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Livelihood Diversification and Its Impact on Household Food Security among Farming Households in Kalu Wereda, South Wollo, Ethiopia

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Abstract
Diversifying livelihoods is one of the key strategies often adopted to tackle the challenge of food insecurity. This study analyzed the existing livelihood strategies pursued by the smallholder farmers and their impact on the food security status of farm households in Kalu Wereda, South Wollo Zone in Ethiopia. Thereby two-stage sampling procedure was employed to draw 246 rural households randomly as study participants. Data were collected from primary and secondary sources using interview schedules, key informants, and Focus Group Discussion. The data were analyzed using descriptive statistics and econometric models. The survey result indicates that much of the rural households (62.22%) in the study area practice diversified livelihood strategies that combined on-farm activities with non/off-farm activities. Results from Propensity Score Matching shows that livelihood diversification brought a positive impact on households' food security status. It can be concluded that livelihood diversification can have a positive impact on rural households' food security status. Thus, it is advisable to encourage rural households' participation in different livelihood activities in addition to agriculture through facilitating credit services and creating market linkage for smallholder farmers in the study area.
Keywords: livelihood diversification; food security; propensity score matching, Ethiopia
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Introduction

Ethiopia's economy is based mainly on agriculture, including crop and livestock production, which contributes 43% of the national Gross Domestic Product (GDP), more than 80% of employment opportunities and over 83% of the foreign exchange earnings of the country (UNDP, 2014). Yet agriculture is the country's most promising resource and majorities of rural households in Ethiopia make a living through agriculture. Apart from farm production; rural households are involved in a wide range of income-generating activities.

However, farming as a primary source of income has become failed to guarantee sufficient livelihood for most farming households in sub-Saharan African countries (Babatunde, 2013). This is because the agricultural sector in the sub-Saharan African countries is highly characterized by decreasing farm sizes, low levels of output per farm, and a high degree of subsistence farming (Jirstrom et al., 2011). The agricultural activities in rural Ethiopia is also dominated by smallholders, the majority cultivating less than 0.5 ha and producing mostly basic staples for the subsistence of their households. Furthermore, their agricultural activities are characterized by backward production technologies, small fragmented land size, irregular rainfalls, increasing soil erosion, land degradation, aridity in some regions and pervasive tropical diseases in the others (Bazezew et al., 2013). Thus, the expectation that achieving the goal of reducing poverty only through increasing agricultural productivity and redressing the issues of access to key agricultural resources without non/off-farm livelihood diversification could not be successful in the sub-Sahara African countries (Asmah, 2011). Hailu and Hassen (2012) indicated that in rural Ethiopia if there had not been other sources of income apart from agricultural production, the land scarcity by the farmers coupled with agricultural risks could not generate enough income to feed household members and they cannot fulfill household needs. This suggests the necessity of non/off-farm diversification in rural Ethiopia. From the point of view of reducing poverty and food insecurity in rural Ethiopia, it is extremely important to reduce the vulnerability of the poor through diversification of the sources of their livelihoods.

In Ethiopia, undiversified livelihood options and complete dependency on agricultural production are the main problems that exacerbate food insecurity in the rural area. The ability to diversify at all is often critical to the food security of the most vulnerable rural populations, (Ellis, 2004). In many rural areas, agriculture alone cannot provide sufficient livelihood opportunities. Rural people 's livelihoods are derived from diverse sources and are not as overwhelmingly dependent on agriculture as previously assumed (Gordon and Catherine, 2001). According to Asmamaw, (2004), the limited opportunity for livelihood diversification, due to the absence of supplementary income from other non-farm activities has made the Ethiopian rural poor more vulnerable. Given the inability of most Ethiopian smallholders to make a living from agriculture, because of resource constraints and recurrent shocks, increasing policy attention has turned to support alternative livelihood activities (Devereux et al, 2005). Similarly, Dessalegn (2003), as cited in Asmamaw (2004), argues that the decline in the size of cultivable land is envisaged to further exasperate the currently observed worse food insecurity situation unless non-farm activities

are made to compensate for the livelihood stress prevalent in the rural areas. Furthermore, livelihood diversification is believed to be a solution, and an effective strategy for the reduction of poverty and food insecurity in rural Ethiopia (Yizengaw et al., 2015).

The aim of rural livelihood diversification is to reduce risk which is related to agricultural activity and to supplement farm income. Although livelihoods are predominantly agriculture-based, labor productivity is low and most Ethiopians are net cereal buyers. Because of the primary dependence on subsistence crop production in the country, harvest failure leads to household food deficits, which in the absence of off and non-farm income opportunities leads to asset depletion and, increasing levels of destitution at the household level (Zeleke et.al., 2017). However, if the condition doesn't allow the rural people to diversify their income it will be very difficult for the poor to diversify their income source so that the poor become more food insecure than the rich.

As the study area is known for its food insecurity, most studies focus on food security and related issues. Moreover, those earlier studies tried to show the level of food insecurity in the area and they are not comprehensive enough to give a complete picture of the impact of livelihood diversification on food security. Therefore, this study is to examine the existing livelihood strategies pursued by the smallholder farming rural households and to examine the impact of livelihood diversification on the food security status of farm households in the study area.

Materials and methods

Study area

Kalu is one of the woredas in the Amhara Region of Ethiopia. Part of the south Wollo Zone, Kalu is bordered on the west by Dessie Zuria, on the north by Were Babu, on the south and east by the Oromia Zone, on the southeast by Argobba special woreda, and on the southwest by Abuko. The administrative center for this woreda is kombolcha; other towns in Kalu include Ancharo, Gerba and Degan. The district has 35 rural and 5 urban kebeles. A highway linking Kombolcha and Afar bisects Kalu into two parts. The altitude of this woreda ranges from 800 meters above sea level in the lowlands bordering the Oromia Zone to 1,750 meters at the foot of the mountains north of Kombolcha; the climate of Kalu varies from dry sub-humid to semi-arid.

Sampling Techniques

A two-stage sampling technique was used to select the sampling households. In the first stage, one kebele from the highland and two kebeles from the low land were purposively selected through low land area covers 71% of the total this study used two kebeles from lowland from these a total of 3 kebeles (Gerba, Degan and Harbu) *was* select purposively.

At the second stage, the selected rural kebeles sample households were determined by using the sampling techniques method. Following this, sample households were taken as sample for the household survey residing in rural kebeles. Lastly, representative samples were selected randomly from sampled kebeles based on proportional sample size. Ultimately, a total of 246 sample household heads were selected by using a systematic simple random sampling technique (Table 1).

Table 1: Sample Household by Kebeles

Sample kebeles	**Total Household size**			**Sample size**		
	Male	Female	Total	Male	Female	Total
Gerba	789	96	885	73	9	82
Degan	810	123	933	71	23	94
Harbu	634	72	706	59	11	70
Total			2524			246

Data Collection

The data collected for this study included both primary and secondary data source. The primary data of the study was collected directly from the sample household. And it was also obtained through key informant interview and focus group discussion. The secondary sources were the Woreda Agriculture office report and other documents and various sources to supplement the data obtained from the survey.

Data Analysis

Mixed research approach qualitative and quantitative approach was used. Depending on the objectives of a given study and nature of data available analysis to be made requires different approaches. Descriptive analysis was used to describe various aspects of sample respondents and estimate associations. And econometric model was used to examine the impact of livelihood diversification on food security propensity score matching (PSM) model. Specification of the Model was described as follows:

Propensity score matching

To assess effect of certain intervention or treatment on specified outcome variable depend on the assignment of

the individual being treated or not. In this study the assignment of rural households to diversify their livelihood are assumed to be non-random. This was lead to use one of the quasi-experimental techniques in assessing the impact of livelihood diversification on food security can be called average treatment effect on the treated (ATT). Accordingly, one of the techniques used to assess the effect on the treated group in quasi-experimental design is by using the propensity score matching technique. This technique mainly focuses as the name itself indicates matching the non-user (non-treated) households with user (treated) households of certain intervention with the probability of being treated (propensity score) and by comparing their outcome variable.

Propensity score matching (PSM) constructs a statistical comparison group that is based on a model of the probability of participating in the treatment, using observed characteristics.

Participants are then matched on the basis of this probability, or propensity score, to nonparticipants. Accordingly, in this study there are two groups; those who diversify their livelihood (treated group) and those who are not diversify their livelihood (non- treated group). These groups were matched with one another using propensity score and compare their food security status. According to Gertler et.al. (2016), impact evaluation hand book the technique depends on two major assumption; conditional independence (namely, that unobserved factors do not affect participation) and presence of a common support. The assumption describes that set of explanatory variables are not affected by the treatment; the outcome variable for both treated and controlled group are independent of the treatment.

$(Y_t^T, Y_t^C) \perp T_t, X_t$

Where in our study Y_t^T and Y_t^C stands for food security status of household who diversify livelihood and who does not diversify livelihood. T shows treatment, X stands for the covariates that affect livelihood diversification of household.

The second assumption states that every rural household have perfect predictability about the probability of either diversify or not diversify livelihood.

$0<P\ (T_t = 1|X_i) < 1\ |$

This assumption confirms that households who diversify livelihood have a comparison group who does not diversify livelihood based on propensity score distribution. The impact of livelihood diversification on food security status can be calculated as follows

$ATT=E(Y_t^T|T_t = 1) - E(Y_t^C\ |T_t = 1)$

$= E\ \{(\ Y_t^T - Y_t^C)|T_t = 1)\}$

$= E\ \{(Y_t^T - Y_t^C|T_t = 1, p(x))\}$

$= E\ \{(Y_t^T|T_t = 1, p(x) - E(Y_t^C)|T_t = 0, p(x))\}$

According to Caliendo and Kopeinig (2008), there are steps in implementing PSM. These are estimation of the propensity scores, checking on common support condition, choosing a matching algorism and testing the matching quality.

Estimation of Propensity Score

The first step in PSM analysis is to estimate the propensity score. Normally, a logit or probit function is used for this purpose, given that treatment is typically dichotomous (i.e., 1 for the treated (diversify) and 0 for untreated (non-diversify) units. For this study a logit model was used to estimate propensity scores and matching was then performed using propensity scores of each observation. In estimating the logit model, the dependent variable was livelihood diversification, which takes the value of 1 if a household diversify their livelihood and 0 otherwise.

Checking Range of Common Support

Imposing a common support condition ensures that any combination of characteristics observed in the treatment group can also be observed among the control group. The common support region is the area which contains the minimum and maximum propensity scores of treatment and control group households, respectively. It requires deleting of all observations whose propensity scores is smaller than the minimum and larger than the maximum of common support area (Caliendo and Kopeinig, 2008).

Choosing Matching Algorism

The next step in propensity score matching is to get the matching algorism which best matches the treated observations with untreated based on the propensity scores from the preceding step. Each of the matching algorithms has its own advantages and disadvantages and the attempt of the researcher is to select a matching technique which best fits to the data at hand. Here after, matching techniques frequently used in PSM and which were used in this research are discussed.

Nearest Neighbor (NN) Matching

It is mostly named as the straightest forward and frequently used matching estimator in PSM. The individual from the control group is chosen for the treated group based on the nearest propensity score results. Under nearest

neighbor matching there are two ways of matching, named with replacement and without replacement. In the former case, an untreated individual can be used more than once as a match, whereas in the latter case it is considered only once (Smith and Todd, 2005).

Caliper matching

To avoid the problems of bad matches resulted from the Nearest Neighbor matching, economists impose a tolerance level on the maximum propensity score distance (caliper). Imposing a caliper works in the same direction as allowing for replacement. Bad matches are avoided and hence the matching quality rises. However, if fewer matches can be performed, the variance of the estimates increases. Applying caliper matching means that an individual from the comparison group is chosen as a matching partner for a treated individual that lies within the caliper ('propensity range') and is closest in terms of propensity score (Caliendo and Kopeinig, 2008).

Kernel matching

This method of matching uses the weighted averages of all household in the control group to construct the counterfactual outcome of a treated household. The advantage of this matching is it provides low variance since it used more information, by using all covariates that affects plastic pond RWH technology.

Assessing Matching Quality

As it was discussed in the above sub-section, it gives sense to try the different approaches on the available dataset at hand and select the best match. For this purpose, the research used different criteria to select the best match. This was ensuring the distribution of the explanatory variables is balanced at both in control and treated group. In this study standard bias method of assessing matching quality was used. The bias method of checking quality of the matching used employed; which states that the acceptable mean bias of the propensity score should less than 5 after matching (Rosenbaum and Rubin, 1983).

Results and Discussion

The findings of this research are organized based on the two major emergent themes, namely: types of livelihood strategies, and the impact of livelihood diversification on food security status. It also presents and discusses the descriptive statistics and econometric model results under each theme.

Household Livelihood Strategies

Livelihood strategies are the combination of activities that people choose to undertake in order to achieve their livelihood goals (Ellis and Allison, 2004). Livelihood activities are actions taken by the household to obtain household income. In the study area like other rural areas of the country households engaged in different activities in addition to the basic agricultural activities. To determine those strategies, it has been done by categorizing households who have followed similar strategies among the choices of farm, off-farm and non-farm activities. Therefore, here, livelihood strategies grouped based on clustering the sources of income that were identified in the study area. In the study area, smallholder farm households obtained their household income from three major categories of livelihood activities which include on-farm, non-farm, and off-farm activities.

On-farm activities are focused on both crop production and animal husbandry activities. Different crops are grown in the study kebeles. Some of the major crops grown in the study area include Teff, Sorghum, Maize and Bean. Cattle, sheep and goats, donkey, camel and poultry are reared for both income and consumption purpose. Livestock by-products which are valuable in the study areas are skimmed milk, butter, yoghurt, whey, and cheese. Key informants stated that livestock serve as a draught power, transportation service, and provides meat, milk, yoghurt, and cheese. Based on the survey result, the majority (95%) of the households were engaged in rearing at least one of the livestock types. In contrast to this, 5% do not participated in any one of the livestock rearing activities

Off-farm activities here refer to agricultural activities which take place outside the person's own farm. The activities include local daily wage labour at village level or the neighboring areas in return for cash payment or the agricultural work at another person's farm in return for part of the harvest in kind. Natural resource-based activities like firewood and charcoal selling are the other source of off-farm income for some households in the study sites. From the total sample households, only 34.5% of the households participated in off-farm activities while 65.5% households did not participate in any one of the off-farm activities. Again, from the total off-farm participants' majority (54.93%) of the households engaged in agricultural wage labor activities.

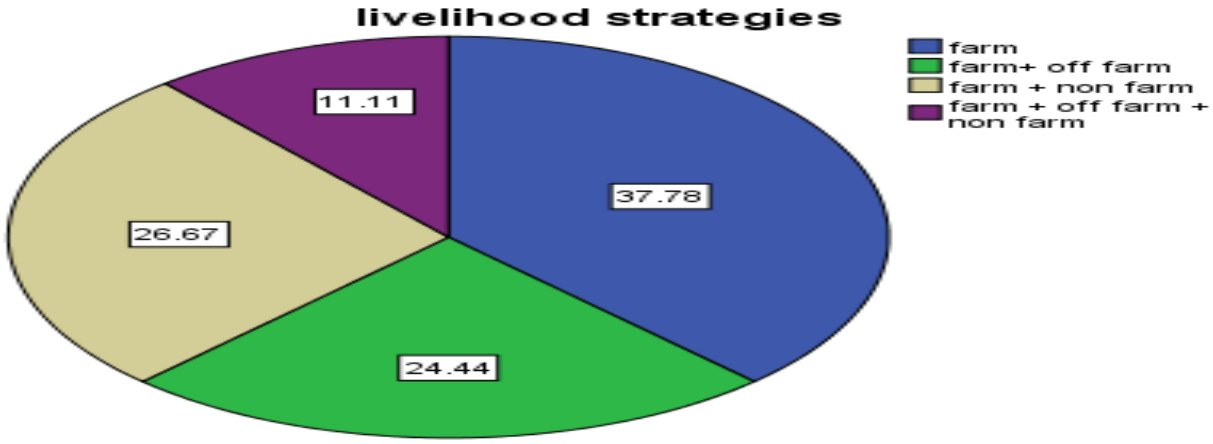
Non-farm activities in this study refer to activities takes place outside the agricultural sector. It includes handicraft activities (weaving, spinning, carpentry), petty trade (grain trade, fruits and vegetables trade), selling of local drinks, trading of small ruminants and cattle, and remittance transfers within and across nations. From the total sample households 43.4% of the households are engaged in non-farm activities while 56.6% of the households are not engaged in any one of non-farm activities.

Rural farm households in the study area have followed one, two or a combination of these livelihood activities

to pursue their livelihood strategies. Accordingly, four livelihood strategies were identified which include the on-farm only strategy, on-farm plus non-farm, on-farm plus off-farm and a combination of on-farm off-farm and off-farm activities.

As shown in the pie chart (Figure 1), 37.78% of the households entirely depend on the on-farm only livelihood strategy, 24.44% households depend on on-farm plus off-farm, 26.67% of the respondents depends on on-farm plus non-farm, and the rest 11.11% of sample respondents depend on on-farm plus off-farm plus non-farm livelihood diversification strategy.

Figure 1: livelihood strategies used by rural households in the study area.



Source: Own Survey Data, 2019

Propensity Score Matching Model Result and Discussion

This part of the study focuses on the impact of livelihood diversification on food security status using propensity score matching method. The use of propensity score matching method requires mainly the use of four steps namely; estimating propensity score, testing the assumption of common support, matching and estimating average effect of diversify livelihood on the treated group (ATT) and checking matching quality.

Estimating Propensity Score

To measure the average treatment effect on the treated (ATT) for intended outcome variable, a logit model was estimated in order to get the propensity scores. The use of propensity score matching involves the selection of covariates that affect the outcome variables in order to provide propensity score; which describes the probability of the non-treated group to be treated. Accordingly, in order to determine covariates that could statistically affect the probability of the rural household diversify livelihood or not, logistic regression had been done. The logistic regression result shows that it is seven variables are affecting the rural household probability of diversify livelihood.

Table 2; logistic regression result

Logistic regression Number of obs = 246
Wald chi2(10) =3882.29 Prob > chi2 = 0.0000
Log pseudolikelihood = -58.470171 Pseudo R2 = 0.5100

_Idive_1	Odds Ratio	Std. Err.	z	P>z
Age	1.209209	.1041777	2.20	
_Isex_1	.0987553	.1171953	-1.95	0.051*
_Iedu_1	9.114956	8.347542	2.41	0.016**
Ladsz	2574187	1.0507	3.63	0.000***
_Icreduse_1	37.37592	87.08273	1.55	0.120
_Iextcon_1	2.4010	3.9010	14.72	0.000***
_Icredt_1	1.0009	1.8309	-11.30	0.000***
Famsz	.7830095	.4579901	-0.42	0.676
_Icrprisk_1	.0049738	.0118771	-2.22	0.026**
_Iurblink_1	2.448056	.8684993	2.52	0.012**
_cons	2.75e-08	1.6607	-2.89	0.004

*** p<0.01, ** p<0.05, * p<0.1significant level

Source own survey data 2019

Common Support condition

The next task in propensity score matching technique is to check the common support condition. The assumption

of common support states that under propensity score matching, matching could be possible if there are households who have similar propensity sores both in controlled and treated group. Only observations in the common support region will be matched with the other group and others should be out of further consideration. Once the common support region is defined, individuals that fall outside this region have to be rejected and hence the treatment effect cannot be estimated. This could be checked using the ps graph, which shows both for the controlled and treated group. Figure 2 shows the result of ps graph to see there is common supports those households who diversify livelihood and those who do not.

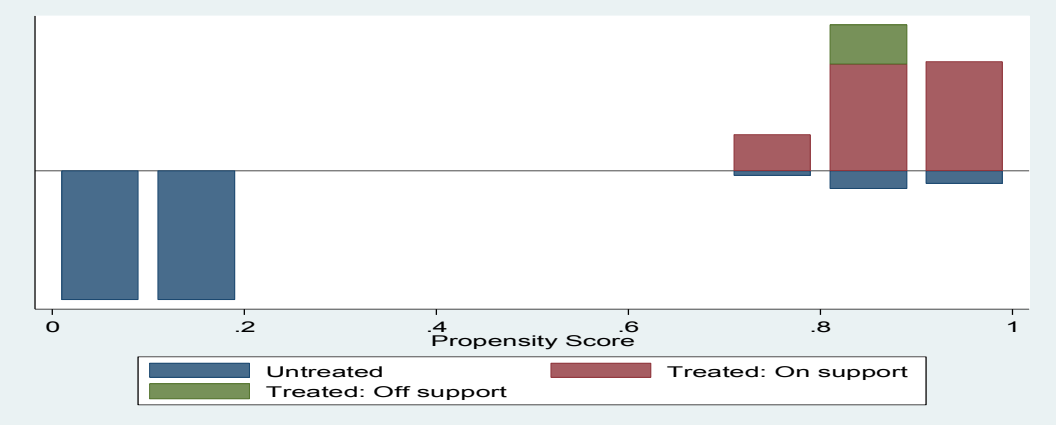


Figure 2 Ps Graph of Common Support
Source: Own Survey Data, 2019

Matching and Estimating ATT (Average Treatment effect on the Treated)

After estimating the propensity scores and checking that there is common support, a nearest neighbor, caliper and kernel matching method was used to match the treated households with non-treated households. This will help use to find the counter factual rural households from the non-treated group for the treated households. After matching, the average treatment effect on the treated group was estimated (ATT).

This method of matching was used the weighted averages of all households in the control group to construct the counterfactual outcome of a treated household. As shown in Table 3, the average treatment effect on the treated is positive. This means that the treatment had affected those households who diversify livelihood to increase their food security by .3092 unit per year compared with those who does not.

Table 3: Result of ATT using Kernel Matching Method

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Food security	Unmatched	8.91071429	13.7794118	4.86869748	.549825737	7.8
	ATT	9.36082474	9.05154639	.309278351	1.58972872	3.2

Source: Own Survey Data, 2019

Assessing Matching Quality

The use of matching technique needs to check its quality. This was ensured the distribution of the explanatory variables balance both in the controlled and treated group. Selecting matching estimator has it is own criteria. The final choice of a matching estimator was guided by different criteria such as the bias method of checking quality of the matching was employed. In bias method the acceptable mean bias of the propensity score should less than 5 after matching (Rosenbaum and Rubin, 1983).

Accordingly, matching estimators were evaluated by matching the user and non-user households in common support region. Therefore, the bias is less than 5 are preferred.

Based on these criteria, kernel matching with mean bias of 4.8 and balancing test was found to be the best matching algorithm.

Table 4: Result of mean bias using kernel Method

Sample	Ps R2	LR chi2	p>chi2	Mean Bias	Med Bias	B	R	v
Unmatched	0.193	52.00	0.000	46.6	60.1	113.5*	2.64*	67
Matched	0.011	3.52	0.833	4.8	2.9	25.2*	1.02	67

Source: Own Survey Data, 2019

Livelihood diversification brought statically significant effect in households' food security. It has been found that diversification increase household's food security of diversified households by .309 unit on average. This result has been supported by (Zeleke et.al., 2017), Households having non and off-farm sources of income tend to easily become food secured than households that do not have access. Also,Nasa et.al 2010, result shows that when comparing farmers on the basis of livelihood diversification in respect to food security, diversified farmers are

relatively food secured than the undiversified farmers. A Pearson correlation analysis was carried out by Echebiri et. al., 2017 in Abia State Nigeria shows thata positive correlation at 1% was found to exist between livelihood diversification and income as well as food security. This implies that increasing the number of livelihoods means engaged in by a household, the income level will increase with a consequent tendency towards food security. It is therefore worthy to note that livelihood diversified households are more income stable and food secured than the reverse households.

Conclusion and policy implication

Generally, from the finding of the study has revealed that farmers' involvement in livelihood diversification activities is as a result of overwhelming need to increase households' income and to maintain livelihood. The quest for improved standard of living which has been sought after by rural dwellers and their sympathizers would be met with higher successes when rural people realize the potentiality and effectiveness of livelihood diversification in the overall scheme of rural poverty reduction especially in rural communities of low-income countries. It is therefore, the general conclusion of this study that livelihood diversification is a positive undertaken and an antidote to food insecurity desolating rural areas. This is because it enables rural people improving their food security status. Rural farmers should be given opportunity to participate in varied income generating activities in both agriculture and nonagricultural ventures and rural development programmes which would enhance their livelihood diversification activities and living standard be initiated and encouraged; the effect of education on household livelihood diversification cannot be over-emphasized therefore strengthening both formal and informal education and vocational or skill training should be promoted in the study area. Access to credit can create an opportunity to be involved in economic activity that generates revenue to households. Development partners operating in the study area should implement provision of credit to eligible households using targeting criterion that reflects actual characteristics of food insecure households.

Livelihood options should be broadening the government and non-governmental institutions in the study area should give due attention for livelihood diversification and policies should also give emphases for non –farm and off-farm livelihood activities.

Declaration

The authors declare that this article is their own original work and all ethical clearances are undertaken. The materials used for references are dually acknowledged and all sources are cited accordingly. Data collection was performed based on the informed consent received from respondents.

Competing interests

The authors declare that there are no competing interests.

Availability of data and materials

The authors declare that we can submit the data at any time based on the publisher's request. The datasets used and/or analysed during the current study are available from the authors upon reasonable request.

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Authors' contributions

Emebet Ayele and Samuel Tadesse were responsible for designing the research, collecting data, analysing the data, and writing the final report.

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