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Impact of Livelihood Diversification on Food Security of Rural Households in Boloso Sore District of Wolaita Zone, South Ethiopia

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About Article

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ABSTRACT

This study analyzes the impact of livelihood diversification strategies on rural households' vulnerability to food insecurity in Boloso Sore District, Wolaita Zone, Southern Ethiopia. Using a multinomial logistic model, it examines how socio-economic, institutional, and demographic factors influence the choice of livelihood strategies, including on-farm alone, on-farm plus non-farm, on-farm plus off-farm, and a combination of all three. Key determinants include age, education, gender, access to credit, training, land size, livestock holding, income, and cooperative membership. The results show that on-farm alone is negatively influenced by education, credit, and training, but positively by land size. The combined strategy is positively influenced by education and training but negatively by age and income. An impact assessment method shows that diversification increases household income, with an ATT of 1360.51. The study recommends promoting diversified strategies, credit access, and training to enhance food security.

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1. INTRODUCTION

1.1. Background of the Study

In developing countries, rural households primarily depend on agriculture for their livelihoods (Dethier & Effenberger, 2012), with agricultural activity being predominant in Sub-Saharan Africa (SSA), offering potential for growth, poverty reduction, and food security (WB, 2008). In Ethiopia, where the majority live in rural areas, agriculture remains the key livelihood source (Abebe, 2018), but it alone cannot sufficiently address poverty and food insecurity due to declining returns and population pressure (Moseley, 2020). As a result, rural households are increasingly adopting strategies such as agricultural intensification and livelihood diversification to enhance food security and improve living standards (Bekele, 2017).

Livelihood diversification, defined as building a portfolio of activities to manage risks and improve incomes (Ellis, 1998; Scoones, 1998), is commonly seen as a survival mechanism against shocks, resource scarcity, and poverty, while others view it as an income-boosting strategy (Ellis, 2000). In Ethiopia, many rural households engage in a combination of on-farm, off-farm, and non-farm activities to cope with livelihood challenges (Titay, 2013). Diversification strategies are classified into four categories: full-time farming, farming with wage labor, farming with non-farm work, and a mixed strategy combining all three. These strategies are crucial for improving incomes and food security (Kassa, 2019).

In rural Ethiopia, 83% of households participate in farming, but only 27% engage in non-farm activities (Gebru *et al.*, 2018). With limited landholdings and declining agricultural returns, many households are forced to diversify their livelihoods (Wondem, 2020). Diversification into non-agricultural activities has helped reduce poverty and improve food security (Belay & Bewket, 2015). The ability to diversify, often influenced by factors such as access to assets, social relations, and institutional support, plays a significant role in achieving livelihood security (Stage *et al.*, 2002). These factors create opportunities or obstacles, affecting the capacity of rural households to diversify and enhance their resilience.

Despite the growing trend of livelihood diversification, rural households in Ethiopia, especially in areas like the Wolaita Zone, still face challenges due to small landholdings and limited non-farm opportunities (WZFEDD, 2015). In the study area of Boloso Sore Woreda, rural households engage in various non-farm and off-farm activities to supplement their agricultural income. However, factors such as lack of credit, skills, and employment opportunities hinder diversification efforts. This study aims to estimate the effects of these factors on livelihood diversification and assess their impact on household income and food security, addressing a critical research gap in understanding the drivers of diversification in Boloso Sore District.

2. LITERATURE REVIEW

2.1. Empirical Review

Studies on rural livelihood diversification in Ethiopia reveal key determinants. Bishar and Abduselam (2022) in Kebri Dahar, Somali region, found that 52.9% of respondents diversified their livelihoods, with on-farm, off-farm, and non-farm activities playing varying roles. Similarly, Jemal *et al.* (2021) identified factors such as education, land ownership, livestock, and access to credit as positively influencing non-agricultural participation, while age and family size had negative impacts.

Andualem and Umer (2023) in North Wollo highlighted that male-headed households, landholding, and cooperative membership positively impacted agriculture strategies, while market distance was a negative factor. For non-farm strategies, education, total income, and remittances played positive roles, whereas sex of the household head negatively influenced participation.

Ayana *et al.* (2021) in Assosa found education, irrigation access, and dependency ratio to be significant predictors of livelihood diversification, while variables like age, sex, credit access, and livestock ownership were insignificant. Amente and Tewodros (2020) in Kuormuk and Homosha districts observed that access to training positively influenced diversification, while age and land size had negative associations

Additionally, several studies, including Zerihun (2016) and Gebru *et al.* (2018), emphasize that younger households, better access to resources, and favorable conditions increase engagement in off-farm and non-farm activities. On the other hand, constraints such as high dependency ratios or poor market access limit households' ability to diversify.

3. METHODOLOGY

3.1. Sampling Techniques and Sample Size Determination

The study employed a multi-stage sampling technique, selecting Boloso Sore Woreda purposively due to its vulnerability to food insecurity and lack of livelihood diversification, with three agro-ecological zones. Three rural kebeles were chosen from different ecological zones (lowland, middle land, and highland). A total of 372 households were sampled using Yamane's formula (1967) with a 5% margin of error and 95% confidence level. The sampled respondents in each kebele were determined using probability proportional to size.

The study utilized both descriptive and inferential statistical methods, including a multinomial logistic model to estimate the effect of socio-economic, demographic, and institutional factors on livelihood diversification strategies that improve food security. Four categories of livelihood diversification strategies were considered: on-farm alone, on-farm plus off-farm, on-farm plus non-farm, and a combined strategy of on-farm plus off-farm plus non-farm. Since these strategies are mutually exclusive, the multinomial logistic model was appropriate. Additionally, the impact of livelihood diversification on vulnerability to food insecurity was assessed using propensity score matching.

3.2. Methods of Data Analysis

The study has used both descriptive and inferential statistical methods of data analysis for qualitative and quantitative information. The study has employed multinomial logistic model to estimate the effect of socio-economic, demographic, and institutional factors on livelihood diversification activities that improve food security. In line with the dependent variables, the study has used the four categories of livelihood diversification strategies including, on-farm alone, on-farm plus off-farm, on-

farm plus non-farm, and the combined strategy of on-farm plus off-farm plus non-farm. The livelihood diversification strategies in which the households have engaged are independent, so a multinomial logistic model has been employed to estimate the effect of socio-economic factors, demographic factors and institutional factors on the choice of the households' livelihood diversification strategies that improve food security for rural households. The impacts of participation in livelihood diversification activities on food security of the rural households has evaluated using propensity score matching method, and compare the food security of the rural households that are participants in livelihood diversification activities with that of non-participants.

3.2.1. Multinomial Logistic Model

As rural households may engage in various livelihood diversification activities, there may have more than two alternatives for participation in livelihood diversification activities, and either multinomial logistic or multivariate probit regression models are appropriate to estimate the effects of the variables that could influence the livelihood diversification activities of the rural households. The multinomial logistic has become popular in livelihood diversification studies, in which it assumes that if a household has been clustered in a given category of livelihood diversification strategy, it does not participate in another category of livelihood diversification strategies. The multinomial logistic regression model has become suitable only when the livelihood strategies are mutually exclusive. In the case, the rural household could participate in the four categories of the livelihood diversification strategies, namely; on-farm, on-farm plus non-farm, on-farm plus off-farm, and on-farm plus non-farm plus off-farm. However, the household couldn't participate in more than one category of the livelihood diversification strategies in the same time. The independent of livelihood diversification strategies have been considered, a multinominal logistic model has employed to analyse the factors that influence the choice of the rural households' livelihood diversification strategies (Greene, 2012).

Income of the households has considered the observed outcome of livelihood diversification activity. Consider the i^{th} rural household (i=1,2,3,...N), facing a decision problem on whether or not to engage in k^th available livelihood diversification activities to generate additional income. Let P_{ik} denotes the probability of i^{th} household to participate in k^{th} livelihood diversification activities. Then, the multinomial logistic model expressed as;

$$P_{ik} = \frac{\exp\ (X_i' \beta_k)}{\sum_{k=0}^{J} \exp\ (X_i' \beta_k)}$$

where; β denotes the coefficient of covariates which varies across the alternative livelihood diversification strategies, X denotes the characteristic of the households which remains constant across the alternative livelihood diversification strategies.

$$P_{ik} = \begin{cases} 1 = \text{ if } P_{ik} > 0 \\ 0 = \text{otherwise} \end{cases}$$

where P_{ik} denotes the probability of engaging in k activities for the livelihood diversification of an individual, for k = 1 (on-farm), k = 2 (on-farm plus non-farms), k = 3 (on-farm plus off-farm), and k = 4 (on-farm plus non-farm plus off-farm), where, P_{i1}=1, if the households engage in on-farm only (0=otherwise), P_{i2}=1, if the households engage in on-farm plus non-farm (0=otherwise) P_{i3}=1, if the households engage in on-farm plus off-farm (0=otherwise), P_{i4}=1 if the households engage in on-farm plus non-farm plus off-farm (0=otherwise), X_i= the vector of factors affecting livelihood diversification activities, β= the vector of the estimated coefficient, and ε_i= the error term.

3.2.2. Propensity Score Matching

Propensity score matching has been used to evaluate the impacts of livelihood diversification strategies on the food security. According to Rosenbaum and Rubin (1983), the propensity matching score can be expressed as the conditional probability of getting a treatment given pre-treatment features. Let, assume that Yi^T, and Yi^C are the outcome variables for the participants (treated) and non-participants (control) of the rural households in livelihood diversification activities. The difference in outcome between the participants (treated group) and non-participants (control group) can be denoted and expressed as; $\Delta I = Yi^T - Yi^C$, where Yi^T represents the outcome variable of the treatments, Yi^C represents the outcome variable of the control, and ΔI represents the difference between the outcomes of the treatment and control.

In basis on the difference between the outcomes of the treatment and control, denote Di=1 or 0, and if the individuals are treated, it conveys 1, and if they are not treated, it conveys 0. Therefore, the average treatment effect on i^th individual can be written as; $ATE = E(Yi^T \mid Di=1) - E(Yi^T \mid Di=0)$, where ATE represents the average treatment effect on the outcome of an individual, $E(Yi^T \mid Di=1)$ represents the average outcome of the treated individuals that are participants in livelihood diversification activities, and $E(Yi^T \mid Di=0)$ represents the average outcome of the non-treated individuals that are non-participants in livelihood diversification activities. The average treatment effect on the treated (ATT) for the sampled households can be expressed as; $ATT = E(Yi^T - Yi^C \mid Di=1) = E(Yi^T \mid Di=1) - (Yi^C \mid Di=1)$, where; ATT represents the average treatment on the treated, $E(Yi^T - Yi^C \mid Di=1)$ represent the difference in outcome of the treatment and control groups.

As Rosenbaum *et al.* (2007) stated, the feasible of propensity score matching estimator for impact evaluation depends on two fundamental assumptions:

i. Conditional Independence: it states that the treatment (Di) conditional on the attributes (Xi) in which it has to be independent of the post program outcome. It noted as, $(Yi^T - Yi^C) \perp D|Xi$. To reduce the dimensionality problem in calculating the conditional expectation, Rosembaum and Rubin (1983) revealed that instead of matching on the base of X's one can equivalently match treated and control units based on "propensity score" expressed as the conditional probability of getting the treatment given the values of X's. The conditional probability of getting the treatment given the values of Xi, notational expressed as, P(Xi)=P(Di=1|Xi), and the average treatment effect on the treated conditional on the probability of participation can be expressed as,

$ATT = E((Yi^T \mid P(Xi), Di=1) = E((Yi^C \mid P(Xi), Di=1)$

Conditional independence assumption levies a restriction that choosing to participate in livelihood diversification activities has been purely random for similar individuals. The conditional independence assumption eliminates the familiar dependence between outcomes and participation that might lead to a self-selection problem (Heckman *et al.*, 1998).

ii. Common Support (0<P(Xi)<1): As Becker and Ichino (2002) stated, the test of the balancing propensity has to be performed only on the observations whose propensity score belongs to the common support region of the propensity score of the treated and control groups.

4. RESULTS AND DISCUSSION

4.1. Descriptive Analysis

4.1.1. Extent of Livelihood Diversification Strategies Adapted by Households

Table 1 summarizes the livelihood diversification strategies pursued by rural households in Boloso Sore District. Among the 372 households, 44% relied solely on on-farm activities, 30% combined on-farm with non-farm activities, 18% engaged in both on-farm and off-farm activities, and 8% employed a highly diversified strategy combining on-farm, non-farm, and off-farm activities. Nearly half (43.82%) of the households depended entirely on agriculture, making them more vulnerable to food insecurity due to environmental and market risks. In contrast, households combining farming with non-farm (30.38%) or off-farm (18.28%) activities were better able to manage risks and enhance income stability. The 7.53% of households that diversified across all three activities demonstrated the highest resilience to food insecurity, benefiting from multiple income streams that buffer against agricultural risks and seasonal variations.

Table 1. Distribution of Livelihood Diversification Strategies by Households

Livelihood Diversification Strategies	Frequency	Percent
On-farm	163	44
On-farm + non-farm	113	30
On-farm + off-farm	68	18
On-farm + non-farm + off-farm	28	8
Total	**372**	**100**

Source: Own computation, (2024)

4.1.2. Descriptive Analysis for Categorical Explanatory Variables

Table 2 presents the distribution of categorical explanatory variables and their significance on household livelihood strategy choices. Among 372 households, 10.75% were female-headed, with a higher engagement in the combined on-farm, non-farm, and off-farm strategies, while male-headed households favored on-farm plus off-farm strategies, although gender was not statistically significant ($p > 0.05$). Education level was significant ($p < 0.05$), with illiterate households mostly engaging in on-farm alone (75.46%), whereas households with higher education diversified more. Credit access significantly affected strategy choice ($p < 0.05$), with 57% receiving credit and most choosing on-farm plus non-farm (78.76%) or the combined strategy (82.14%). Training access, though widespread (68.82%), had no significant effect on strategy choice ($p > 0.05$). Landholding had a significant effect ($p < 0.05$), with 57.53% cultivating

Table 2. Summary of Categorical Explanatory Variables

	Livelihood Diversification Strategies									
	On-farm		On-farm + non-farm		On-farm + off-farm		On-farm + non-farm + off-farm		Chi Square Test	
Variables	**No.**	**%**	**No.**	**%**	**No**	**%**	**No.**	**%**	**Chi2**	**p-value**
Female	17	10.43	11	9.73	9.73	8.82	6	21.43	3.7290	3.7290
Male	146	89.57	102	90.27	90.27	91.18	22	78.57		
Illiterate	123	75.46	31	27.43	39	57.35	7	25.00	104.64	0.000
Primary	40	24.54	57	50.44	29	42.65	12	42.86		
Secondary	0	0.00	25	22.12	0	0.00	9	32.14		
No Acc. Credit	86	52.76	24	21.24	45	66.18	5	17.86	50.289	0.000
Access to Credit	77	47.24	89	78.76	23	33.82	23	82.14		
No Training	53	32.52	33	29.20	23	33.82	7	25.00	1.0609	0.787
Training	110	67.48	80	70.80	45	66.18	21	75.00		
No Own Land	42	25.77	70	61.95	28	41.18	18	64.29	41.656	0.000
Land Ownership	121	74.23	43	38.05	40	58.82	10	35.71		
No Experience	99	60.74	28	24.78	19	27.94	6	21.43	47.813	0.000
Have Experience	54	39.26	85	75.22	49	72.06	22	78.57		

No Cooperative Member	131	80.37	50	44.25	45	72.06	16	57.14	39.141	0.000
Cooperative Member	32	19.63	63	55.75	23		12	42.86		
No Livestock	25	15.34	70	61.95	27	39.71	23	82.14	85.312	0.000
Own Livestock	138	84.66	43	38.05	41	60.29	5	17.86		

Source: Own computation, (2024)

their own land alone, and those renting or sharing land more likely to diversify. Experience in livelihood diversification was significant ($p < 0.05$), with experienced households more engaged in diverse strategies. Cooperative membership also significantly influenced strategy choice ($p < 0.05$), with non-members primarily engaging in on-farm alone, while members were more diversified. Lastly, livestock holding, an indicator of wealth, had a significant impact ($p < 0.05$), with livestock holders favoring on-farm alone (84.66%), while non-holders were more likely to engage in diversified strategies, particularly the combined on-farm, non-farm, and off-farm option (82.14%).

4.1.3. Calorie intake with each livelihood diversification activities

Households engaged solely in farming have the lowest average calorie intake (1162.42 KcalAE), suggesting greater vulnerability to food insecurity due to reliance on a single, risk-prone income source. In contrast, those combining farming with non-farm activities have a higher average intake (2058.24 KcalAE), indicating improved food security from income diversification. Households involved in both farming and off-farm activities exhibit an even higher calorie intake (2636.22 KcalAE), benefiting from the more stable income provided by off-farm work. The highest food security is seen in households that diversify across all three strategies (farming, non-farm, and off-farm), with an average of 2730.99 KcalAE. The significant t-test results across all groups emphasize the positive impact of livelihood diversification on food security, showing that households with more diversified income sources are substantially more food secure. These findings highlight the importance of promoting livelihood diversification in rural areas to mitigate food insecurity risks.

Table 3. Calorie intake with each livelihood diversification activities

Livelihood diversification activities	Obs	Mean	Std. Dev.	Min	Max	T-value
Farm only	163	1162.419	405.4036	418	2096.5	36,5759
Farm + non-farm	113	2058.243	875.7173	508	3618	24.9603
Farm + Off- Farm	68	2636.217	407.2967	2102.5	3810	53.3126
Farm + Non- Farm + Off- Farm	28	2730.991	491.6432	2106	3740	29.3503

Source: Own Computation (2024)

4.2. Econometric Analysis

4.2.1. Regression Results of Multinomial Logit Model

The results of the multinomial logistic regression model reveal the factors influencing rural households' choice of livelihood diversification strategies. Key variables such as age of the household head, education level, access to credit, land size, access to training, livestock holdings, annual cash income, land holdings, household experience, membership in cooperatives, and dependency ratio were statistically significant in shaping diversification choices. The study found that older household heads were more likely to engage in on-farm plus non-farm activities, increasing participation by 6.2% per year of age. Education also played a significant role, with households where the head had primary or secondary education being more likely to diversify into off-farm or non-farm activities. Access to credit and training had positive effects, enabling households to diversify, while larger land size and livestock holdings had negative effects, as these households were less likely to diversify beyond farm activities. Membership in cooperatives and higher annual cash income also encouraged non-farm diversification, while households with higher dependency ratios were less likely to pursue non-farm income strategies.

The negative effect of land size and livestock holdings suggests that households with more agricultural resources tend to focus on farming, while those with fewer resources seek alternative income sources. Additionally, the positive impact of household experience and cooperative membership underscores the importance of knowledge and social networks in adopting diversified livelihood strategies. Conversely, the dependency ratio negatively affected diversification choices, implying that households with more dependents face greater challenges in seeking non-farm or off-farm income. Overall, the study highlights the complex interplay of socio-economic factors in shaping rural households' livelihood strategies, with certain assets, knowledge, and support systems facilitating diversification, while resource constraints and higher dependency levels hinder broader income opportunities.

Table 4. Farm and Off-Farm, Farm + non-farm and, Farm + off-farm + non-farm livelihood strategies relative to farm only livelihood bases

Variables	Robust					
	Farm + Non-farm		Farm + Off-farm		Farm + Off-farm + Non-farm	
	Coefficient	P-Value	Coefficient	P-value	Coefficient	P-value
AGE	.0623	0.038	.026	0.359	.037582	0.394
Male	.2645	0.648	.436	0.418	-.4771233	0.440
Primary	1.676	0.000	.9555	0.023	1.444195	0.041
Secondary	17.02	0.000	-.437	0.345	17.3565	0.000
FS	-.1299	0.589	.1938	0.375	.0784251	0.834
Access to Credit	1.524	0.000	-.524	0.133	1.601285	0.011
LS	-1.742	0.000	-.899	0.048	-2.712815	0.001
Access to Training	.8917	0.050	.4297	0.329	1.252123	0.087
Livestock	-2.165	0.000	-1.047	0.005	-2.668896	0.000
Income	.00001	0.005	-3.5e-06	0.528	-3.10e-06	0.701
Land Holding	-1.254	0.001	-.868	0.015	-1.503254	0.006
Experience	1.101	0.008	1.48	0.000	1.645505	0.011
Cooperative Member	1.195	0.004	.474	0.186	.5905683	0.313
Dependency Ratio	-3.302	0.089	-.1599	0.933	-4.155765	0.227

Source: Own Computation, (2024)

4.3. Regression Results of Propensity Score Matching Method

To analyze the impact of livelihood diversification on rural household income, propensity score matching was used. Following Grilli & Rampichini (2011), the process involved estimating propensity scores, selecting a matching algorithm, and checking the common support region. Observations outside the common support region, defined by the range of propensity scores, were excluded (Caliendo & Kopeinig, 2008). As shown in Table 5, the propensity scores for participants ranged from 0.029 to 0.99, and for non-participants, from 0.0123 to 0.9056, indicating a common support region between 0.029 and 0.9056.

Table 5. Predicting the Propensity Score for Common Support Region

Category	Obs.	Mean	Std. Dev.	Min	Max
Non- participate	163	.3229234	.2278303	.0122902	.905631
Participate	209	.7548084	.2583826	0.029	.9999833
Total	372	.5655684	.3257867	.0122902	.9999833

As indicated in Table 6 & Figure 2, the treated and untreated households that did find suitable match (On-support), and didn't find suitable match (Off-support) have presented. Accordingly, from the total of 163 untreated (non-participant) households 4 are off-support for the match and 159 are on-support for the match, while from the total of 209 treated (participant) households 85 are off-support and 124 are on-support for the match.

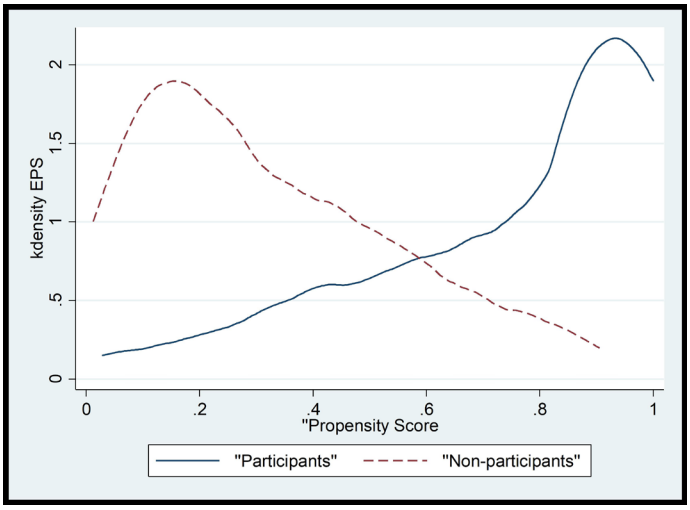

Figure 1. Region of Common Support

Table 6. Distribution of Treated and Untreated across Off/On-support

psmatch2: Treatment assignment	psmatch2: Common support		Total
	Off-support	On-support	
Untreated	4	159	163
Treated	85	124	209
Total	**89**	**283**	**372**

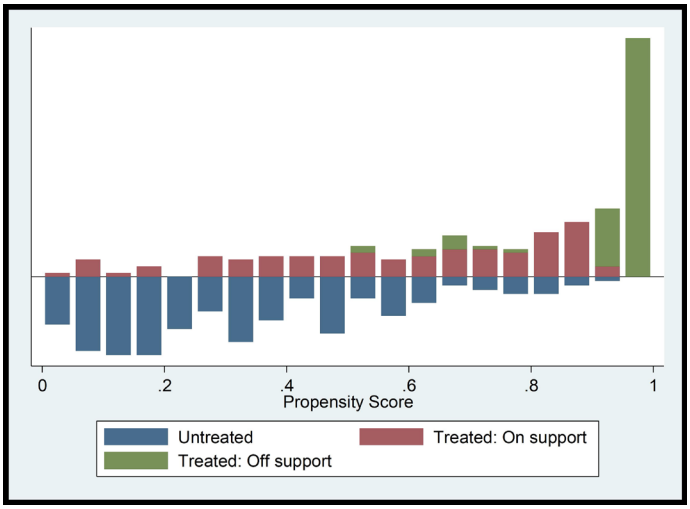

Figure 2. Untreated and treated across Off-support and On-support

4.1.2. Matching Algorithms of Participant and Non-Participant Households

The choice of the matching estimator was based on balancing qualities, including the equal means test, pseudo-R^2, and matched sample size (Dehejia & Wahba, 1999). Key criteria included pseudo-R^2, sample size after matching, standardized bias, and the number of insignificant variables (Caliendo & Kopeinig, 2005). Among the three algorithms, caliper matching with a 0.1 bandwidth was the most effective. It achieved the lowest pseudo-R^2 (0.012), minimal standardized bias (5.1%), and a matched sample size of 283. This method offers superior covariate balancing and bias reduction, making it the best choice for reliable impact assessment.

The balancing test assessed whether the mean values of pre-treatment characteristics differed significantly between the two groups, preferring no significant differences. Matching estimators were evaluated for balanced means (insignificant differences in all variables), low pseudo-R^2, and large matched sample sizes. After matching, mean differences in covariates were reduced, with a pseudo-R^2 of 0.012, indicating low systematic differences (Caliendo & Kopeinig, 2008). As shown in Tables 4.6 and Table 7, mean differences were statistically insignificant after matching, with p-values exceeding 5%, confirming that the balancing property was satisfied and supporting reliable impact assessment.

Table 7. Performances criteria of matching algorisms

Matching Algorisms	Performances criteria			
	Balancing test	**Pseudo- R2**	**Matched Sample Size**	**Mean SB**
Nearest Neighbor Matching				
Nearest Neighbor (1)	13	0.026	283	7.3
Nearest Neighbor (2)	12	0.025	283	7.6
Nearest Neighbor (3)	13	0.026	283	8.3
Nearest Neighbor (4)	13	0.027	283	8.4
Nearest Neighbor (5)	11	0.065	283	15.6
Radius Matching				
Radius (0.01)	13	0.034	223	10.2
Radius (0.1)***	13***	0.012***	283***	5.1***
Radius (0.25)	13	0.022	283	8.7
Radius (0.5)	10	0.095	283	15.3
Kernel Matching				
kernel bandwidth (0.01)	13	0.045	223	11.8
kernel bandwidth (0.1)	13	0.012	283	5.6
kernel bandwidth (0.25)	13	0.014	283	6.8
kernel bandwidth (0.5)	13	0.053	283	11.9

*Source: Own computation, survey data, (2024). **** Algorithm that fulfill the criteria*

4.3.3 Estimating Average Treatment Effect on the Treated (ATT)

The propensity score matching (PSM) analysis, utilizing the `psmatch2` command with radius matching and a bandwidth of 0.1, evaluated the impact of livelihood diversification on kilocalorie intake per adult equivalent (KcalAE) among rural households. The optimal matching estimator, which balanced more independent variables and achieved a low pseudo-R^2 with a large matched sample size, was identified as radius matching with a bandwidth of 0.1. Key findings indicate that education, household expenditure, and mutual credit group membership positively influence diversification, while livestock ownership, land size, and literacy negatively affect it. The average treatment

Table: 8. Balancing Test for Matching

Variable	Matching	Mean		% Reduct.		t-test	
		Treated	Control	% Bias	|bias|	t	p>|t|
Age	Unmatched	48.239	50.577	-28.8		-2.78	0.006
	Matched	49.153	49.394	-3.0	89.7	-0.24	0.808
Gender	Unmatched	.88995	.89571	-1.9		-0.18	0.859
	Matched	.87097	.88737	-5.3	-185.1	-0.39	0.693
Education	Unmatched	.79426	.2454	94.3		8.78	0.000
	Matched	.45161	.4475	0.7	99.2	0.06	0.950
FS	Unmatched	5.2297	5.1104	13.7		1.32	0.188
	Matched	5.2419	5.3682	-14.5	-5.9	-1.21	0.226
Credit	Unmatched	.64593	.47239	35.4		3.40	0.001
	Matched	.50806	.49239	3.2	91.0	0.25	0.806
LS	Unmatched	1.8732	2.1074	-47.8		-4.65	0.000
	Matched	1.9798	1.9751	1.0	98.0	0.08	0.938
Training	Unmatched	.69856	.67485	5.1		0.49	0.625
	Matched	.67742	.69803	-4.4	13.1	-0.35	0.727
Livestock	Unmatched	.42584	.84663	-97.0		-9.11	0.000
	Matched	.62097	.61399	1.6	98.3	0.11	0.910
Income	Unmatched	1.1e+05	98387	35.0		3.29	0.001
	Matched	1.1e+05	1.0e+05	13.6	61.2	1.01	0.315
Land Holding	Unmatched	.44498	.74233	-63.4		-6.02	0.000
	Matched	.59677	.6482	-11.0	82.7	-0.83	0.406
Experience	Unmatched	.74641	.39264	76.3		7.35	0.000
	Matched	.65323	.62635	5.8	92.4	0.44	0.661
Cooperative Member	Unmatched	.4689	.19632	60.3		5.69	0.000
	Matched	.37097	.36533	1.2	97.9	0.09	0.927
Dependency Ratio	Unmatched	.2262	.23517	-10.0		-0.96	0.338
	Matched	.23216	.2312	1.1	89.3	0.08	0.935

Source: Own Computation, (2024)

Table 9. Joint Balancing Test for Matching

Matching	Ps R2	LR chi2	p>chi2	Mean Bias	Med Bias	B	R	%Var
Unmatched	0.378	192.74	0.000	43.8	35.4	167.3*	2.56*	50
Matched	0.012	4.05	0.991	5.1	3.2	25.6*	1.56	17

Table 10. ATT Estimation Results: impact of Livelihood diversification on food security

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
KcalAE	Unmatched	2336.42105	1162.41871	1174.00234	66.395379	17.68
	ATT	2412.34879	1051.83468	1360.51411	102.547767	13.27

effect on the treated (ATT) revealed a significant increase in KcalAE of 1360.51 (S.E. = 66.39, T-stat = 13.27) for diversified households, highlighting the positive impact of livelihood diversification on food security.

5. CONCLUSIONS

Livelihood diversification is crucial for rural households to enhance their income sources, categorized into four strategies: on-farm alone, on-farm plus non-farm, on-farm plus off-farm, and a combination of all three. A multinomial logistic estimation model was employed to assess socio-economic, institutional, and demographic factors influencing these choices. Key determinants include the household head's age, education level, access to credit and training, cultivated land size, livestock holding, annual cash income, experience, cooperative membership, and dependency ratio.

Findings reveal that on-farm alone is negatively influenced by factors such as age, male-headed households, and family size, while positively affected by education and livestock holding. The on-farm plus non-farm strategy is negatively influenced by family size and land size but positively by education and credit access. The on-farm plus off-farm strategy also faces negative impacts from education and family size, yet positively influenced by training access and dependency ratio. Overall, 43.82% of households rely solely on farming, indicating a significant push towards diversification for economic stability and food security.

RECOMMENDATIONS

Based on the findings, the researcher recommends that households expand low-investment livelihood strategies, such as poultry and animal husbandry, while commercializing traditional practices. Local plans should promote a shift from traditional food crops to cash crop production, with agricultural offices facilitating a balance between the two. Additionally, enhancing access to credit for rural households will enable them to invest in both farm and non-farm activities, thereby improving their living standards. Local governments should advocate for policies that consider the unique contexts of communities, and a rural diversification policy should be developed to boost production and meet market demands. Promoting educational programs will enhance farmers' skills in diverse activities, and offering financial assistance will support those engaging in off-farm and non-farm ventures.

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