Effect of livelihood diversification on rural households' poverty reduction in Central Zone of Tigray regional state, Ethiopia

Yohannes Halefom Gebretsadik (yohanneshalefom6@gmail.com)
Adigrat University College of Agriculture and Environmental Sciences https://orcid.org/0000-0003-2575-7598

Berhane Tsegay Teklemariam
Adigrat University

Hailay Nigusie Gebru
Adigrat University

Research

Keywords: binary logit, Foster Greer Thorbecke index, livelihood diversification, and rural households' poverty

Posted Date: March 11th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-16923/v1

Effect of livelihood diversification on rural households' poverty reduction in Central Zone of Tigray regional state, Ethiopia

Yohannes Halefom Gebretsadik*[1], Berhane Tsegay Teklemariam[2], and Hailay Nigusie Gebru[3]

Abstract

Rural livelihood diversification studies previously conducted in Ethiopia lack linkages with poverty. This study was aimed at investigating the effect of livelihood diversification on rural households' poverty reduction. The result of this study revealed that 49.80%, 40.41% and 9.80% of the rural households' income was generated from: agriculture, both agricultural & non-agricultural and non-agricultural income sources respectively. The mean rural livelihood diversification index (SDI) was 0.38. This low diversification index was a source of vulnerability to the adverse effects of climate change. The absolute poverty line was calculated 6067.75 Birr/year/adult equivalents. Hence, 39.58% of female-headed households, 30.96% male-headed households and 32.65% of the population were poor. The logistic marginal effect analysis indicated that as the households' SDI increased by one unit, the probability of being poor was reduced by 0.282 ($p<0.01\%$). To reduce rural poverty, diversification of rural livelihood beyond agricultural income sources should be promoted through skill training, saving mobilization, improving access to credit access, market information and rural transport facility. Moreover, an appropriate institutional arrangement should be made for promoting a rural non-farm economy that can be possible by capacitating and extending of small and micro-enterprises development agency into rural areas.

Keywords: binary logit, Foster Greer Thorbecke index, livelihood diversification, and rural households' poverty

*[1] Corresponding author:
E-mail address: yohanneshalefom6@gmail.com
Adigrat University, Department of Agricultural Economics
[2] Co-Author, Email address: berhanet01@gmail.com
[3] Co-Author, Email address: kinghailay12@gmail.com

1. Introduction

Rural livelihood diversification is an active social process through which rural households construct diverse income source portfolios and find new paths of raising income and social support capabilities that enable them to struggle for survival, improve their standards of living and build resilience against environmental risks (Ellis 1999; Hussein and Nelson 1998; Niehof 2004). It is shifting away from the precarious agricultural livelihood system to an expanding rural non-farm economy or increasing the income sources per household regardless of the sector (Alobo Loison 2015; Start and Johnson 2004). Livelihood diversification has got due focus from researchers as an effective approach for small farmers' poverty reduction (Dixon, Gibbon, and Gulliver 2001; Ellis 2004) and response to rainfall variability, production uncertainty and climate change in Sub-Saharan Africa (SSA) (Ellis 2005; Alobo Loison 2015). However, contrasting perspective critics and much debate are still arising whether livelihood diversification impetus for poverty reduction and improving standards of living in rural areas of SSA (Ellis 2005; Alobo Loison 2015; Alobo Loison 2017). Therefore; such empirical researches on livelihood approach to poverty tends to uncover its effects on rural poverty that have not been well understood or have been neglected in policy mainstreaming discourses (Ade Freeman, Ellis, and Allison 2004; Jones et al. 2010).

Rural households' livelihood reliance on agricultural income sources has increased vulnerability to poverty in Ethiopia (Eshetu and Mekonnen 2016; Michler and Josephson 2017; Weldegebriel and Prowse 2013). Despite its historical greatness, Ethiopia has a long-standing record of poverty and the longest food aid running in the world (Mammo 1999; Ali 2012; Devereux and Sussex 2000a). About 80,657,042 its population lives in rural areas of whom 29.6% was below the nationally defined poverty line (CSA 2015). Rainfall is the single most important determinant of Ethiopian economic success or failure (Ali 2012; Bewket 2009; Devereux and Sussex 2000a) with an extreme variability ranging from -20 to + 20 (Devereux and Sussex 2000a). Cultivated landholding per capita is steadily falling in SSA (Alobo Loison 2015; Devereux 2009) and particularly in Ethiopia, a total area of cultivable land 11,047,249 hectares had been fragmented into 35,340,605 parcels owned by 11, 507,442 farmers (Devereux and Sussex 2000a). From1960 to 2015, Ethiopian population has exploded from 23,550,000 to 99,465,819. Consequently, per capita land holding shrunk from 0.28 to 0.1 hectares and per capita food entitlement collapsed by 41% (Befekadu and Berhanu 2000).

Ethiopia has recognized for several decades, but unable to achieve drought-proof, and diversified rural livelihood that has low correlation with rainfall, hence; "Agricultural sector remains our Achilles of heel and source of vulnerability and we remained convinced that agricultural-based development is the only source of hope for Ethiopia" Prime minister Meles Zenawi, in April 2000 as quoted in (Devereux and Sussex 2000b). Diversification into different types of on-farm and off-farm income sources was suggested as a panacea for poverty (Hilson 2010), it might be expected (a) to reduce the risk of income failure from single income source; (b) to reduce seasonal income variability, and (c) to enable the households to smooth consumption requirements in the deficit season before harvest (Ellis 1998). However, the due focus was not given in both rural policies mainstreaming and empirical researches; in Ethiopia, much attention was being given to agricultural income sources.

Declining agricultural per capita output due to adverse effects of climate change and rapid population growth enforced smallholder farmers to search income sources beyond agricultural activities. According (Luo and Zhu 2006), diversification of rural livelihood to nonfarm income sources played an increasingly important role in raising income and reducing poverty in rural China. According to them, the GDP share of rural nonfarm income was increased from 17% in the early 1980s to 40% in the late 1990s. Moreover, (Demissie and Legesse 2013; Gebreyesus 2016) concluded that livelihood diversification is a key approach to rural poverty reduction especially the non-farm rural economy is a crucial pathway to rural households get out of poverty.

There is a growing consensus that rural livelihood should not be based only on agriculture (Chapman and Tripp 2004), hence, rural households are looking for more diverse opportunities to increase and stabilize their consumption needs and enhance their livelihoods (Ellis 1999; Carney 1998). However, it is not possible to conclude whether or not rural household's engagement in more diversified livelihood strategies is either a sign of failing to poverty or a getting out of poverty without conducting empirical studies that consider the context of the study area (Dimova and Sen 2010). Therefore, the authors of this study motivated to conduct such kind of study in the context of Northern Ethiopia particularly in Tigray region.

In the context of the study area, the study was sought to answer the following questions: what looks the extent of rural livelihood diversification? And what it implies? Is there any discrepancy in the poverty status of rural households participating in different degrees of livelihood diversification?

This study was carried out to empirically answer the above questions by measuring and analyzing rural households' degree of livelihood diversification and its effect on rural households' poverty reduction. Thereafter, implications for effective rural livelihood improvement and development policy mainstreaming to alleviate the problem of rural poverty in study areas are drawn. Rural livelihoods and the problems of rural poverty are complex and dynamic in nature; therefore, the scope of this study was limited on specific issues of rural income sources diversification and its effect on income poverty reduction at household level by taking cross-sectional data hence, it didn't capture the complex and dynamic natures of rural livelihood and poverty.

2. Research methodology

2.1. The study area

This study was conducted in Ahferom district located in the Central zone of Tigray regional state, Ethiopia. The district is located at latitude of 14°06′39′′ to 14°38′26′′ N and longitude of 38°56′21′′ to 39°17′16′′ E. The livelihood of the population predominantly relied upon agriculture; out of the total population of the district 202,283, 165,371 (81.75%) were rural dwellers (CSA 2015) During the study, 47.5% of rural households were chronically food insecure, hence; they were targeted beneficiaries of productive safety net program (BOARD 2019; WOARD 2019)

According to the Tigray region, livelihood zone analysis report (BOARD 2005), the district has delineated into three major livelihood zones that consist of 27 rural *kebeles*[2] the central mixed crop livelihood zone which covers eleven rural communities and 35.94% the population, second; '*gesho*' & wheat highland livelihood zone covered eleven rural communities and 42.55% of the population and third; '*mereb*' basin covered five rural communities and 21.51% of population.

2.2. Sample size and sampling procedure

A three-stage cluster sampling technique with proportional allocation was applied to constitute the desired sample size. In the first stage, the study area was selected randomly. Secondly, one *kebele* from each livelihood zone was selected randomly. In the third stage, the sample size was determined and proportionally allocated to each *kebeles* and finally, a systematic random sampling technique was applied to identify 245 respondent households.

The sampling formula provided by (Kothari 2004) was used because of its capability to give a mathematical solution for calculating more precise sample size and is a frequently used technique in most kinds of literature (Kumar 2019)

$$\boldsymbol{n} = \frac{z^2 * p * q * N}{e^2\,(N-1) + Z^2 * p * q} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{2.1}$$

It implies $\mathbf{n} = \frac{(1.96)^2 * 0.5 * 0.5 * 5592}{(0.062)^2 * (5592-1) + (1.96)^2 * 0.5 * 0.5} = \frac{5{,}368.636}{22.4445 + 0.9604} = \mathbf{239.19 \approx 239}$

Where, n= desired sample size, N = Population which is finite (= 5,592)

e = acceptable error (degree of precision = 0.062%), P = Sample proportion, q = 1-p = (expected none prevalence) and Z= standard variant at given confidence interval. To take advantage of the larger sample size, the researchers used 245 sampled respondents.

2.3. Data collection methods

Trained data enumerators were employed to collect primary data from 245 sampled rural households by using a structured questionnaire interview. This method brought advantages of the highest response rate, direct observation and it was appropriate for smallholder farm households who couldn't read and write (Kothari 2004; Kumar 2019). Moreover, focus group discussions were conducted by establishing one FGD per each *kebele* having purposefully selected six members from community leaders and representatives to collect more qualitative data.

2.4. Methods of data analysis

2.4.1. Analysis of respondents degree of livelihood diversification

Three different approaches were specified to analyze rural livelihood diversification (Barrett, Reardon, and Webb 2001). These are classifications by sector, function and space or location. This study used the classification of income source diversification of by sector, it uses criteria like natures of the product and factors production used in the production process irrespective of

[2] It is the fifth tier of elected government in the administrative structure of the Federal Democratic Republic of Ethiopia.

location, scale, technology or rate of returns from the income-generating activity. Based on this, it is classified as farm and nonfarm or agricultural and non- agricultural income sources.

- **i.** *On-farm income sources:* this refers to income generated from farming activities such as the production of unprocessed crops, fruits, livestock, fish and forestry.
- **ii.** *Nonfarm income sources:* it refers to all income-generating activities except primary agricultural activities. It includes income generated from agro-processing activities, transport service, petty trade, construction, cottage industries, quarrying and wage employment.

Various indicators and indices can be used to measure the extent of livelihood diversification. The most widely used measures include Simpson index (SDI), Herfindahl index, Ogive index, Entropy index, Modified Entropy index, Composite Entropy index (Shiyani and Pandya 1998). SDI is widely used because of its computational simplicity, robustness and wider applicability (Shiyani and Pandya 1998). Hence, it was used in this study as below:

$$\boldsymbol{SDI_{i=1}^{N} = 1 - \sum_{i=1}^{N} P_i^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots \mathbf{2.2}$$

N = total number of income sources, i.e. agricultural, off-farm, employment and their combinations

Pi = proportion of income sources coming from the i^{th} source

SDI is always between 0 and 1, if P_i = 1 then SDI = 0, this implies that no diversification or reliant on only one income source. In other words, if P_i = 0, then SDI =1, this implies perfect diversification of income sources. In general, the closer the value of SDI to zero, the less degree of diversification and the further SDI from zero, the more diversified livelihood income sources.

2.4.2. Method of analysis for respondents' poverty status

There are several alternatives to households' poverty analysis: Foster Greer and Thorbecke index (FGT index), Sen-Shorrocks-Thon index (PSST) and time taken to exit from poverty. FGT index is the most widely used measure of poverty (Sultana, Hossain, and Islam 2015; Oyinbo and Olaleye 2016) because of its comparative advantages such as it is consistent and additively decomposable and satisfies desired characteristics of poverty measures (Foster, Greer, and Thorbecke 1984; Bogale, Hagedorn, and Korf 2005; Haughton and Khandker 2005). Therefore; this study used FGT index for measuring respondents' status of poverty based on locally calculated absolute poverty line as following:

$$P_\alpha = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{Z-Y_i}{Z}\right)^\alpha = P_\alpha = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{G_i}{Z}\right)^\alpha \quad \ldots\ldots\ldots\ldots 2.3$$

Depending upon the weights attached to α,(Bogale, Hagedorn, and Korf 2005) there are three types of poverty conditions;

i. Giving no weights to the severity of poverty, which is equal to α=0. In this case, P (0) measures the incidence of poverty (headcount ratio), which is indicated in equation 3.3.

$$P_0 = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{Z-Y_i}{Z}\right)^0 = \frac{q}{n} \quad \ldots\ldots\ldots\ldots 2.4$$

ii. Giving equal weights to the severity of poverty among poor households is equivalent to α=1. The summed value of the numerator indicates the poverty gap or the depth of poverty. This indicates the amount of money needed to lift the poor into the poverty line.

$$P_1 = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{Z-Y_i}{Z}\right)^1 \quad \text{.....2.5}$$

iii. Giving more weights to inequality among the poor household is equivalent to α>1. The most widely used in the poverty index is to set α = 2, yielding the poverty severity among the poor groups:

$$P_2 = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{Z-Y_i}{Z}\right)^2 \quad \text{.....2.6}$$

q= number of poor households, n= total number of sampled households, Z= poverty line and Yi = per capita income per adult equivalent per year measured in expenditure approach.

The expenditure approach based on the cost of basic needs (CBN) was applied to estimate the absolute food poverty line. This approach was used to estimate the amount of money per adult equivalent that could buy a basket of goods to meet the minimum nutritional thresholds. The total diets consumed per day were converted into food energy intake per adult equivalent which is a standardized measure of food security: in Ethiopia 2200kcal per day per adult, the equivalent is required for an active and healthy life (DFID 2000; Gebre 2012; Bimerew and Beyene 2014). This is given by:

$$FEAH_i = \frac{TECH_i consumed\ in\ one\ day}{TAEH_i} \quad \text{..... 2.7}$$

Where $FEAH_i$ is food energy intake per adult equivalent for the i^{th} household, $TECH_i$ was used to denote the total amount of energy consumed by the i^{th} household per day and TAEHi is the total sum of adult equivalents of the i^{th} household.

The CBN method was preferred because of its advantages over other alternatives (direct calorie intake and food energy intake): scalability, ability to compute corresponding nutritional status at market price and it is most widely applied in poverty analysis (Ravallion and Bidani 1994).

2.4.3. Econometric model specification

Modeling the effect of livelihood diversification on rural households' poverty: binary logit model was used to examine the effect of livelihood diversification on poverty because the outcome (poverty) is a qualitative response dichotomous variable. The Logit model was specified as below:

$$Logit = L_i = E(Y_i = 1\ /X_i) = \frac{1}{1+e^{-z}} \quad \text{..... 2.8}$$

It can be represented as $L_i = \frac{e^z}{1+e^{-z}}$ whileL_i is the probability of being poor

$$Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n \quad \text{..... 2.9}$$

$X_1 \ldots X_n$ were explanatory variables that affected the poverty status of respondents

The logs of the odds ratio are the ratio of the probability of being poor (P_i) to the probability of being non-poor (P_i-1) and it summarizes the relationship between variables (Olayemi 1995).

$(\frac{P_i}{1-P_i}) = \frac{1+e^{Z_i}}{1+e^{-Z_i}}$ is non-linear, but it can be changed in to linear by changing to the log of odds ratio: $L_i = Ln\,(\frac{P_i}{1-P_i}) = Z$. …… 2.10

The inverse relation of variables in the Logit model was$L_i = Ln\left(\frac{P}{1-P}\right) = Z$, the natural logarithm of the odds ratio is known as the Logit model. It can be expanded as:

$$\boldsymbol{L_i = Ln\left(\frac{P_i}{1-P_i}\right) = Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{2.11}$$

As P_i goes from 0 to 1, Z varies from $-\infty\ to\ \infty +$ and L_i goes from$-\infty\ to\ \infty +$, the probabilities of being poor lie between 0 and 1.

2.4.4. Specification of variables

Dependent variable: the poverty status of rural households (Po_stat) is a qualitative response dichotomous variable that takes the value of 1 if the household was poor and 0, if non-poor (Geda et al. 2001; Bogale, Hagedorn, and Korf 2005).

Independent variables used: the operational definition, measurement and expected sign of independent variables are presented in the table below;

Table 1: Summary of explanatory variables used

Variables	Definition	Type	Measurement
hhgendr	gender of the household head	Dummy	1= male and 0= female
hhage	age of the household head	Continuous	years
marstat	marital status of household head	Categorical	If single = 1, married = 2, divorced=3 and widowed = 4
spedu	the educational level of his/her spouse	Continuous	educational grade in years
hhsize	size of the household	Continuous	adult equivalent in number
SDI	degree of livelihood diversification	continuous	Simpson diversification index
svga	mount of money saved	Continuous	Number in Birr
tlu	size of livestock asset measured by tropical livestock unit	Continuous	Number
tirrland	total irrigable land owned	Continuous	Hectare
depnr	dependency ratio	Continuous	Number
radow	radio owning (proxy to market information access)	Dummy	1= have information access, 0 = have not
mobow	mobile phone-owning status(proxy to access to market information)	Dummy	1= have access, 0= have no access
trac	access to public transport	Categorical	1= no, 2= rarely, 3 = always
croffi	amount of loan taken for off-farm income-generating activities	Continuous	number
cronfi	amount of loan taken for on-farm income-generating activities	Continuous	Number
rumem	household membership on rural saving and credit cooperative (RUSACCOs)	Dummy	1= member, 0 = not member

Source: Authors' own analysis, 2020

3. Results and discussion

3.1. Descriptive statistics

This sub-section indicates brief information about the socioeconomic and demographic characteristics of respondents. As it is presented in Table 2, the mean household age was 46.17 years. The spouse's basic literacy rate was 42.5% with a mean education level of 2.46 years. The family size of respondents was converted into an adult equivalent using the standard (see Table 11 A5), hence the mean household size was 4.075 of whom 48.1% were unproductive whose livelihood depends upon others. Regarding marital status (see Table 3), 0.82% of respondents were single or never married, 79.18% married, 13.06 % divorced and 6.94% widowed.

The socioeconomic status of the respondent households as it is summarized in Table 2 below; the extent of livelihood diversification of respondents was heterogeneous ranging from 0 to 0.871. At the mean value of 0.38, respondents had less diversified income source which might be a source of their vulnerability to the adverse effects of climatic shocks and poverty. Respondent households' mean residual saving amount was 4,809.50 Birr per household.

Livestock assets like a dairy cow, oxen, sheep, goats, poultry, beehives, and equines are important sources of income, prestige and social insurance in the study area. The researcher used a tropical livestock unit (see Table 12 A6) to convert the asset into a single comparable unit. Accordingly, the mean livestock asset was 3.22 per household. The mean irrigable land per household was 0.027 hectares. Access to irrigation was a source of year-round income, resilience to drought and employment opportunity in the study area. Regarding rural credit service, 35.1% had got a mean credit of 2,042.50 Birr for on-farm activities and 14.7% accessed mean credit of 2,452.90 Birr for off-farm income-generating activities implementation.

Memberships in RUSACCO as financial & social capital (see Table 3), 54.69% were members and the remaining 45.31% were not members. Access to relevant information was included and analyzed by using proxy variables of the utilization of the market and other relevant information using mobile telephones and radio (see Table 3). Hence, 75.51% and 52.65% of respondents owe and utilize relevant information using mobile telephones and radio respectively.

Table 2: description of socioeconomic and demographic continuous variables (N=245)

Variables	Mean	Std. Dev.	Min	Max
hhage	46.17	13.08	20	77
spedu	2.46	3.45	0	10
adeq	4.075	1.85	0.88	8.32
SDI	0.38	0.209	0	0.871
svga	4,809.50	7,497.60	0	68,000
Tlu	3.22	2.57	0	14.005
tirrland	0.028	0.07	0	0.50
depr	48.10	19.13	0	85.71
cronfi	2,042.50	4,956.60	0	46,000
croffi	2,452.90	8,853.90	0	70,000

Source: Authors' own computation from surveyed data, 2020

Table 3: statistical description dummy/categorical variables (N=245)

Variables	Description	Freq	Percent	Cum
hhgendr	gender of the household head			
female	female-headed household	48	19.59	19.59
Male	male-headed household	197	80.41	100
marstat	marital status of the household head			
Single	never married,	2	0.82	0.82
married	married and he/she was a couple	194	79.18	80.0
divorced	single but he/she was married	32	13.06	93.06
widowed	single and has no plan to married	17	6.94	100
information access proxy by				
mobow	households' mobile telephone ownership			
yes	own and use a mobile telephone	185	75.51	75.51
no	did not own and not use a mobile telephone	60	24.49	100
radow	household's radio ownership			
yes	own and listen to the radio	129	52.65	52.65
no	did not own and not use radio	116	47.35	100
rumem	RUSACCOs membership			
yes	was a member of RUSACCO[3]	134	54.69	54.69
no	was not a member of RUSACCO	111	45.31	100

Source: Authors' own computation, 2020

3.2. Poverty status of respondents

According to the results revealed in Table 4 below, the local food poverty line was calculated 5,129.99 Birr per year per adult equivalent. However, the CBN include non-food costs like the cost of clothing, schooling, medication, obtaining information, etc. As it is presented in equation 2.12 below, the food poverty line was regressed to estimate the non-food share of total expenditure.

$$Sf_i = \alpha + \beta \log\left(\frac{Y_c}{Z^f}\right) + \varepsilon_i \qquad (2.12)$$

where Sf_i is used to indicate the food share from the i^th household's total consumption expenditure, Y_c refers to the household's total consumption expenditure, Z^f is the food poverty line, β is a regression coefficient, α typifies intercept of the food share when $Z^f = Y_c$, and ε_i refers to the error term.

Hence, the regression outcome revealed 937.76 Birr as the non-food poverty line and the total poverty line which is the sum of the food poverty line and none food poverty line was 6067.75 Birr per adult equivalent per year. This was used as a cutoff point below which the populations are said to be poor and above it non-poor.

[3] RUSACCO is used to denote rural saving and credit cooperatives which is used as a social asset

The incidence of poverty as presented in Table 4 below indicated that 39.58% of female-headed households, 30.96% male-headed households and 32.65% of the total population fell below the absolute poverty line and counted as poor. The researcher found that female-headed households have a higher incidence of poverty by 8.62% than male-headed households in the study area. The result of this study indicated that poverty status was slightly higher than the nationally reported status for Tigray Region: rural incidence of poverty was 31.8% and rural severity of poverty was 2.7% in 2013/2014 and country poverty headcount report of 31.8% (CSA 2015).

Table 4: absolute poverty indices of respondents (N=245)

Parameter (α)	Status of Poverty by Gender of Respondents			LB	UB	Poverty Line
	Male	Female	Population			
0	0.3096	0.3958	0.3265	0.2674	0.3857	6067.76
1	0.0654	0.1117	0.0745	0.0572	0.0917	6067.76
2	0.0195	0.0439	0.0243	0.0168	0.0318	6067.76

Source: Authors' own computation from surveyed data, 2020

A parameter (α = 1) indicates the poverty gap, on average, 0.1117*6067.75 = 677.80 Birr for female-headed households and 0.0654*6,067.75 = 396.80 Birr for male-headed households per adult equivalent was needed to lift them into the poverty line. On average income, female-headed households were found 281 Birr per adult equivalent far below the poverty line than male-headed households.

A parameter (α = 2), shows the severity of poverty was 2.43% for the population which indicated the inequality between poor female and men headed households was 4.39% and 1.95% respectively which indicated the severity of poverty is higher between female-headed households than their counterparts.

3.3. Correlation analysis between livelihood diversification and rural poverty

Before conducting the econometric analysis, it was necessary to test the presence or absence of a correlation between the two. As it is illustrated in Figure 1 below, 63.29% of the poor rural households were either no or low level of livelihood diversification whereas 77.11% of the non-poor households were found to have medium to a high level of livelihood diversification. Therefore, the study revealed that the extent of livelihood diversification and rural households' poverty status has a strong negative correlation which was statistically significant at <1%.

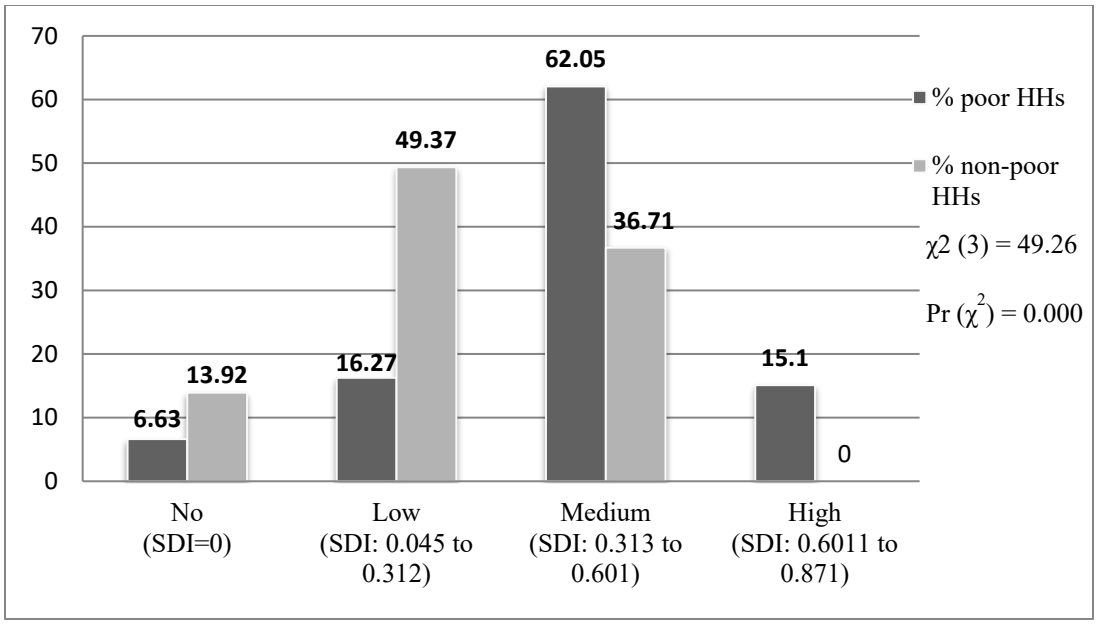

Figure 1: Correlation analysis between the SDI and poverty status of respondents (N=245)
Source: Authors' own computation, 2020

3.4. Econometric analysis

3.4.1. Effects of livelihood diversification on rural households' poverty

Before econometric analysis, different diagnostic tastes were conducted to realize the assumptions and prediction power of the binary logit model as well as assure the data were clean and ready for regression. The Prob > chi^2 = 0.000 and Pseudo R^2 = 0.6970 (see Table 6 A2) indicated the binary logit model has high prediction power as the correctly predicted outcomes were greater. No endogeneity problem was detected by link test as Ho: Prob Ch^2 > | hatsq | >5%, i.e. 0.000 < 0. 964 > 5%, (Table 8 A2) which revealed that the model is correctly specified: as neither more relevant variables excluded from nor irrelevant variables were included into the model. Moreover, the goodness of fit for the dependent variable was tested by Hosmer - Lemeshow gof test and sensitivity analysis (Table 9 A3 and Table 7 A1) failed to reject the null hypothesis which revealed that the poor and non-poor respondents were correctly classified. In general, these combined tests indicated that the model was correctly specified and have high prediction power.

After the model was correctly specified, the data were detected for heteroskedasticity, normality, and multicollinearity. A heteroskedasticity problem was detected & robust regression was used to solve it. Functional forms of variables were selected to get a normally distributed data. Contingency coefficient test was conducted to detect multicollinearity problems and variables the have higher (>0.5) pairwise correlation coefficients were not simultaneously regressed.

The result binary logit regression and it's marginal effect analysis as it is summarized in Table 5 below, indicated that household size (p<0.01),), household's head age (p<0.01), degree of rural households' livelihood diversification (p<0.01), educational level of the spouse of the household head (p<0.05), livestock asset holding (tlu, p<0.05), market information access using mobile

telephone (p<0.01), amount of credit taken for non-farm activities (croffi, p<0.05), being married (Imarstat_2, p<0.05), being divorced (p<0.01), being widowed (p<0.01 and squared age of household head (p<0.01) were found to have theoretical and statistically significant effect on the rural households' poverty.

Table 5: Binary Logit regression result on the effect of rural livelihood diversification on rural poverty

Po-stat	coef.	Robust Std. Err.	p> |z|	dy/dx
Household size in adult equivalent	0.79952	0.22523	0.000***	0.02446
Age of the household head	0.55826	0.17312	0.001**	0.017084
Simpson diversification index	**-9.21535**	**1.72177**	**0.000*** **	**-0.282000**
Spouse's educational level	-0.26447	0.11108	0.017**	-0.00809
Size of livestock asset in tlu	-0.38277	0.16258	0.019**	-0.01171
Market information access by mobile telephones	-2.10200	0.57640	0.000***	-0.11849
Amount of credit taken for off-farm activities	-0.00008	0.00004	0.032**	-0.00002
Being married	16.11013	1.42606	0.000***	0.482277
Being divorced	15.63618	1.31934	0.000***	0.99575
Being widowed	18.23617	1.44135	0.000***	0.99087
Amount of money saved	-0.00576	0.00013	0.000***	-0.00002
Being membership in RUSACCO[4]	0.14778	0.53297	0.782	0.00449
Amount of credit taken for on-farm activities	-0.00098	0.00007	0.008**	-0.00006
Age square	-0.00545	0.00167	0.001**	-0.00017
_cons	-25.90614	4.4320	0.000	
Summary statistics				
Number of obs		245		
Log pseudo-likelihood		-51.23		
Wald $chi^2(14)$		269.60		
Prob > chi^2		0.000***		
Pseudo R^2		0.6674		

Source: Authors' own computation from surveyed data, 2020

Remark: ***, ** and* stands for statistically significance at 1%, 5% and 10% respectively

The variable of interest in this study was analyzing the effect of livelihood diversification (SDI) on rural households' poverty reduction. Hence; the result of binary logit regression and its marginal effect analysis indicated that SDI has theoretically (dy/dx = -0.282) and statistically (p<0.01) significant effect on rural households' poverty reduction. Those rural households who had a greater degree of livelihood diversification index showed a greater likelihood to be non-poor. Ceteris paribus, the marginal effect analysis of livelihood diversification index indicated that a unit increase in the extent of livelihood diversification index, the likelihood to be non-poor increased by 0.282, or the probability of being poor is reduced by 0.282. This result is consistent with the findings of (Oluwatayo 2009) which is the study conducted on poverty and income

[4] rural saving and credit cooperatives

diversification among rural households in Nigeria and (Lanjouw 2001) concluded that rural household who had diversified their income sources to non-farm income sources were more productive and non-poor in rural El Salvador.

4. Conclusion and recommendations

Livelihood diversification was traditionally developed without any institutional and technical supports as their coping mechanism to recurrent and wide climatic change-driven hazards. In general, the result revealed that there was heterogeneity in rural households' extent livelihood diversification. Moreover, it uncovered that rural households who participated in different degrees of livelihood diversification showed discrepancies in their poverty status. Those who relied upon more diversified livelihoods showed a greater likelihood to be non-poor than their counterparts. This implied that in countries like Ethiopia where there is rapid population growth, declining cultivated land per capita and increasing trend of rural landlessness, the agricultural sector alone shall not be as the core livelihood strategy for rural households to improve their livelihood and get out of poverty.

To eradicate or at least to minimize rural households' poverty, it is recommended to exploit the untouched potential of the rural nonfarm economy. Government policies, institutions, other development partners and the rural households need to integrate both on-farm and off-farm livelihood strategies. Hence, it requires a departure from equalizing rural livelihood to agricultural income sources only. Contextually, it needs additional institutional arrangement and policy support to promote off-farm livelihood strategy in rural areas, possibly by capacitating and extending the small and micro enterprises development agency from the urban-centered approach into rural areas.

Availability of Data and Material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration of competing for interest

The authors declare that no potential conflict of interest was reported from financial, personal relationships or any point of view that can influence the publication of this research article.

Funding

This study was financially supported by the Central zone of Tigray Region Administration Office.

Acknowledgment

We owe heart full gratitude to the Central Zone of Tigray Region Administration Office for financial support and to the rural households who sacrificed their time during the data collection and validation process.

Authors' contributions statement

The first author handled the research conceptualization, funding acquisition, methodology, software, formal analysis, writing an original and final draft. While other supervised the data collection process, contributed in data entry, writing- edition & reviewing and validation.

Author Information

Yohannes Halefom Gebretsadik is currently working as instructor and researcher at Adigrat University, College of Agriculture and Environmental Sciences Department of Agricultural Economics.

Berhane Tsegay Teklemariam is currently working as instructor and researcher at Adigrat University, College of Agriculture and Environmental Sciences Department of Agricultural Economics.

Hailay Nigusie Gebru is currently working as instructor and researcher at Adigrat University, College of Agriculture and Environmental Sciences Department of Agricultural Economics.

References

Ade Freeman, H, Frank Ellis, and Eddie Allison. 2004. "Livelihoods and rural poverty reduction in Kenya." *Development policy review* 22 (2): 147-171.

Ali, Seid. 2012. "Climate Change and Economic Growth in a Rain-fed Economy: How Much Does Rainfall Variability Cost Ethiopia?" *Available at SSRN 2018233*.

Alobo Loison, Sarah. 2015. "Rural livelihood diversification in Sub-Saharan Africa: A literature review." *The Journal of Development Studies* 51 (9): 1125-1138.

Barrett, Christopher B, Thomas Reardon, and Patrick Webb. 2001. "Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications." *Food Policy* 26 (4): 315-331.

Befekadu, Degefe, and Nega Berhanu. 2000. "Annual report on the Ethiopian economy." *Volume1. The Ethiopia Economy Association, Addis Ababa, Ethiopia*.

Bewket, Woldeamlak. 2009. "Rainfall variability and crop production in Ethiopia: a Case study in the Amhara region." Proceedings of the 16th International Conference of Ethiopian Studies.

Bimerew, Tilksew Getahun, and Fekadu Beyene. 2014. "Factors influencing rural household food insecurity: The case of Babile district, East Hararghe Zone, Ethiopia." *Journal of development and agricultural economics* 6 (4): 149-158.

BOARD. 2005. Tigray Regional state livelihood zone profile.

BOARD. 2019. Regional state of Tigray bureau of agriculture and rural development productive safety net program report.

Bogale, Ayalneh, Konrad Hagedorn, and Benedikt Korf. 2005. "Determinants of poverty in rural Ethiopia." *Quarterly Journal of International Agriculture* 44 (2): 101-120.

Carney, Diana. 1998. "Sustainable livelihoods." *Sustainable Livelihoods: What contribution can we make*.

Chapman, Robert, and Robert Tripp. 2004. "Background paper on rural livelihood diversity and agriculture." AgREN electronic conference on the implications of Rural Livelihood Diversity for Pro-poor Agricultural Initiatives.

CSA. 2015. Summary and statistical report of the 2015 population and housing census, Population Size by Sex and Age, Addis Ababa, Ethiopia: CSA. In *The world bank economic review*.

Demissie, Amare, and Belaineh Legesse. 2013. "Determinants of income diversification among rural households: The case of smallholder farmers in Fedis district, Eastern Hararghe zone, Ethiopia." *Journal of Development and Agricultural Economics* 5 (3): 120-128.

Dercon, Stefan, and Krishnan Pramila. 1998. "Changes in poverty in rural Ethiopia 1989-1995: Measurement, robustness tests and decomposition." *CES-Discussion paper series (DPS) 98.19*.

Devereux, Stephen. 2009. "Why does famine persist in Africa?" *Food security* 1 (1): 25.

Devereux, Stephen, and I Sussex. 2000a. *Food insecurity in Ethiopia*. Institute for Development Studies.

Devereux, Stephen, and I Sussex. 2000b.

DFID, Disability. 2000. "Poverty and Development." *London: British Government Department for International Development*.

Dimova, Ralitza D, and Kunal Sen. 2010. "Is household income diversification a means of survival or a means of accumulation? Panel data evidence from Tanzania." *Panel Data Evidence from Tanzania (April 6, 2010)*.

Dixon, John A, David P Gibbon, and Aidan Gulliver. 2001. *Farming systems and poverty: improving farmers' livelihoods in a changing world*. Food & Agriculture Org.

EHNRI. 2000. Food Composition Table for use in Ethiopia, Addis Ababa: EHNRI. .

Ellis, Frank. 1998. "Household strategies and rural livelihood diversification." *The journal of development studies* 35 (1): 1-38.

Ellis, Frank. 1999. *Rural livelihood diversity in developing countries: evidence and policy implications*. Overseas Development Institute London.

Ellis, Frank. 2004. "Occupational diversification in developing countries and implications for agricultural policy." *Hot topic paper-Programme of Advisory and Support Services to DFID (PASS) Project No. WB0207*.

Ellis, Frank. 2005. "Small farms, livelihood diversification, and rural-urban transitions: Strategic issues in Sub-Saharan Africa." The future of small farms.

Eshetu, Fassil, and Elias Mekonnen. 2016. "Determinants of off farm income diversification and its effect on rural household poverty in Gamo Gofa Zone, Southern Ethiopia." *Journal of Development and Agricultural Economics* 8 (10): 215-227.

Foster, James, Joel Greer, and Erik Thorbecke. 1984. "A class of decomposable poverty measures." *Econometrica: journal of the econometric society*: 761-766.

Gebre, Girma Gezimu. 2012. "Determinants of food insecurity among households in Addis Ababa city, Ethiopia." *Interdisciplinary Description of Complex Systems: INDECS* 10 (2): 159-173.

Gebreyesus, Baharu. 2016. "Determinants of livelihood diversification: the case of Kembata Tambaro Zone, Southern Ethiopia." *J Poverty Invest Dev* 23 (0): 1-10.

Geda, Alemayehu, Niek De Jong, Germano Mwabu, and Mwangi Kimenyi. 2001. "Determinants of poverty in Kenya: A household level analysis." *ISS Working Paper Series/General Series* 347: 1-20.

Haughton, J, and SR Khandker. 2005. "Introduction to poverty analysis." *World Bank Institute*.

Hilson, Gavin. 2010. "'Once a miner, always a miner': Poverty and livelihood diversification in Akwatia, Ghana." *Journal of Rural Studies* 26 (3): 296-307.

Hussein, Karim, and John Nelson. 1998. "Sustainable livelihoods and livelihood diversification".

Jones, Lindsey, Susanne Jaspars, Sara Pavanello, Eva Ludi, Rachel Slater, Natasha Grist, and Sobona Mtisi. 2010.

Kothari, Chakravanti Rajagopalachari. 2004. *Research methodology: Methods and techniques*. New Age International.

Kumar, Ranjit. 2019. *Research methodology: A step-by-step guide for beginners*. Sage Publications Limited.

Lanjouw, Peter. 2001. "Nonfarm employment and poverty in rural El Salvador." *World development* 29 (3): 529-547.

Luo, Xubei, and Nong Zhu. 2006. *Nonfarm activity and rural income inequality: A case study of two provinces in China*. The World Bank.

Mammo, Tirfe. 1999. *The paradox of Africa's poverty: the role of indigenous knowledge, traditional practices and local institutions--the case of Ethiopia*. The Red Sea Press.

Michler, Jeffrey D, and Anna L Josephson. 2017. "To specialize or diversify: agricultural diversity and poverty dynamics in Ethiopia." *World Development* 89: 214-226.

Niehof, Anke. 2004. "The significance of diversification for rural livelihood systems." *Food policy* 29 (4): 321-338.

Olayemi, JK. 1995. "A survey of approaches to poverty alleviation. A paper presented as (NCEMA)." National Workshop on Integration of Poverty Alleviation Strategies into Plans and Programmes in Nigeria.

Oluwatayo, Isaac B. 2009. "Poverty and income diversification among households in rural Nigeria: A gender analysis of livelihood patterns." Conference Paper.

Oyinbo, Oyakhilomen, and Kehinde Tobi Olaleye. 2016. "Farm Households Livelihood Diversification and Poverty Alleviation in Giwa LocalGovernment Area of Kaduna State, Nigeria." *Consilience* (15): 219-232.

Ravallion, Martin, and Benu Bidani. 1994. "How robust is a poverty profile?" *The world bank economic review* 8 (1): 75-102.

Shiyani, RL, and HR Pandya. 1998. "Diversification of agriculture in Gujarat: A spatio-temporal analysis." *Indian journal of agricultural economics* 53 (4): 627.

Start, Daniel, and Craig Anthony Johnson. 2004. "Livelihood options?: The political economy of access, opportunity and diversification."

Storck, Harmen, Berhanu Adenew, Bezabih Emana, R Begander, and Getu Hailu. 1997. *Management strategies for farming systems in an uncertain environment and approaches for their improvement*.

Sultana, Naznin, E Hossain, and K Islam. 2015. "Income diversification and household well-being: A case study in rural areas of Bangladesh." *Int. J. Bus. Econ. Res* 4 (3): 172-179.

Weldegebriel, Zerihun Berhane, and Martin Prowse. 2013. "Climate-change adaptation in Ethiopia: to what extent does social protection influence livelihood diversification?" *Development Policy Review* 31: o35-o56.

WOARD. 2019. *Ahferom woreda productive safety net program report.* Enticho.

Figures

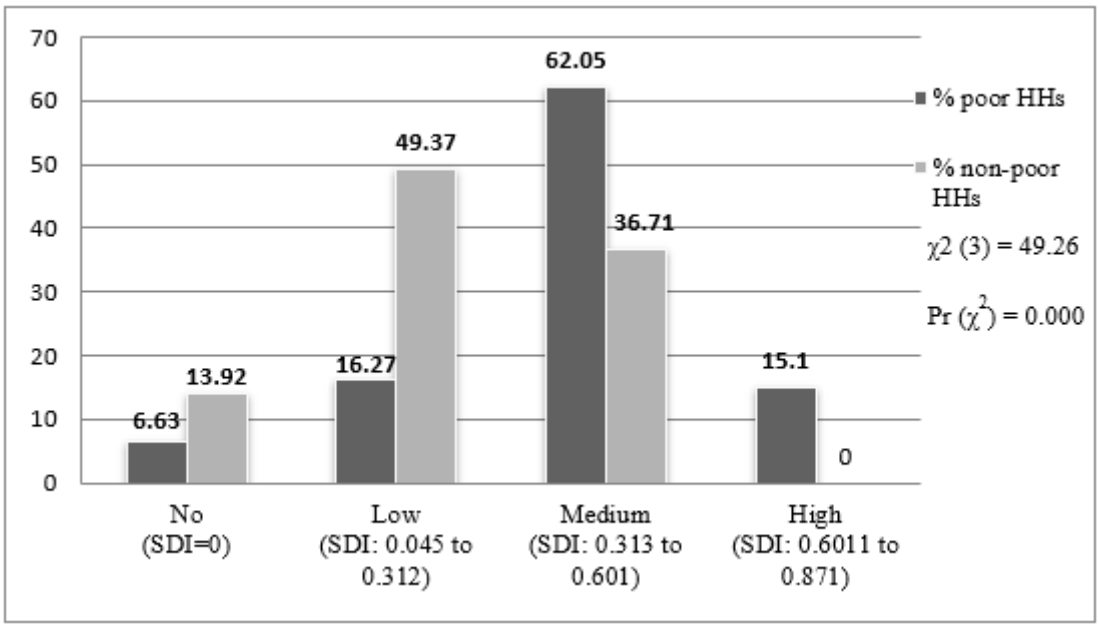

Figure 1

Correlation analysis between the SDI and poverty status of respondents (N=245) Source: Authors' own computation, 2020

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupportiveTablesAnnex.docx