Determinants and Impacts of Livelihood Choice Strategies on Farm Households' Food Security Status in North Shewa Zone Oromia, Ethiopia

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Abstract: Livelihoods diversification strategies are one means of meeting the overgrowing world population's food demand. This study identified household-level determinants of livelihood diversification strategies and its impact on food security status in North Shewa, Oromia, Ethiopia. Both primary and secondary data about the 2021/22 production year were collected for this study. Primary data was collected from 400 smallholder farmers that were collected using a simple random sampling technique. Descriptive statistics and econometric models were used for data analysis. Looking into the estimated coefficients, the results indicate that livelihood strategy is significantly influenced by fourteen explanatory variables. Agro ecology, sex, family size, farm size, economic active member, training, credit access, livestock holding, education level, experience in farming, irrigation experience, media, distance from the market were significant variables that affect the household livelihood strategy status. Impact evaluation estimated result indicated that participation of farming with non-farming livelihood diversification strategies increases farm household food security status by 25% while, participation in farming with off farming and farming with both non-farming and off farming livelihood diversification strategies increases households' food security status by 43 and 37% respectively over non-diversified households at a 1% probability level. This study indicated that there is room to improve rural households' level of food security status using more of the aforementioned socio-economic variables. Therefore, policymakers should give due emphasis to the identified variables and improve the livelihoods of rural households.

Keywords: Food Security, Livelihood Strategies, Determinants, Multinomial Logit Model, Multinomial Endogenous Switching, Ethiopia

1. Introduction

1.1. Background and Statements of Problems

Livelihood diversification is attracting considerable interest as a tool to cope with economic shocks and resist vulnerability [1]. The ultimate goal of livelihood diversification is bringing sustainable livelihood outcomes like securing economic, social and environmental improvement for urban households [2]. Livelihood capital, on the other hand, refers to the human, social, natural, physical, and financial resources that are critical to people's survival in the face of shocks and stresses, without sacrificing the base of natural resources [3, 4].

During income generation activities for an individual or a household, livelihood capital can be transferred, exchanged, and stored [5, 6]. However, depending on asset patterns and financial and climatic hazards faced by individuals or households, livelihood strategies may change frequently [7]. Climate change is a current threat to asset portfolios and livelihood strategies, and it is recognized as a global threat, with nations around the world considering urgent measures to

adapt to and mitigate the effects of climate change [4, 8]. Climate change has emerged as a warning sign for natural resource bases and rural livelihood systems [9], implying that changes in livelihood strategies may be required.

Despite its growing importance for Ethiopia's poor, the need for livelihood diversification has received little attention. A large body of evidence suggests that livelihood diversification activities have a significant impact on increasing household income and coping with various livelihood shocks [10, 11]. Several Ethiopian research studies, for example Admasu *et al.*; Muluneh [12, 13], have examined a range of factors that influence the choice of livelihood diversification options. Households' choice and implementation of livelihood diversification activities is influenced by the distribution of income and wealth status. However, rural households' livelihood diversification is not unique, and the factors determining households' for choosing and adopting livelihood diversification strategies were not yet studied in the North Shewa Zone.

As a result, the purpose of this study is to investigate the determinants of livelihood diversification in Ethiopia, with a particular emphasis on the North Shewa Zone. This paper adds to the literature by encouraging readers to learn more about the factors that influence urban households' livelihood diversification strategies in North Shewa Zone, Oromia Region, Ethiopia. The study makes three contributions to the existing literature. For starters, previous research has focused on the factors that influence rural households' livelihood diversification strategies, such as Gebru *et al.*; Ambaye *et al.*, Ayana *et al.*; Kasie *et al.*; Washo *et al.* [10, 14-17]. However, little attention has been paid to impacts of livelihood diversification. Second, many studies evaluated livelihood diversification strategies by demonstrating a distinct component of livelihood diversification strategies options classified by sector as farm or non-farm, function as wage employment or self-employment, or location as on-farm or off-farm and fails to account for complementarity of livelihood diversification strategies, for example Alobo & Bignebat; and Teshome & Edriss [18, 19].

1.2. Research Objectives

The specific objectives of the research are:
1) To investigate the determinants of smallholder farmers decision in the choice of livelihood strategies in North Shewa zone
2) To analyze the role of farm household livelihood strategies on food security status

2. Method and Materials

2.1. Description of the Study Area

The research was conducted in Barak, Wuchale and Sululta districts of North Shewa zone, Oromia National Regional State. These districts are located 50-100 Kms away from Addis Ababa to the North direction. The Zone has a total land area of about 1893 square-kilometers. The topography of the area is mostly plain with mountains and the altitude of the area ranges between 1300-2500 meters above sea level. The land area of North Shoa zone extends from $9^{0}47'$ to $10^{0}11'$N and $38^{0}27'$ to $38^{0}43'$ E [20].

North Shoa zone gets rainfall during both belg and meher seasons. The 'Belg-rain' is between February and April, followed by the Meher rain extending from June to September. According to the report from North Shoa Agriculture office, the average annual rainfall of the Zone ranges from 1400 mm to 1600 mm while the mean annual temperature varies between 15°C and 19°C from the cold temperature of Yaya Dekebora to the relatively warm lower valley of Jema River.

According to CSA (2020), the population of North Shoa is estimated to be 242341, out of which 120472 are female. The average family size of the Zone is estimated to be 6.3 and the average population density is 128 per km^2. Regarding distribution of the population, 92.2% live in rural areas while the rest 7.8% live in towns [20]. The population of the Zone are followers Orthodox Christian, Evangelical Christians and Muslim religions.

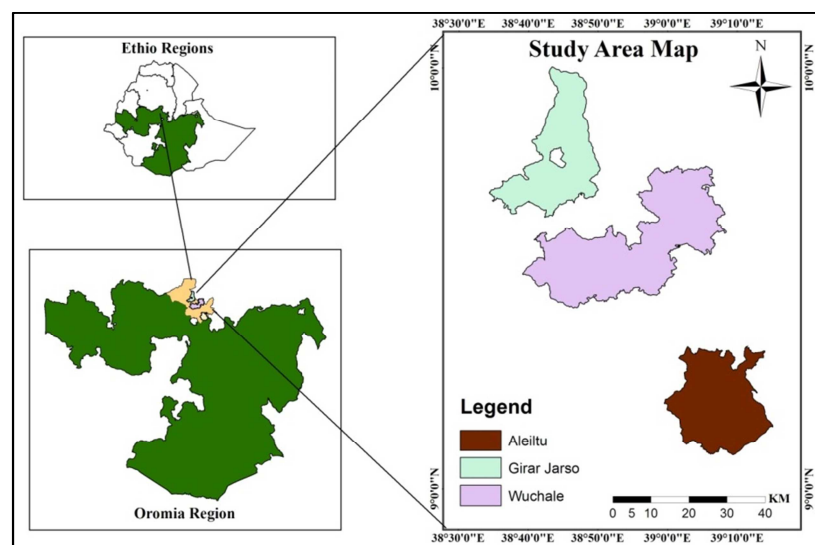Figure 1 below shows maps of the study area.

Figure 1. Map that show description of the study area.

2.2. Sample Size and Sampling Techniques

The sampling procedures employed for this particular research were stratified multi stage random sampling. Out of the 17 districts in the Zone, three districts were randomly selected. From each district, four kebeles were randomly selected and from each kebele representative households were selected using simple random sampling approach. As a result the total sample size is determined to be 400 households. A skip factor of k for each Kebele (which is the total households 'N' divided by the samples allocated for a given kebele) was used depending on the total number of households in each Kebeles.

Selection of the first household at random for any value between 1 and K was made, and then every k[th] households from the lists in each location was selected. This will provide a total sample that is representative of the district as a whole as well as each community.

Table 1. *Sample districts and sample households for the study form north shawa zone.*

s.no	Districts	Total population	Selected sample
1	Aleltu	75,687	100
2	Wucale	137,830	178
3	Girar jarso	92,448	122
	Total	305,965	400

2.3. Methods of Data Analysis

The quantitative data was analyzed using various analytical tools. These tools include descriptive and inferential statistical tools and econometric models. These tools are outlined and discussed in the following sub-sections.

2.3.1. Descriptive and Inferential

Data on the age, educational levels, land size, herd size, rural institutions participation, gender, types of livelihood, and other important socio-economic variables were analyzed using descriptive tools. Similarly, in order to measure the statistical significance and distribution of some parameters chi-square and t-tests shall be used as found necessary. Moreover, in order to measure the different types of livelihood strategies pursued by the households, the first objective of the research, statistical analysis was used. Moreover livelihood framework was employed to analyze the livelihood strategies of the population. The livelihood strategies taken up in relation to level of social capital, participation in rural livelihoods and gender issues was analyzed using statistical tools.

2.3.2. Econometric Models

To address the objectives of the study, in addition to descriptive statistics, econometric models was employed. Descriptive statistics such as mean, percentage, chi square and t-test was used. In order to achieve the objectives of the study the multinomial logit and multinomial endogenous switching logit econometric models were employed.

Measurement of livelihood strategies

Therefore, livelihood strategies are the combination of activities that people choose to undertake to achieve their livelihood goals [21]. Livelihood diversification is grouping of on-farm, off-farm and non-farm activities to earn a living [22].

2.4. Multinomial Logit Model

The study employed a multinomial logit selection model to measure the decision to participate in the livelihood strategies as one of the random utility frameworks. Following Kassie *et al.* [23, 24] consider the latent model (U_{jit}) below which describes the behavior of the ith farmers in choosing strategies $j(= 1,2,3,4)$ at time t over any alternative strategies m:

$$U_{jit} = \alpha_j X_{jit} + \omega_j X_{ji} + \varepsilon_{jit} \text{ With } U = \int_J^1 \dots \cdot \begin{matrix} if\ U_{jit} > max_{m \neq 1}(u_{mit})\ or \tau_{jit} < 0 \\ if\ u_{jit} > max_{m \neq j}(u_{mit})\ or\ \tau_{jit} < 0 \end{matrix} \text{ for all } m \neq j \qquad (1)$$

Where X_{jit} is a vector of observed exogenous covariates that the households level characteristics, α_j and ω_j are vectors of parameters to be estimated, and ε_{jit} is the random error term.

Estimation of the multinomial logit selection model could be inconsistent due to the correlation of unobserved factors with explanatory variables. To overcome this we use Mundlak's [25] and Wooldridge's [26] approach where the means ($\overline{x}_{ji}$) of all time-varying covariates are included as additional covariates in the multinomial logit selection model. Unlike the participation decision which is observable, the utility derived from the livelihood strategies is unobservable. Therefore, eq (1) entails that the ith farmer will participate in livelihood strategies to maximize expected benefits if the participation provides greater utility than an alternative strategies m: e.g., if $\tau_{jit}(U_{mit} - U_{jit}) < 0$, assuming that are independent and identically Gumbel distributed [27]. As indicated by Mc-Fadden [28], the probability that a farmer i will choose strategies j can be expressed as a multinomial logit selection model with:

$$P_{jit} = (\tau_{jit} < 0\ X_{jit}) = \frac{\exp(\alpha_j x_{jit} + \omega_j x_{ji})}{\sum_{m \neq 1}^1 \exp(\alpha_m X_{mit} + \omega_m X_{mi})} \qquad (2)$$

Thus the multinomial logit selection model in the above equation is estimated using mlogit command in Stata statistical software (STATA 14.2).

Multinomial endogenous switching regression (MESR)

In the second stage of multinomial endogenous switching regression, the relationship between the livelihood strategies and food security outcome variables and a set of explanatory variables (z) is estimated for each livelihood strategies e.g. j=1 (farming only as a reference category); participation in farming only, j=2, farming plus non farming, j=3 participation in farming plus off farming, j=4 participation in farming plus both off-farming and non-farming activities. The livelihood strategies and food security outcome equation

for each possible regime (j) is given as:

$$\int \begin{matrix} Regine\ 1: Y_{1it}=\beta_1 z_{1it}+\delta_1 z_{1i}+\mu_{1it}\ if\ U=1 \\ Regime\ J: Y_{jit}=\beta_j Z_{jit}+\delta_j z_{ji}+\mu_{jit}\ If\ U=J \end{matrix} \downarrow \qquad (3)$$

where Y_{jit} are the livelihood and food security outcome variables of the th farmer in regime j at time t and the error terms (ε_{jit}) are distributed with $E(Y_{jit}|$ X, z$)$ =0 and variance $(\delta_{jit}\ |$ x, z$)=\delta j^2$. Y_{jit} are observed if only one of possible livelihood participation combinations is used.

This approach can minimize the problem of unobserved heterogeneity [25, 26]. The error term (U_{jit}) is comprised of unobserved individual effects (ci) and a random error term (U_{jit}). Therefore, OLS estimates in Eq. (3) ε_{jit} and U_{jit} will be biased if β_j and δ_j are not independent. A consistent estimation of and requires the inclusion of the selection correction terms of the alternative choices in Eq. (3). In the multinomial choice setting, there are j-1 selection correction terms, one for each alternative participation combinations. Following Di Falco [29] and Kassie et al. [23, 24], the second stage of MESR with consistent estimates is specified as follows:

$$\int \begin{matrix} Regine\ 1: Y_{it}=\beta_1 Z_{1it}+\alpha_1 \lambda_{1it}+\delta_1 z_{1i}+\mu_{1it}\ if\ U=1 \\ Regime\ J: Y_{jit}=\beta_j jit+\alpha_j \lambda_{jit}+\delta_j z_{ji}+\mu_{jit}\ If\ U=J \end{matrix} \ j=2,3,4 \quad (4)$$

where μ_{jit} is the error term with an expected value of zero, δ_j is covariance between and ε_{jit}, U_{jit}, λ_{jit} is the inverse Mills ratio computed from estimated probabilities in Eq. (4) as follows:

$$\lambda_{jit} = \sum_{m\neq j}^{j} \rho_j \left(\frac{\rho_{mi} l_n(\rho_{mi})}{1-\rho_{mi}} + l_n(\rho_{jit})\right). \qquad (5)$$

At this point ρ is the correlation between ε_{jit} and U_{jit}. Standard errors in Eq. (5) are bootstrapped to account for the heteroscedasticity arising from the generated repressors due to the two stage estimation procedure.

Estimation of average participation effects on the participant

The multinomial endogenous switching regression framework mentioned above is used to estimate average treatment effects on the treated (ATT). To estimate average treatment on the treated we compared expected values of the outcomes of participants of different livelihood strategies in actual and counterfactual scenarios as given below;

Adopters with adoption (actual)

$$E(Y_{jit}|\ U=J,Z_{jit},z_{ji},\lambda_{jit}) = \beta_j Z_{jit}+\delta_j z_{ji}+\sigma_j \lambda_{jit} \quad (6)$$

Participants had decided not to participate (counterfactual)

$$E(Y_{jit}|\ U=J,Z_{jit},z_{ji},\lambda_{jit}) = \beta_1 Z_{1it}+\delta_1 z_{ji}+\sigma_1 \lambda_{jit} \quad (7)$$

The above equation defines the value of the outcome variable for participants which would have been obtained if the coefficients on their characteristics $(Z_{jit}, z_{ji}\ and\ \lambda_{jit})$ had been the same as the coefficient on the only farming participant characteristics Kassie *et al.,* [24]. The expected values of the livelihood strategies and food security outcomes for the households that participated in livelihood strategies j can be calculated by taking differences between actual and counterfactual outcomes following Kassie *et al.* [23] as:

$$ATT = E(Y_{jit}|\ U=J,Z_{jit},z_{ji},\lambda_{jit}) - E(Y_{jit}\ U = j,Z_{jit},z_{ji},\lambda_{jit} \qquad (8)$$

$$Z_{jit}(\beta_j - \beta_1) + z_{ji}(\delta_j - \delta_1) + \lambda_{jit}(\sigma_j - \sigma_1) \qquad (9)$$

The expected change in the mean outcome variable if participants had the same characteristics and resources as only farming-participants is captured by the first term (Z_{jit}) on the right-hand side of Eq (8). The third term (λ_{jit}) on the right-hand side of the Eq. (9) along with the Mundlak approach (z_{ji}) corrects selection bias and endogeneity originating from unobserved variables.

3. Result and Discussions

3.1. Descriptive Results for Continuous Variables

Age of household head: The average age of the total samples were found to be 44 years. The average age of households with farming only, farming and non-farming, farming and off farming; and farming with both non farming and off farming livelihood diversification strategies were 46, 41, 44 and 44 years, respectively. According to the F-test results there is a statistically significant mean difference between the groups at a 10% probability level. Households who adopted more diversified livelihoods strategies have higher education level compared to others.

Family size: The mean family size for all sample households was found to be 5. The average family size for farm only households, farming plus non-farming, farm plus off farm, farm plus non-farm and off farm are 6, 5, 5 and 5, respectively. According to the F-test results there is a statistically significant mean difference between the four groups in terms of family size at a 1% probability level with highest at farming only households (Table 2). The result is consistent with the national average family size which is 5.

Education: The average years of formal schooling in terms of grade completed for the total samples were found to be grade 4.4 years. The average education level for households who did use farming, farming and non-farming, farming and off farming and farming with both non farming and off farming livelihood diversification strategies were 3.7, 4.7, 4.6, and 4.7 grades, respectively. According to the F-test results there is a statistically significant mean difference between the groups at a 10% probability level. Households who adopted more diversified livelihoods strategies have higher education level compared to others. The result implies that more educated farmers are relatively better off to have better access to technologies, and look for alternative livelihood opportunities.

Farming experience: The average farming experience for the total samples were found to be 23 years. The average farming experience for households who did use farming only, farming and non-farming, farming and off-farming and farming with both non-farming and off-farming livelihood diversification strategies were 25,19, 24, and 23 years, respectively. The F-test result shows that there is a statistically significant mean difference between the groups at a 1% probability level. Households with farming only

livelihoods have higher farm experience compared to others. This implies that farmers with high level of farm experience are relatively old and less attempt to diversify their livelihood than with less age of experience in farming.

Extension contacts: Advice, training, demonstration, and input distribution are all examples of extension services. According to the survey results, extension agents contact farmers for an average of 4 days per year. The average frequency of extension contact for farming only households was found to be 3 times. Extension contact for the household's farm and non-farm; farm and off farm; and farm plus non-farm and off-farm were found to be 4, 3, and 4 times per year, respectively. The F-test results revealed that there is a statistically significant mean difference between the four groups in terms of frequency of extension contact at a 5% probability level with farm only and more diversified farming strategies having higher extension contact.

Livestock holding: The mean livestock holding in Tropical Livestock Unit (TLU) for all sample households was found to be 6. The average livestock holding for farm only households, farm plus non-farm, farm plus off farm, farm plus both non-farm and off farm are 5, 6, 5 and 7 TLU, respectively. According to the F-test result, there is a statistically significant mean difference between the four groups in terms of livestock holding at a 1% probability level with Farming +off + non-farming having higher livestock (Table 2). Thus it shows that farm households with high livestock in terms of TLU were became diversified.

Distance to all weather roads: Availability and proximity to all-weather road a means to ensure access to market for agricultural products for rural farmers. Road accessibility significantly contributes to reducing farm gate prices of manufactured goods and increasing farm gate prices of agricultural goods. Road access is therefore a determinant of the profitability and sustainability of agricultural products, as well as a proxy for agricultural marketing services. The average distance in minutes between the villages and the all-weather road for the entire sample was found to be 4.37km. The average all weather road distance for farming only households was 5.59km, whereas the all average weather road distance for farming plus non- farming households, farming plus off-farming households are 3.47 and 4.84 km, respectively. The average distance from all-weather roads to farming plus non-farming and off-farming households is 3.53 km. At a 1% probability level, the F-test results revealed that there is statistically significant mean differences among the

four groups in terms of all-weather road distance with livelihood strategies have less all weather road distance for farming plus off farming livelihood households.

Cultivated land: The average total cultivated land for the entire sample is 2.14 hector. The average total cultivable land for households with farm only livelihoods was 2.35 hectare, whereas the average total farm size for households' livelihood strategies with farm plus non-farm, farming plus off-farm and farming, non-farming and off-farming practices are 2.3, 1.92, and 2.12 hectares respectively. The result was The F-test results show that there is a statistically significant mean difference in cultivable land size among the four groups at a 1% probability level with farming only households having higher cultivable land size (Table 2).

Total farm income: The average total farm income for the entire sample is 118,170.28 Birr. The average total farm income for farm only households was 62,235.6birr, whereas the average total farm income for households' livelihood strategies with farm plus non-farm, farming plus off-farm and farming, non-farming and off-farming practices are 134,169.8, 136,554.6, and 122,318.9 birrs respectively. According to the F-test results of the group mean difference comparison, there is statistically significant mean difference at 1 % probability level in farm income among the four groups (Table 2). Thus the Farm households whose livelihoods diversify to farm on, off and nonfarm activities have the highest total farm income than others. This indicates that when households diversify their livelihood activities they tend to earn more income from different livelihood opportunities through off and non-farm involvements in addition to farming practices.

Economic active member (EAM): The average EAM of the household for the entire sample is 2.32. The economic active family members for farm only households was 2.04, whereas the economic active family members for households' livelihood strategies with farm plus non-farm, farming plus off-farm and farming plus non-farming and off-farming practices are 1.91, 2.42 and 2.93 respectively. According to the F-test results of the group mean difference comparison, there is 1% statistically significant mean difference in EAM among the four groups (Table 3). The presence of large number of economically active members in the household improves the capacity and ability of household to participate in multiple non/off-farm self and wage activities. This enables to generate better income than those households constrained by availability of working age family members.

Table 2. Descriptive statistical results for sample households' continuous variables.

Variables	Farming only	Farming + non	Farming + off	Farming + off + non	Total	F-value
Age	46	41	44	44	44	3.72**
Family size	6	5	5	5	5	5.79***
Education	3.7	4.7	4.6	4.7	4.4	2.15*
Extension	3	4	3	4	4	7.07**
Farm size	3.02	2.9	2.7	2.8	2.8	0.53
Cultivated	2.35	2.3	1.92	2.12	2.14	2.51*
Experience	25	19	24	23	23	6.69***
Livelihood ex	23	15	20	21	21	7.21***
Economic acti	2.04	1.91	2.42	2.93	2.32	15.55***

Variables	Farming only	Farming + non	Farming + off	Farming + off + non	Total	F-value
Livestock	5	6	5	7	6	4.20***
all-weather di	5.59	3.47	4.84	3.53	4.37	5.55***
Income	62,235.6	134,169.8	136,554.6	122,318.9	118,170.28	4.46***

Source: Own survey result, 2023, *,** and *** means significant at10%, 5% and 1% respectively

3.2. Descriptive Statistical Results for Dummy Variables

Gender of household head: The study findings shows that 78 percent of the total sample respondents were Male headed households while the remaining 22 percent are female headed households. In a comparison of different livelihood practices, approximately 13.8, 21.2, 28%, and 17 male headed households used farming, farming with non-farming, farming with off farming and farming with both non farming and off farming livelihood diversification strategies. At a 5% probability level, the chi-square test revealed a statistically significant mean difference in farmer training among the four groups (Table 3).

Media Attendance: According to the study findings, 55.2 percent of the total sample respondents were attending mainstream media while the remaining 44.8 percent are not attending media. In a comparison of different livelihood practices, approximately 6.5, 17.2, 18%, and 13.2% of the respondents who were attending media practice farming, farming with non-farming, farming with off farming and farming with both non farming and off farming livelihood diversification strategies. At a 1% probability level, the chi-square test revealed a statistically significant mean difference in media attendance among the four groups (Table 3).

Cooperative membership: The survey results revealed that 45.5 percent of the total samples were members of cooperative, while the remaining 54.5 percent did not. The comparison across different livelihood strategies revealed that approximately 4.5, 15.5, 13.8, and 11.8 percent of sample households who did practice farming, farming with non-farming, farming with off farming and farming with both non farming and off farming livelihood diversification strategies, respectively were cooperative members. The chi-square test revealed a statistically significant proportion difference in terms of male headed households at 1% probability level.

Farmers training: According to the study findings, 46.5 percent of the total sample household participated in farmer training, while the remaining 53.5 percent did not. In a comparison of different groups of livelihood strategies, approximately 6.2 percent, 12.5 percent, 17.8, and 10 percent of households who practice livelihoods of farming, farming with non-farming, farming with off farming and farming with both non farming and off farming livelihood diversification strategies, respectively had participated in farmer training. At a 1% probability level, the chi-square test revealed a statistically significant mean difference in farmer training among the four groups (Table 3).

Livelihood training: The study findings indicate that 8.5 percent of the total sample household received technical advice on livelihood, while the remaining 91.5 percent did not. The comparison across different groups of livelihood strategies revealed that approximately 0.5, 0.5, 2.5, and 5 percent of households practicing farming only, farming plus non farming, farming plus of farming and farming plus on and off farming, respectively received livelihood trainings. At a 1% probability level, the chi-square test revealed a statistically significant mean difference in livelihood training among the four groups.

***Table 3.** Descriptive results for the sample households dummy variables.*

Variables		Farming		Farming + non		Farming + off		Farming+ non + off		Total		X²-value
		Num	%	Num	%	Num	%	Num	%	N	%	
	F	13	3.2	2	0.5	11	2.8	3	0.8	29	7.2	
Sex	M	67	16.8	99	24.8	126	31.5	79	19.8	371	92.8	15.5***
	Total	80	20	101	25.2	137	34.2	82	20.5	400	100	
	Fh	25	8.2	16	4	33	8.2	14	3.7	88	22	
Gender	Mh	55	13.8	95	21.2	104	28	68	17	312	88	10.79**
	Total	80	20	101	25.2	137	34.2	82	20.5	400	100	
	Other	53	13.2	32	8	65	16.2	29	7.2	179	44.8	
Media	Yes	27	6.8	69	17.2	72	18	53	13.2	221	55.2	25.3***
	Total	80	20	101	25.2	137	34.2	82	20.5	400	100	
	No	2	0.5	2	0.5	10	2.5	20	5	34	8.5	
Livelihood training	Yes	78	19.5	99	24.8	127	31.8	62	15.5	366	91.5	36.7***
	Total	80	20	101	25.2	137	34.2	82	20.5	400	100	
	No	55	13.8	51	12.8	66	16.5	42	10.5	214	53.5	
Farmers training	Yes	25	6.2	50	12.5	71	17.8	40	10	186	46.5	9.79**
	Total	80	20	101	25.2	137	34.2	82	20.5	400	100	
	No	65	16.2	87	21.8	88	22	44	11	284	71	
Irrigation practice	Yes	15	3.8	14	3.5	49	12.2	38	9.5	116	29	30.3***
	Total	80	20	101	25.2	137	34.2	82	20.5	400	100	
	No	62	15.5	39	9.8	82	20.5	35	8.8	218	54.5	
Cooperative membership	Yes	18	4.5	62	15.5	55	13.8	47	11.8	182	45.5	33.3***
	Total	80	20	101	25.2	137	34.2	82	20.5	400	100	

Source: Own survey result, 2023. ***, ** means significant at 1% and 5% probability level respectively

Irrigation practice: According to the study findings, 29 percent of the total sample household practice irrigation in the study area, while the remaining 79 percent did not. The comparison across different groups of livelihood strategies revealed that 3.8, 3.5, 12.2, and 9.5 percent of households practicing irrigation under farming only, farming plus non farming, farming plus of farming and farming plus on and off farming, respectively. At a 1% probability level, the chi-square test revealed a statistically significant mean difference in livelihood training among the four groups.

3.3. Econometric Model Results

This section presents the results of the econometric models results. In this study household livelihood strategies are the dependent variables. Therefore, the results of multinomial logistic regression were employed to identify determinants of households' livelihood strategies.

Determinants of livelihood strategies

The results of the multinomial logistic regression model, which was used to identify the determinants of farm households' livelihood in the study area, are presented in this subsection. The dependent variable in this model, as previously stated, is a multivariate variable indicating various types of livelihood strategies. The model was estimated using STATA 14.2 computing software. The dependent variable in the multinomial logit model is farm household livelihood strategies, with a value of 1 to 3.

According to the estimated coefficients, fourteen explanatory variables have a significant influence on livelihood strategy. Agro ecology, gender, family size, farm size, economic active member, training, credit access, livestock holding, education level, farming experience, irrigation experience, media, and distance from the market are all important factors influencing household livelihood strategy status.

Agro-ecology: At a 10% probability level, this variable was found to be negatively and significantly related to household livelihood strategies. The variable's odds ratio value of 0.0636 indicated that, when all other factors are held constant, the odds ratio in favor of being in the high level of livelihood diversification strategies decreases by a factor of 6.36 percent as the agro ecology is highland. The findings of this study were found to be consistent with those of Abera *et al.;* Guduro *et al.*; Gebbisa & Mulatu [30; 31; 32].

Sex of household hea: At the 1% probability level, this variable has a negative and significant relationship with the probability of household livelihood strategies with farming and non-farming practices. The marginal effects of -0.009 of sex of households indicated that, while other factors remained constant, the probability of the sample household head is being female. The results of this study found to be consistent with the findings of Shikur & Leza, Dirribsa &Tasew; and Abera *et al.* [33; 30; 34].

Family Size: This variable has a negative and significant relationship with the probability of household livelihood strategies at the 5% probability level. While other factors

remained constant, the probability of in livelihood strategy as farming plus non farming decreased and increased by 3.2 percent as the farm size of the household decreased by one person, according to the marginal effects of 0.0325 of family size. As a result, households with large family sizes are more likely to engage in non-farm and/or combination activities. The positive relationship between household size and diversification could be attributed to the relationship between large family size and household labor, as well as corresponding food demand. Additionally, labour shortage challenges farmers in rural areas thus; households with more family labour could spare surplus family labour to attend the more diversified livelihoods. The results of this study found to be consistent with the findings of Girma *et al.*; Shikur & Leza;, Dirribsa &Tasew; and Abera *et al.* [36; 33; 30; 34].

Farming experience: This variable has a negative and significant relationship with the probability of choosing household livelihood strategies at the 10% probability level. The marginal effects of farming experience of 0.0078 and 0,0065 indicated that, while other factors remained constant, the probability of in livelihood strategy as farming plus non farming and on farm and off farm practices decreased and increased by 0.08 and 0.65 percent, respectively, as the household's farming experience increased by one year. This implies that as people get older, their participation in various livelihood strategies decreases. In other words, younger households are more likely than older households to be involved in non-farm and/or combination of activities. The possible explanation is that younger households cannot get enough land to support their livelihoods compared to the older households. Focus group discussion participants also mentioned that as age of the farm household increases, the farmer will be getting older and could not be capable of diversifying livelihoods and more likely concentrate on agricultural activities for their subsistence. The results of this study found to be consistent with the findings of Dinku; and Abera *et al.* [37, 34].

Education of head: This variable has a negative and significant relationship with the probability of households choosing farming only livelihood strategies at the 5% probability level. The marginal effects of 0.016 of education level showed that, while other factors remained constant, the probability of having a farming only livelihood strategy decreased by 1.6 percent as the household head's education level increased by one level. Highly educated households diversified their livelihood options through remunerated jobs, self-employment, trading, or off-farm activities, whereas less formally educated households engage in lower-priced labor, lower wage earnings, and fewer non-farm activities.

More educated households have more knowledge and skills, giving them more opportunities to engage in non-farm activities than illiterate and undereducated households. In terms of household head education, the more educated household heads engage in non-farm and off-farm diversification strategies. This is because better-educated households are better equipped to calculate the costs and benefits of income-generating activities, allowing them to

participate in non-farm and off-farm activities. The findings are consistent with those of Eshetu & Mekonnen; Gebru *et al.*; Girma *et al.* and Dirribsa &Tasew [39, 10, 36, 30].

Fam Size: This variable has a negative and significant relationship with the probability of farming plus nonfarm household livelihood strategies at the 5% probability level. While other factors remained constant, the probability of in livelihood strategy as farming plus non farming decreased and increased by 2.7 percent as the household farm size decreased by one hectare. This implies that households with a large land holding size are less likely to diversify their livelihoods than those with a small land holding size. As a result, households with large farm sizes rely on agriculture rather than diversifying their livelihood activities to meet their needs. The possible reason can be large land holding size enables the farm households to follow agricultural intensification to produce more and increase farm income. The results of this study found to consistent with the findings of Girma *et al.*; Shikur & Leza; Dirribsa & Tasew; and Abera *et al.* [36, 33, 30, 34].

Extent Active Family Members: This variable has a negative and positive significant relationship with the probability of household livelihood strategies with farm only and farming plus non farming at the 1% probability level. The marginal effects of active family members of -0.060, 0.101 indicated that, while other factors remained constant, the probability of in livelihood strategy as farming only and farming plus non farming decreased and increased by 6 and 10%, respectively, as active family member farm size increased by one person. Similarly, at the 5% level of probability, this variable has a positive and significant relationship with the probability of household livelihood strategies that include farming plus off-farming, farming, non-farming, and off-farming livelihood strategies.

The marginal effects of 0.066 and 0.0959 of active family members indicated that, while other factors remained constant, the probability of livelihood strategy as farming plus non farming and farming, non-farming plus off farming decreased and increased by 6.6 and 9.6 percent, respectively, as the farm size of active family member increase by one person. The result of this study is in line with the findings of Bird *et al.* [40]; and Tamerat [41], while it contradicts from the study done by Gebru *et al.* [10]; large household size does not mean all the household members are productive labor force. This is since some of the household members are not active members.

Farmer training: At the 5% probability level, this variable has a negative and significant relationship with the probability of household livelihood strategies with farm only and farming plus off farming. The marginal effects of -0.015, -0.016, of active livelihood training indicated that, while other factors remained constant, the probability of in livelihood strategy as farming only and farming plus non farming decreased and increased by 1.5 and 1.6%, respectively as the farm household being accessed training.

Similarly, at the 1% level of probability, this variable has a positive and significant relationship with the probability of household livelihood strategies that include farming plus non-

farming and farming, non-farming, and off-farming livelihood strategies. While other factors remained constant, the probability of livelihood strategy as farming plus non-farming and farming, non-farming plus off farming decreased and increased by 1.65 and 1.46 percent, respectively, as households' accessed training. The findings are consistent with those of Eshetu & Mekonnen; Gebru *et al.*; Shikur & Leza; Dinku *et al.* and Abera *et al.* [39, 10, 33, 37, 34].

Cooperative Distance: This variable has a negative and significant relationship with the probability of household livelihood strategies with farming plus non farming at the 5% probability level. The marginal effects of distance from cooperative office of -0.0131 indicated that, while other factors remained constant, the probability of in livelihood strategy as farming plus non farming decreased and increased by 1.3 percent as household distance from cooperative office increased by one. Similarly, at the 5% level of probability, this variable has a positive and significant relationship with the likelihood of household livelihood strategies that include farming plus off-farming. The marginal effects of 0.015, of distance from cooperative office indicated that, while other factors remained constant, the probability of in livelihood strategy as farming plus off farming decreased and increased by 1.5%, as the distance from cooperative office of household increase by one. In line with the findings of Ayana *et al.*, Guduro *et al.*; Dirribsa and Tasew [15, 31, 30].

Irrigation practice: At the 5% probability level, this variable has a negative and significant relationship with the probability of household livelihood strategies with farm only and farming plus non farming. The marginal effects of -0.111, -0.306, of irrigation practices indicated that, while other factors remained constant, the probability of in livelihood strategy as farming only and farming plus non farming decreased and increased by 11.1 and 20.6 percent, respectively as the number of training increase by unit. Similarly at 10% probability level, this variable has a positive and significant relationship with the probability of household livelihood strategies with farming plus off farming and farming, non-farming and off farming livelihood strategies. While other factors remained constant, the probability of livelihood strategy as farming plus off farming and farming, non-farming plus off farming decreased and increased by 1.65 and 1.46 percent, respectively, as the farm household being accessed irrigation practice. In short, households were significantly more likely to be involved in livelihood diversification than relying on complete specialization of livelihood, as revealed by model analysis, and the result was consistent with studies by Gebru et al.; Ayana *et al.*, Guduro *et al.*; and Dirribsa & Tasew [10, 15, 31, 30].

Access to media: This variable has a negative and significant relationship with the probability of household livelihood strategies based solely on farming at the 1% probability level. The marginal effects of media access of -0.258 indicated that, while other factors remained constant, the probability of in livelihood strategy as farming plus non farming decreased and increased by 25.8% as household media access increased by one. Similarly, at the 5% level of probability, this variable has

a positive and significant relationship with the likelihood of household livelihood strategies that include farming and off-farming. If the farmers get better access to media they are expected to diversify livelihood strategies than others. The marginal effects of 0.1955, of media access indicated that, while other factors remained constant, the probability of livelihood strategy as farming, non-farming plus off farming decreased and increased by 1.5%, as the access to media of household increase by one. This result consistent with the findings of Shikur &Leza; Ayana *et al.*; Guduro *et al.*; Dirribsa & Tasew [33, 15, 31, 30].

Farmer training: At the 1% probability level, this variable has a negative and significant relationship with the probability of household livelihood strategies with farming only. The marginal effects of -0.140, of farmer training indicated that, while other factors remained constant, the probability of in livelihood strategy as farming plus non farming decreased and increased by 25.8 percent, as farmer training of household increase by one. This implies that households who were not participated in agricultural training are less likely diversifies their livelihood activities, whereas farm households who participated in agricultural training were practiced diverse livelihood strategies. Thus, training enhances and improves knowledge, skills and experiences of the farmers which support them to expand income generation options. The result is consistent with the findings of Eshetu & Mekonnen; Gebru *et al.*; Shikur & Leza; Dinku; and Abera *et al.* [39, 10, 33, 37, 34].

Credit Access: At the 10% probability level, this variable has a positive and significant relationship with the probability of household livelihood strategies with farming, non-farming and off farming. The marginal effects of 0.0814, of credit access indicated that, while other factors remained constant, the probability of in livelihood strategy as farming plus non

farming decreased and increased by 8.4 percent, as the credit access of household increase by one. Conversely, those households who have access to credit facilities are more engaged in different livelihood activities. This is because credit access and utilization allow the possibility to invest in non/off-farm activities. The key informants mentioned that providing credit for resource poor farmers will enhance the livelihood diversification. The result is consistent with the findings of Eshetu and Mekonnen; Gebru *et al.*; Shikur and Leza; Dinku; and Abera *et al.* [39, 10, 36, 37, 34].

Distance from All-weather Road: at 10% probability level, this variable has a positive and significant relationship with the probability of household livelihood strategies with farming only and farming plus off farming. The marginal effects of 0.0074 and 0.0020 of distance from all-weather road indicated that, while other factors remained constant, the probability of livelihood strategy as farming only and farming plus off farming decreased and increased by 0,74 and 0.20%, respectively, as the distance from all-weather road of the households increase by one.

The marginal effects of 0.027, of distance from all-weather road indicated that, while other factors remained constant, the probability of in livelihood strategy as farming plus non farming decreased and increased by 2,7 percent, as the distance from all-weather road of household increase by one. The likely reason for a positive and significant relationship between distance from all-weather road and non-farm and off-farm activities could be that residing nearer to the all-weather road enables farm households to engage in non- farm and off-farm activities mainly trading and service provision. The results of this study found to consistent with the findings of Larato; Girma *et al.*; Shikur and Leza; Abera *et al.*: and Ayana *et al.* [42, 36, 33, 37, 34, 15].

Table 4. Determinants of participation in diversified livelihoods of farm households,

Variables	Farming only		Farming +non-farming		Farming +off		Farming + non+ off farming	
	M. E	S. E	M. E	S. E	M. E	S. E	M. E	S. E
Ecology	-0.0636*	0.032	0.069	0.036	0.012	0.0437	-0.0176	0.0374
Sex	-0.0975	0.104	0.19****	0.034	-0.084	0.1308	-0.0136	0.1229
Age	0.0020	0.003	-0.0009	0.003	-0.0017	0.0042	0.0007	0.0033
Family Size	0.0136	0.009	-0.032**	0.012	0.0165	0.0141	0.0024	0.0119
Gender	-0.0321	0.063	-0.0004	0.069	-0.0068	0.0887	0.0394	0.0696
Experience	0.0010	0.003	-0.009**	0.003	0.0065*	0.0039	0.0004	0.0031
Education	-0.016**	0.006	0.0009	0.006	0.0069	0.0088	0.0085	0.0071
Farm Size	0.0125	0.011	0.0270**	0.013	-0.024	0.0179	-0.0146	0.0156
Economically Active family	-0.060***	0.022	-.101***	0.025	0.066**	0.0279	0.0959***	0.0197
Livestock	-0.015**	0.007	0.0165**	0.007	-0.016*	0.0096	0.0146*	0.0074
Distance from Cooperative	-0.0030	0.005	-0.013**	0.005	0.015**	0.0074	0.0009	0.0063
Irrigation	-0.111**	0.040	-0.31***	0.039	0.24***	0.0726	0.1794**	0.0657
Media	-0.258***	0.049	0.0649	0.045	-0.0022	0.0611	0.1955***	0.0472
Training	-0.140***	0.041	0.0039	0.043	0.0914	0.0564	0.0446	0.0456
Extension	-0.0085	0.007	0.0052	0.008	-0.007	0.0100	0.0107	0.0077
Credit	-0.0424	0.045	-0.0304	0.048	-0.0086	0.0595	0.0814*	0.0464
Distance from all-weather Road	0.0074*	0.004	-.027***	0.006	0.020**	0.0068	-0.0006	0.0060
Multinomial logistic regression Number of obs = 400								
LR chi2(51) = 238.12								
Prob > chi2 = 0.0000								
Log likelihood = -425.20336 Pseudo R2 = 0.2188								

Source: Own survey result, 2023. ***,** and * means significant at 1% 5% and 10% probability levels respectively.

Livestock holding: The potential reason could be households who attained the required amount of cash from livestock may not need to involve in non-farm and off-farm activities for additional income whereas farmers with lower livestock holding may be obliged to diversify livelihoods into non-farm and off-farm activities to fulfill household assets and achieve their food security. The possible explanation for this could be attributed to the fact that households with more TLU have better opportunity to earn more income from livestock production which enables them to fulfill their livelihood requirements. Consequently, farm household who can get the required income from livestock may not engage in other income generating activities. Conversely, households with less number of livestock endeavor to diversify their income sources by participating in a range of livelihood activities. This is because small number of livestock holding does not enable them to generate enough income to support family needs which cause them to participate in other alternative livelihood options. The results of this study found to consistent with the findings of Girma *et al.*; Shikur & Leza; Dirribsa & Tasew; and Abera *et al* [33, 30, 37, 34].

3.4. Impact Evaluation Results: Second Stages of MESR

3.4.1. Impacts of the Livelihood Strategies on Farm Income

Table 5 shows the effects of livelihood diversification on farm households' farm income generation of the sample households. The estimated result indicated that participation of farming with non-farming livelihood diversification strategies increases farm household total income by 44% over that of only farming dependent households. Likewise, participation in farming with off farming and farming with both non-farming and off farming livelihood diversification strategies increases households' total farm income by 76 and 82% respectively over non-diversified households, and this difference is statistically significant at a 1% probability level (Table 5).

***Table 5.** Impacts of livelihood diversification on households' total income.*

Livelihood strategies	Actual	Counter	Treatment	T-value
Farming +non farming	134169.6	133291.7	.4435532***	.2169634
Farming +off farming	127606.8	119545.5	.7628736***	.1702203
Farming +non + off farming	136458.3	133871.9	82.181812***	.1909249

Source: Own survey result, 2022. *** means significant at 1 % probability level.

The following figure indicates the mean levels of farm households' farm income status measured in Ethiopian birr by different livelihood diversification strategies' of the farm households in the study area.
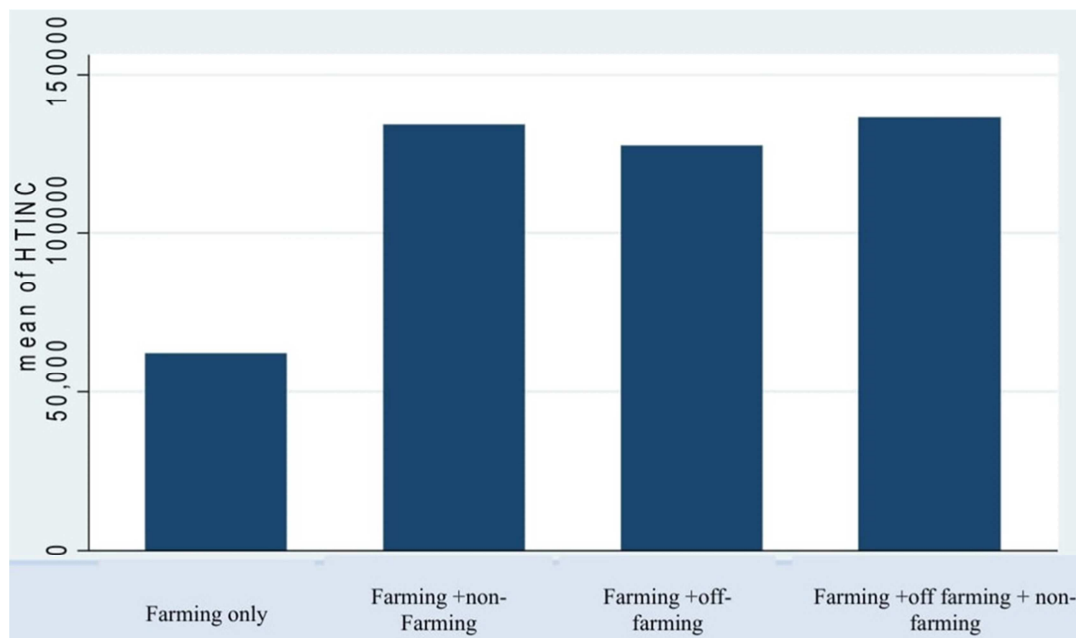

***Figure 2.** Total farm income across livelihood diversification strategies.*

3.4.2. Impacts of the Livelihood Diversification Strategies on Food Security

Table 6 shows the effects of livelihood diversification on farm households' food security status generation of the sample households. The estimated result indicated that participation of farming with non-farming livelihood diversification strategies increases farm household food security status by 25% over that of only farming dependent households. Likewise, participation in farming with off farming and farming with both non-farming and off farming livelihood diversification strategies increases households'

food security status by 43 and 37% respectively over non-diversified households, and this difference is statistically

significant at a 1% probability level (Table 6).

Table 6. *Impacts of livelihood strategies on farm food security status.*

Livelihood strategies	Actual	Counter	Treatment effect	S, E
Farming +non farming	3652.07	3473.76	.2507925***	.0816547
Farming +off farming	3530.6	3240.99	.4298538***	.0804488
Farming +non + off farming	3736.8	3564.56	.3703406***	.094243

Source: Own survey result, 2023. *** means significant at 1 % probability levels

The following figure indicates the mean levels of farm households' food security status measured in food consumption score by different livelihood diversification strategies' of the farm households in the study area.
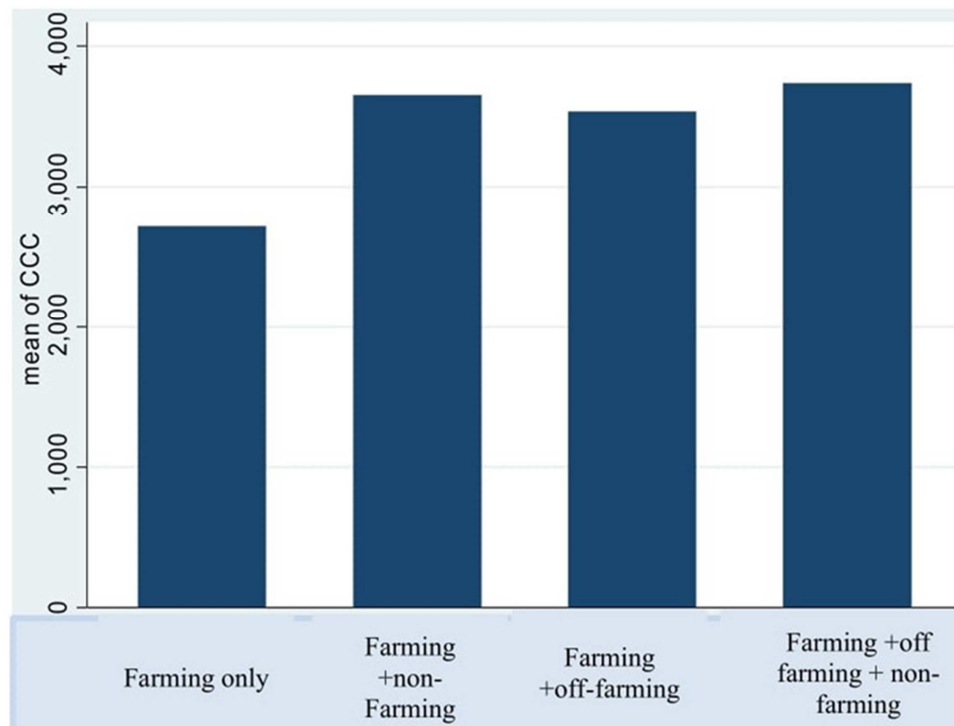

Figure 3. *Food security status across livelihood diversification strategies.*

4. Conclusions and Recommendations

The purpose of this study was to identify the determinants of livelihood diversification strategies and their effects on food security in three districts of Oromia, Ethiopia's North Shewa Zone. For data extraction, the study used both primary and secondary sources. A semistructured questionnaire was used to collect primary data from 400 sample households. Secondary data were gathered from various sources to supplement the primary data. Finding reliable information on livelihood diversification strategies and its effect on food security status at the household level was deemed critical. As a result, the data was analyzed using multinomial endogenous switching model.

Food consumption score was used to calculate calorie intake based the last 7 days before survey. Therefore, based on a 2550kcal crosscut, 63.1 percent of the total sample household was found to be food secured and the rest of 36.9 percent was food insecure. Multinomial logit model results

indicated that the probability of diversifiying the livelihood strategies is significantly influenced by; family size, education level of head of households, gender, farm income, economic active members, cooperative distance, cultivated land area, credit access, livestockholding, access to media information, access to training, agroecology and all weather road distance.

Multinomial endogenous switching model was used for impact evaluations. Impact evaluation estimated result indicated that participation of farming with non-farming livelihood diversification strategies increases farm household food security status by 25% while, participation in farming with off farming and farming with both non-farming and off farming livelihood diversification strategies increases households' food security status by 43 and 37% respectively over non-diversified households at a 1% probability level.

To that end, the following policy recommendations are made based on the study's findings. Therefore, this encourages the policy implication for policy makers in setting the country livelihood diversification strategies and

enhancing strategic policies. Overall the study identified knowledge and skills, finance, awareness and information, infrastructure and information dissemination as a major challenge of livelihood diversifications. Therefore, improving farmers' education, training on livelihood diversification strategies, farmer training and accessing credit services should be some of the policy measures that will facilitate diversification strategies.

Authors Contributions

Gari contributed to all aspects of this paper including data collection, data entering, analyzing, interpreting, and writing of this manuscript. Fekedu, Mengistu and Kedir contributed by commenting on the aspects of this paper from data analyzing, interpreting, and writing up of the final report.

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Data Availability

The author confirms that the data will be available based on the request.

Competing Interests

The authors declare that they have no competing interests related to the publication of this research manuscript.

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