results reveal that males have the highest degree of income diversification, with a value of approximately 0.41, whereas females have a value of approximately 0.11. The results of the study of educational status revealed that the degree of income diversification among illiterate farmers was 0.52, whereas the degrees among primary school and above-educated farmers were 0.45 and 0.35, respectively. These results indicate that farm households with higher educational statuses are more likely to participate in non-farm activities. Additionally, farm households under 35 years of age have a degree of income diversification of approximately 0.42, and farmers between 36 and 50 years have a higher level of diversification than do farmers > 65 years of age. The level of diversification for farmers older than 50 years is the lowest. The results show that as age increases, the income diversification ability of households decreases. Farm holds with more than 6 family sizes have the highest index of approximately 0.41. The level of diversification for farmers with fewer than two family sizes has the most negligible income diversification index. This finding indicates that income diversity was greater for households with large families than for those with small families. This study contradicts the previous study by [28], who reported that income diversity was greater for households with small family sizes than for those with large family sizes.

Access to the market, credit, and participation in agricultural extension programs are important physical and institutional factors affecting income diversification among rural households in the study area. For instance, market access is linked to road accessibility and the ability to sell farm products in the market. Rural households with market access have a greater degree of income diversification (SID = 0.40) than do those with no access to the market (SID = 0.39). This shows that farmers who can access the market can sell their farm products to obtain more diversified income sources and engage in non-farm activities. With respect to access to credit, households with credit access have a degree of income diversification of approximately 0.48, whereas households with no access to credit have a degree of income diversification of approximately 0.29. This finding indicates that households with credit access have a greater ability to diversify their income than do those with no access. The differences in participation in agricultural extension programs indicate that rural households that participate in agricultural extension programs have a greater degree of income diversification (SID = 0.39) than do those that participate (SID = 0.30). This implies that those rural households who participate in agricultural extension programs highly diversify may result from having access to improved seeds; access to information contributes to agricultural production and non-agricultural activities. This is because having access to improved seeds, market information, and professional consultancy from the program helps households have a more diversified income.

Livestock possession and the number of oxen holdings are also important financial resources that affect income diversification among rural households. Households that possess livestock between 0–2, 2–4, 4–6, and above 6 have

**Table 1** Summary of study variables and hypotheses

Variables	Measurement scales and description of study variables	Relationship
Degree of income diversification	It is a continuous variable, measured in the SID index, and ranges between 0 and 1	
Gender (1 = Male)	It is a dummy variable and measured as female or male	±
Age	It is a continuous variable measured in the year and indicates the experience in the livelihood activities and working capacity	+
Education	Educational level is measured as a categorical variable and measured as illiterate, primary, secondary, and above	+
Family size	The number of family size influences income diversification because crop diversification is a labor-intensive job that requires more labor for planting multiple crops to increase its food production levels	+
Agro-ecological zones	It is a categorical variable measured as highland, midland, and lowland. Farmers living in different agro-ecological zones make use of different income diversification strategies and create resilience	±
Farm size	The land is a continuous variable measured in hectares. It is a critical natural resource and determines both on-farm and off-farm activities engagement	+
Livestock holding (excluding oxen)	It is proxy of household wealth in rural Ethiopia and a continuous variable, measured in Tropical Livestock Unit (TLU)	+
Number of oxen holding	It is a continuous variable measured in number; a pair of oxen is expected to result in high crop production timeliness and thoroughness of cultivation	±
Farm land quality	This variable measured farmers' perception of farmland fertility status (fertile or not-fertile)	+
Participated in Local Leadership	Farmers who participate in social leadership in the local area have more likelihood to diversify income into non/off-farm activities than those farmers who have no leadership role in their community	+
Participation in an agricultural extension program	Frequency of extension contact with extension workers would provide the farmer with necessary information about income diversification, the availability of needed resources, market, and prices which encourages him/her to cultivate additional off-farm activities	±
Access to credit	It is a dummy variable; access and use of cash credit for income diversification are one of the critical factors that increase the participation of farmers in different income-generating activities	+
Access to seasonal road	It is a dummy variable; the more the access to facility households has more advantages to engaging in non-agricultural employment and diversifying income sources	+
Market access	Dummy variable; household's access to market (availability of market near or far to the peasant association) influences income diversification	+
Transfers/remittances	Dummy variable; presence of income received from the government or nongovernment for public work or direct supports	±

**Table 2** Sociodemographic characteristics of households versus degree of income diversification

Sociodemographic characteristics of rural households	Values	Degree of income diversification	Chi-square (X) <sup>2</sup> value
Gender of the household head	Male	0.41	21.384***
	Female	0.11	
Age of the household head	20–35	0.42	4.670
	36–50	0.40	
	51–65	0.38	
	Above 65	0.37	
Family size of the household head	≤ 2	0.37	4.722
	3–4	0.40	
	4–5	0.40	
	Above 6	0.41	
Farm size owned	Below 0.5	0.39	7.467**
	0.50–1.00	0.45	
	1.11–1.50	0.44	
	1.51–2.00	0.52	
Agro-ecologies	Above 2	0.36	51.96***
	Highland	0.37	
	Midland	0.49	
	Lowland	0.31	
Livestock (TLU)	0–2	0.23	11.160**
	2–4	0.37	
	4–6	0.42	
	Above 6	0.45	
Draught power owned	No	0.42	6.69***
	1	0.39	
	2	0.36	
	3 & above	0.29	
Farm land quality	Infertile	0.39	7.68
	Fertile	0.40	
Participated in local leadership	No	0.34	22.595***
	Yes	0.45	
Access to seasonal road	No	0.39	9.501*
	Yes	0.41	
Market access	No	0.39	4.508
	Yes	0.40	
Participation in agricultural extension program	No	0.30	11.319**
	Yes	0.39	
Access to credit	No	0.29	28.144***
	Yes	0.48	
Transfers/remittance	No	0.39	3.613
	Yes	0.39	

\*, \*\* and \*\*\* indicate statistical significance at the  $p > t$  value of 10%, 5% and 1%, respectively

degrees of income diversification of 0.23, 0.37, 0.42, and 0.45, respectively. The level of income diversity was highest for households with high TLU and lowest for those with b/n 0–2 livestock. This finding indicates a positive influence of livestock size on income diversification, as livestock solves capital shortages to start non-farm income. This study contradicts the previous study in which farmers with a large number of TLUs were less likely to participate in income diversification than those who own a small number of TLUs were [29] and confirms the prior findings of Aloba [30]. The analysis shows that households holding oxen 0, 1, 2, and 3 & above have degrees of income diversification of approximately 0.42, 0.39,

0.36, and 0.29, respectively. This result suggests that those farmers who owned more oxen were less likely to engage in income diversification than those who owned a small number of oxen.

Farm size, farmland quality, and agro-ecological zones are significant natural resources that influence income diversification among rural households. Farm size is based on the Table 2, with degrees of income diversification of 0.39, 0.45, 0.44, 0.52, and 0.36 for farm households whose income is less than 0.5 hectares, between 0.50–1.00 hectares, 1.11–1.50 hectares, 1.51–2.00 hectares and above 2 hectares, respectively. A large farm size helps farmers cultivate and produce more, which increases farm income and improves the livelihood of a household [31]. This study contradicts the previous study by Yishak [29], indicated that as farm size increases, the concentration level decreases, and the extent of diversification increases. This is because farmers with larger farm sizes are more likely to diversify income sources. This survey indicates that fertile land has an income diversification index of approximately 0.40 and that infertile land has an index of 0.39. The results show that when the land for farm households becomes more fertile, the income diversification index becomes high. Under optimal management, better land quality increases crop production. The study confirms that if farm households have fertile land, the farm can produce more and increase total income, which will be invested in different income-generating activities [32]. The results also show that income diversification varies across the three agro-ecological zones in Dawuro: 0.49, 0.37, and 0.31 in the middle, lowland, and highlands agro-ecological zones, respectively. The rural households living in lowland areas presented the lowest degree of income diversification compared with those living in midland and highland agroecosystems. The main reasons for the difference in the level of income diversification across agro-ecologies were associated with the lowest existing potential. Rural households are motivated to address these shocks they face when living in lowland areas, whereas the progressive income diversification in midland and highland areas is mostly regarded as an *ex ante* strategy implemented by relatively well-off households.

Moreover, most of the lowland parts of the study area are food insecure and vulnerable to climate change problems. Accordingly, off-farm and non-farm income sources are most extensively used by rural households in lowland areas because these areas have the lowest agricultural potential (higher risk) and low agricultural productivity compared with those in the middle and highland areas in Dawuro. This finding aligns with that of Barrett et al. [21].

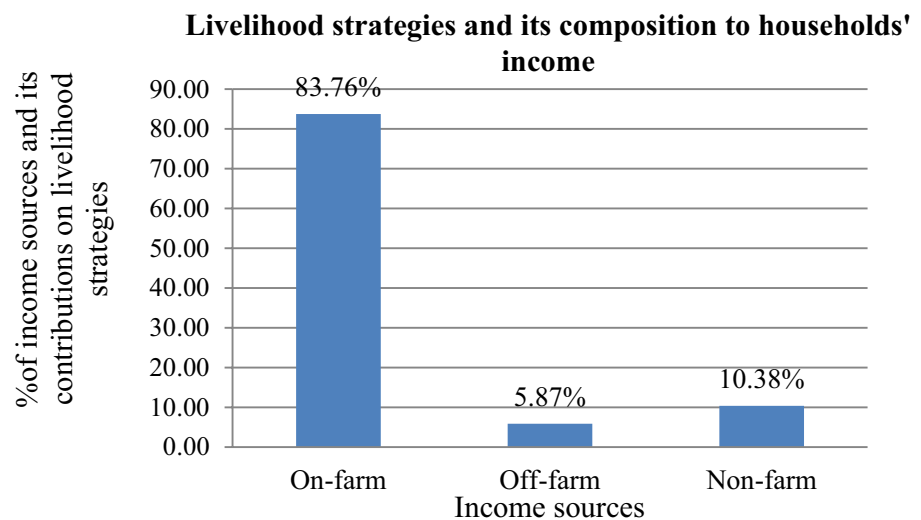
Participation in local leadership and transfer/remittance are other significant social assets that influence income diversification among rural households. Participation in local leadership: according to the survey results, the rural households that participated in local leadership achieved a higher degree of income diversification ( $SID = 0.45$ ) than did those that did not participate in local leadership ( $SID = 0.34$ ). This implies that those farmers who participate in social leadership in the local area are more likely to diversify income. Local leaders are more trusted and accepted by formal and informal financial institutions regarding credit access. As indicated in the analysis, rural households that receive remittances and transfers have equal income diversification ( $SID = 0.39$ ).

## 4.2 Sources and degrees of income diversification among rural households

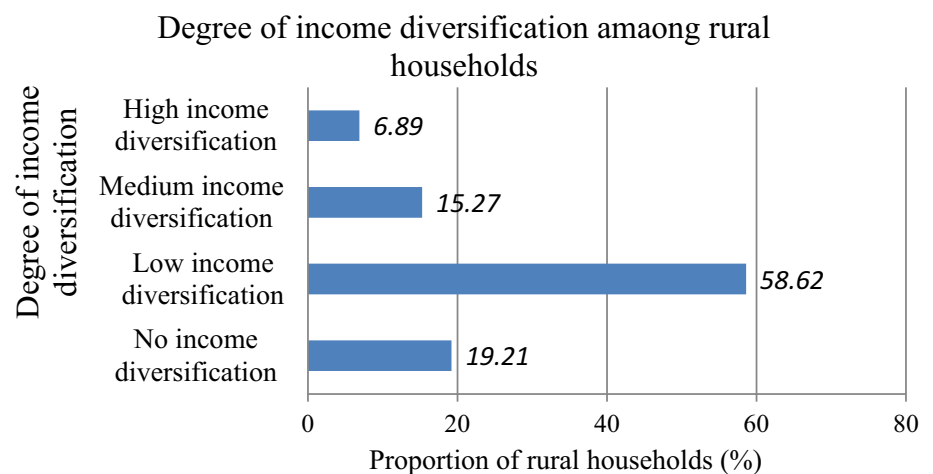
The three major annual income sources in the study area include on-farm, off-farm, and non-farm activities. On-farm (agricultural activities) consists of crop- and livestock-related activities, whereas off-farm activities refer to activities other than those related to crops and livestock production that take place away from household-run farms but still within the agricultural sector. Crop production was dominated by teff, wheat, sorghum, bean, pea, haricot bean, groundnuts, potatoes, sweet potatoes, ginger, barley, maize, enset, horticultural crops (vegetables and fruits), medicinal plants, highland bamboo, and garden coffee farming activities. Enset and bamboo production and marketing are more intense in the highland parts of Dawuro. Livestock husbandry was dominated by cattle, goats, sheep, equines, poultry, and apiculture activities. The study district is well known for “Dawuro butter” production and supply in Ethiopia. The gross on-farm income is obtained from sales of farm products, i.e., crops and livestock plus the value of food produced for consumption or exchange in kind at market prices plus the cost of inputs plus hired labor. The gross off-farm income is also estimated from wages or labor in exchange for food, the share of a harvest, the hiring of oxen, and income from environmental resources such as firewood, charcoal, house building materials, wild plants, medicinal plants, and retail crop and livestock products. The major sources of gross non-farm income of rural households in the study area include non-agricultural wage or labor employment, land and physical resource rent, sales of non-agricultural products, traditional handcrafts, transfers, and remittances. The non-farm income sources also include non-agricultural wages, labor employment plus income, land and equipment rentals, production and sales of non-agricultural products, engagement in petty trade, self-employment, traditional handcrafts, and remittances/transfers.

Accordingly, the average annual household income was 5542.40 ETB (USD 108.14). In terms of total annual income, on-farm, off-farm, and non-farm activities constitute 83.76%, 5.87%, and 10.8%, respectively (Fig. 1). This implies that

**Fig. 1** Composition of household income (gross value) in Dawuro



**Fig. 2** Distribution of rural households by their degree of income diversification



on-farm activities account for the highest share of total annual rural household income in the study area. Low off-farm and non-farm income sources negatively impact food security since agricultural activities are susceptible to climate change and market failure. The share of non-agricultural activities accounts for 16.25% of the annual income in the study area, which is less than the share of the national average (25%) of the non-agricultural sector [30]. Moreover, this study aligns with Lemi [33], who stated that crop income accounts for the largest share of total income, 71%, followed by the share of off-farm income (17%) in rural Ethiopia.

Diversification refers to expanding the range of rural activities outside the farm and is seen as a dynamic adaptation process created through pressures and opportunities [9]. This study computed the degree of income diversification among rural households through the Simpson index of diversity (SID). The study findings have shown that income diversification ranges from perfect income non-diversification to high-income diversification. Among rural households, more than half (58.62%) of the households in the study are low diversifiers ( $SID = 0.01-0.39$ ). A total of 19.21% of the total households in the study area are found under perfect income non-diversifiers ( $SID = 0.00$ ), whereas 15.27% ( $SID = 0.40$  to  $0.60$ ) and 6.89% ( $SID \geq 0.61$ ) are medium and high diversifiers, respectively. (Fig. 2). This finding aligns with Adem and Tesafa [34], who revealed that approximately 32 households or 21.01% had a diversity index between 0.12 and 0.3, 23 households or 15.03% had a diversity index between 0.31 and 0.6, and approximately 22 households or 14.29% had a diversity index between 0.61 and 0.78 in the Asayita district of Afar region, Ethiopia.

**Table 3** Marginal effect results after Tobit model regression: Determinants of income diversification

Variables	dy/dx	Coef (β)	Z value
Agro-ecological zone (midland)	0.074	0.074***	3.09
Agro-ecological zone (highland)	0.054	0.035**	2.01
Gender	−0.256	−0.261***	−3.56
Age	−0.003	−0.003	−1.05
Education level	−0.085	−0.090***	−2.77
Family size	0.015	0.029	1.09
Farm size	−0.015	−0.032**	−2.02
Farmland quality	0.007	0.006	0.19
Irrigated farm size	−0.133	−0.143	−0.59
Number of oxen	−0.081	−0.084***	−3.27
Livestock possession	0.027	0.028**	2.30
Market access	−0.035	−0.038	−0.35
Participated in local leadership	0.094	0.095**	2.73
Participated in agricultural extension program	0.116	0.123*	1.73
Access to credit	0.163	0.172***	1.36
Transfer and remittances	0.003	0.002	0.07
Road access	0.041	0.042	1.13
Constant	–	0.281	0.89

\*, \*\* and \*\*\* indicating significance level of  $p > t$  value 10%, 5% and 1%, respectively. Number of observations = 203, LR  $\chi^2$  (17) = 106.72, Prob >  $\chi^2$  = 0.000, Log likelihood = −15.48, Pseudo  $R^2$  = 0.770; 39 left-censored observations at  $SID \leq 0$ ; 161 uncensored observations; 3 right-censored observations  $SID \geq 0.895$ , lowland agroecology is base variable

### 4.3 Determinants of the degree of income diversification among rural households

Table 3 presents the estimates of the Tobit model on the determinants of the degree of income diversification among rural households. The F statistic is significant ( $p < 0.01$ ), indicating a good fit of the model and that all the variables have a joint influence on the dependent variable (SID index). The variance inflation factor (VIF) score is 2.32, which is lower than 10, and we can conclude that there is no multicollinearity problem among the explanatory variables [35]. In this study, the degree of income diversification was considered the dependent variable and was measured by the SID index. Among the seventeen independent variables used in the Tobit model, agroecology, gender, education, farm size, number of oxen, livestock possession, market access, participation in local leadership, participation in agricultural extension programs, and access to credit were found to significantly affect the degree of income diversification among rural households (Table 3).

*Education level* is human capital and a key determinant of households' livelihoods in general and income diversification in rural areas. Higher levels of education among household members, such as completing secondary school or college, had a negative and significant effect on income diversification among rural farm households. Accordingly, the level of education is significant ( $p < 0.01$ ) and has a negative relationship with the degree of income diversification. The level of education of the household increased by 1 year of schooling, and the degree of income diversification decreased by 8.5%. This finding indicates that those households with high educational levels are less likely to diversify income generation than those who are less educated. This is probably associated with education increasing human capital levels and providing the necessary skills that do not enable entry into more remunerative labor markets, especially non-farm income-generating activities. Moreover, most of the time, educated households gain better skills, experience, and knowledge of agricultural technology adoption and are less engaged in different livelihood strategies. They focused on the specialized farming system rather than diversifying the farming.

*Gender*: The findings in Table 2 show that the income diversification of male-headed households ( $SID = 0.41$ ) was greater than that of female-headed households ( $SID = 0.11$ ). Additionally, from the Tobit model regression, it was found that female headship has a negative and significant effect on the degree of income diversification at the 1% probability level (Table 3). Thus, the level of diversification decreases by 25.6% when the household head is female. In most cases, male-headed households have better access to information on income diversification and are more likely to diversify

than females. The authors highlighted that female-headed households are usually less likely to diversify income since they are less endowed with resources and are less exposed to new information and ideas [36]. Adem and Tesafa [34] reported that problems hinder female head households from participating in different income-generating activities (both farm and non-farm) because of their different culturally defined roles, social mobility limitations, and differential ownership of/access to assets.

**Farm size owned:** Farm size used as a proxy for agricultural potential was significant in determining the level of income diversification. Farm size ownership negatively and significantly influenced the probability of farmers' participation in off-farm and non-farm income diversification activities at the 5% probability level. This result implies that, compared with farmers with small land sizes, those with large farm sizes are less likely to diversify their livelihood into non-farm and/or off-farm. This means that significant farmland ownership by a household decreases the income diversification level by 1.5%. This finding aligns with that of Adeoye et al. [37], who reported that farm size is significant ( $p < 0.1$ ) and negatively correlates with off-farm income diversification among rural farm households in Nigeria. This finding also implies that as farm size increases, the concentration level decreases, and the extent of diversification increases in Nigeria. This is because farmers with larger farm sizes are more likely to diversify their on-farm income sources.

**Agro-ecologies:** Location plays a role in income diversification. Most of the rural households in Dawuro are located in the midland agroecology area. Compared with lowlands, midland agroecology has a positive and significant relationship with the level of income diversification among rural households. Perhaps on-farm, off-farm, and non-farm income sources are more extensively used by rural households in midland areas than in lowlands. The descriptive analysis results also revealed that the highest degree of income diversification among rural households was found in the midland and highland areas (Table 2) because of the greater abundance of natural and physical resources, high agricultural potential, better market access and physical infrastructure, which enable many opportunities to engage in more on-farm, off-farm and non-farm income-generating activities. Thus, the model results show that rural households in the midland and highland agroecosystems had income diversification probabilities of 7.39% and 5.42%, respectively, compared with those of rural households in the lowland agroecology in the study area.

**A number of oxen or draught power:** The number of oxen is the main source of traction power among rural households. Oxen ownership negatively and significantly influenced the probability of diversifying income into non/off-farm activities at the 1% significance level. This result suggests that those farmers who owned more oxen were less likely to engage in income diversification than those who owned a small number of oxen. If a household's oxen ownership increased by one ox, income diversification would decrease by 8.1%. This might be because ownership of draught power improves livelihood strategies for on-farming.

**Livestock possession:** Livestock diversification is a key income-generating strategy in rural Ethiopia. Livestock is the most central indicator of the wealth of rural households and is an important indicator of on-farm diversification in study areas [38–42]. A positive effect on the degree of income diversification among rural households was found. Livestock possession was significant at the 5% probability level. Increasing livestock ownership by one TLU would increase income diversification among rural households by 2.7%. Moreover, rural households with more livestock are more likely to have more diversified sources of income, suggesting that such households are more focused on different livestock production and off-farm activities, reduce their risk aversion, relieve liquidity constraints, and generate income through the sale of products and services. The results of this study confirm the prior findings of Alobo [30] and Bassie [32].

**Participation in local leadership:** This variable was found to positively and significantly influence income diversification into non/off-farm activities at the 5% probability level. Participation in local leadership increases income diversification levels by 9.4%. Dilruba and Roy [43] and Awoyemi et al. [44] reported similar results. Even with respect to credit access, local leaders are more trusted and accepted by formal and informal financial institutions.

**Participation in agricultural extension programs:** The results further show that the number of extension visits increases the degree to which farm households diversify their incomes. It is confirmed that rural households' participation in agricultural extension programs and utilization of development agents' consultancy on agribusiness activities may increase income diversification. This outcome could be attributed to the fact that the presence of extension agents in farming communities has led to support farm households in engaging in other income-generating activities by choosing new crop varieties and species of livestock and providing agricultural services (such as market information, input supplies, and credit access) for income diversification. Accordingly, participation in the agricultural extension program positively affects the level of income diversification of households positively and significantly at the 10% level. This means that participation in agricultural extension programs and household utilization would increase the income diversification level by 11.6%. In lowland areas in Ethiopia, Dinku [45] reported that the number of veterinary extension service providers' contact dates positively and significantly contributes to pastoralists' participation in off-farm and non-farm livelihood

activities at the 0.04 and 0.03 significance levels, respectively. Compared with pastoral practices alone, the likelihood of pastoralists choosing pastoral plus farming and pastoral plus non-farm livelihood strategies increase as the number of veterinary extensions contact dates increases. This implies that a daily increase in pastoral extension contact with relevant extension messages increases the likelihood of farmers' choice of pastoral plus off-farm and pastoral plus non-farm activities by 1.4 and 1.5 units, respectively.

*Access to credit* can help to adopt production-enhancing technology, and this, in turn, helps to generate more income. Sometimes, credit helps them invest directly in non-farming activities. Access to the credit market provides opportunities for farm households to obtain the capital necessary to start up or to have participated in non-farm employment. Access to the credit market is one of the strong and major determinants of participation in non-farm activities. Households with access to formal credit are more likely to participate in non-farm activities than those without access, which improves the level of income diversification. Thus, access to credit positively and significantly affects the income diversification level of households at the 1% level. This means that credit utilization by a household increases the income diversification level by 16.3%. This finding aligns with that of Adem and Tesafa [34], who revealed that credit utilization positively affects the income diversification of households positively and significantly at the 1% level. This means that credit utilization by a household increases the income diversification level by 9.03%. Moreover, Babatunde and Qaim [22] noted that credit can reduce liquidity constraints and increase the capacity of households to perform non-farm business.

## 5 Conclusions

The study focuses on three main areas: sources of income, degree of income diversification among rural households, and determinants of the degree of income diversification among rural households. The household income source or composition includes on-farm, off-farm, and non-farm activities. Focusing solely on agricultural production and marketing is rare in rural areas. The composition of rural household income includes on-farm (83.76%), off-farm (5.87%), and non-farm (10.8%) activities in the study area. Approximately 19.21%, 58.62%, 15.27%, and 6.89% of rural households have perfect income non-diversification, low-income, medium-income, and high-income diversification, respectively. Most rural households' annual income is generated from on-farm income, i.e., the production and sales of crop and livestock products. This status quo may have contributed to chronic food insecurity in the lowland parts of rural areas in Dawuro. The rural household income sources in lowland areas are largely based on rain-fed agriculture and more negligible income diversification, which is subject to climate risks or rainfall shortages and variability.

The decision of rural households to participate in income diversification activities is influenced by individual- or household-specific factors and other social, economic, and environmental factors. The model results indicated that gender, education level, and number of oxen (draught power) were negatively correlated with the degree of income diversification among rural households, whereas midland and highland agro-ecologies, livestock possession, participation in local leadership, participation in agricultural extension programs, and access to accredit services were positively associated with income diversification in this study.

Income diversification is not responsible for improving household well-being over long periods; however, it can only help rural households survive and maintain their daily livelihood during unpredictable income shocks, especially in an agriculture-based economy. Thus, rural development policies should encourage the use of multiple income sources fundamental for the survival of poor rural households because poor people are disposed of external risks such as climate change and the seasonality of their income earnings. Rural households can access a range of assets or resources (physical, natural, economic, human, and social capital) that they can use to engage in on-farm, off-farm or non-farm activities. Thus, initiatives that seek to increase access to and utilization of human, physical, financial, natural, and social assets need to be strengthened to increase opportunities for poor rural households. They should be encouraged to engage in income diversification in off-farm and non-farm activities to increase nutrition and reduce poverty, food insecurity, unemployment, and climate risk.

To build rural household socioeconomic profiles, market access, efficient use of available resources (natural, human and physical), institution support, suitable input supplies, and cooperation through rural development programs and projects can increase the degree of income diversification among rural households. If rural households have an opportunity to access assets such as physical capital (land and productive tools), human capital (education, training, skills, and experience), social capital (networks and membership in formal and informal organizations), natural capital (common property natural resources) and financial capital, there is a high chance of engaging in income diversification activities. Moreover, the infrastructure environment, which is important for market access, especially in terms of transport facilities,

needs to be improved to increase access to a range of opportunities both on the farm and outside the farm to improve the livelihoods of rural households. This study, from different household income diversification analyses, such as asset-based and activity-based analyses, focused on the income-based approach. Moreover, this study did not substantiate all the determinants that may impact the degree of income diversification among rural households, which are the major limitations of this study. Therefore, we suggest that future research consider the dynamics and shortcomings of this study.

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**Author contributions** G.G. and T.K. Conceptualized manuscript, analyzed data and written the manuscript, A.A, analyzed data and written the manuscript. All authors reviewed the manuscript.

**Data availability** Data are available upon request from the corresponding author.

## Declarations

**Ethics approval and consent to participate** This study is based on survey methods involving interviewing farmers to answer questions about their socioeconomic and farming activities. Entire research methods were performed in accordance with the relevant guidelines and regulations issued by Hawassa University institutional research ethics committee. Each questionnaire of this study had a front-page section that required informed consent for interview and publication before the interview could proceed. Interviewers were trained and under instructions to read aloud the consent statement to each interviewee before the interview could advance. Participants were informed that they were under no obligation to answer any questions, or they could stop the interview at any time without giving any reasons and ask that any partial data recorded to be removed from the records.

**Consent for publication** The respondent's participation in the study was voluntary. It ensured the concealment of their identity, and the respondent were informed that their identity would not be known in any study report or publications. Respondents were assured that their household information would be kept strictly confidential and will not be shared with any third party.

**Competing interests** The authors declare no competing interests.

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