ORIGINAL ARTICLE

Assessing Rural Household Livelihoods and Diversification Strategies in Northeast Ethiopia

Sisay Demeke Molla[1], Menberu Teshome Zeleke[2], Sisay Misganaw Tamiru[3] & Getnet Zeleke Tessera[4]

Abstract

Diversification allows livelihoods to be more resilient against all forms of shocks. This study assessed rural household livelihoods and diversification strategies in Raya Kobo District, Northeast Ethiopia. A convergent parallel research design combined with a mixed study approach was employed. The quantitative data were collected from 354 randomly selected respondents, while the qualitative data were collected from purposefully chosen FGDs and KIs. The statistical techniques used include descriptive statistics to analyse livelihood options, the Simpson index of diversity for calculating the livelihood diversification index, and a multinomial logistic regression model to identify livelihood strategy determinants. Qualitative data were analyzed thematically. The results indicate that farm and non-farm activities are feasible livelihood strategies, but farm activity is the dominant livelihood strategy. Households from lowland agro-ecologies had more diversified livelihoods than those in highland and midland agro-ecologies because of better asset accessibility. Agroecology, education, crop farm size, TLU, and social services are positive determinants of livelihoods, whereas dependency ratio, conflicts, ex-coping strategies, and pest attacks are negative determinants. This study has policy implications for achieving sustainable livelihoods.

Keywords: Determinants; Diversification; Livelihoods; Resilience; Vulnerability

1. Introduction

Livelihood would refer to the ways of living, putting stress on processes of earning a living rather than just outcomes like income or consumption. It involves income, social

1 *PhD, Department of Political Science and International Relations, Woldia University, Woldia, Ethiopia. E-mail: demekesisay9@gmail.com; Phone: +251928858849; P.O. Box: 400*

2 *PhD, Department of Geography and Environmental Studies, Debre Tabor University, Debre Tabor, Ethiopia, menberuteshome@gmail.com; Phone: +251930295752; P.O. Box: 272*

3 *PhD, Department of Development and Environmental Management Studies, University of Gondar, Gondar, Ethiopia. E-mail: sisymis27@gmail.com; phone: +251911888625; P.O. Box: 196*

4 *PhD, Department of Geography and Environmental Studies, Woldia University, Woldia, Ethiopia. E-mail: getnetzelke@gmail.com; phone: +251922888653; P.O. Box: 400*

DOI: https://dx.doi.org/10.4314/erjssh.v11i2.1

structures, gender dynamics, property rights, and access to public services (Scoones, 2013; Jones & Tanner, 2017; Quandt, 2018; Quandt, 2019; Nasrnia & Ashktorab, 2021; Quandt & Paderes, 2023). More than providing employment and income, livelihoods are also about identity and social belonging. A livelihood is considered sustainable if it can withstand stresses and shocks while providing the possibilities for the coming generations (Quandt, 2019; Nasrnia & Ashktorab, 2021). Rural households commonly combine different livelihood assets and farm and non-farm income sources in endeavours to achieve outcomes such as improved income, reduced vulnerability, enhanced well-being, better food security, and sustainable use of resources (Maru et al., 2021).

The choice and implementation of livelihood diversification strategies are shaped by factors such as demographics, agro-ecological conditions, and access to assets (Sati et al., 2014; Jones & Tanner, 2017; Quandt, 2019; Wassie et al., 2023; Zeleke et al., 2023; Quandt & Paderes, 2023). Access is considered one of the major determinants shaping household livelihood strategies in Ethiopia. Institutions, land ownership policies, and shocks due to health crises and natural disasters, added to economic and political challenges, shape the strategy for livelihood options (Sati et al., 2014; Jones & Tanner, 2017; Quandt, 2019; Quandt & Paderes, 2023). The major binds are unfavorable seasonal changes in price, production, and employment prospects. These in turn create long-term effects on Ethiopian livelihoods, especially within the study areas, and need urgent and complete attention so that future generations will not suffer under the same stressful conditions (Scoones, 2013; Asfaw et al., 2021; Savari et al., 2023).

There are a few studies on livelihood issues in Ethiopia. Siyoum (2012); for example, researched broken promises: food security interventions and rural livelihoods in Ebinat district. Gemechu (2016) also conducted a study in Bale regarding the interdependence of livelihood strategies and natural resources. Eneyew and Bekele (2012), Gecho et al. (2014), and Asfir (2016) examined determinants of rural households' livelihood strategies in Wolaita and Western Ethiopia, respectively. Ayele (2019) explored challenges to rural livelihoods in Gedeo. Gebru and Beyene (2012) examined rural household livelihood strategies in Tigray's drought-prone areas. Adamseged et al. (2019) investigated the dynamics of rural livelihoods and rainfall variability in Ethiopia's Northern Highlands. Hermans and Garbe (2019) in northern Ethiopia also investigated droughts, livelihoods, and human migration.

Despite their contributions, these studies reveal empirical gaps. They fail to address the relative importance of income variables in diversification and overlook key determinants and challenges of livelihood strategies. Crucial factors such as farmland management practices, peace and security, ex-post coping strategies, and infrastructure development highlighted as essential in rural livelihood studies (Jones & Tanner, 2017; Quandt, 2018) remain unexplored. Thus, it is so challenging to have in-depth knowledge of the livelihood situations of rural families (Scoones, 2013; Savari et al., 2023). Furthermore, other geographical areas of Ethiopia, particularly the present study setting and the lives of impoverished families in farming communities, were not sufficiently covered in these academic publications. For instance, those who studied about the livelihoods of households under drought conditions did not address the present study setting households livelihood situation; however, due to variations in local livelihood assets, income sources, adaptation strategies (Zeleke et al., 2023; Wassie et al., 2023), resilience thinking, and the dynamic nature of resilience (Quandt, 2018), there are differences in overall livelihood scenarios in various locations. This attested that livelihood study is context-specific.

This study aims to fill these gaps by assessing livelihoods and diversification strategies of rural households in Raya Kobo district. Its objectives are to assess the options for liveli-

hood strategies, measure the level of diversification, and determine the factors affecting diversification strategies. Its findings are believed to offer insight into rural livelihood choices, diversification status, and determinants that enhance useful practical insights for policy interventions and new opportunities for research. The SLF was used as the conceptual framework in this study. It is widely used in poverty alleviation, people-centered approaches, and sustainability literature (Scoones, 2013; Sati et al., 2014). SLF looks into how people build their livelihoods. It amalgamates the different livelihood assets and shows the interaction between vulnerabilities, transformative structures, and livelihood outcomes (Alinovi et al., 2010; Quandt & Paderes, 2023).

2. Materials and methods

2.1. Description of the Study Area

The study district is located in North Wollo Zone of AmharaNational Regional State,l. it is found between latitudes 11°30'00" to 12°30'00" N and longitudes 38°30'00" to 40°30'00" E. It shares borders with Gubalafto to the south, Gidan to the west, Tigrai Region to the north, and Afar Region to the east. The district has different agro-ecologies: Kolla, Woina-Dega, and Dega, and the selected Kebeles (Aradom, Tekulesh, and Zobel) have been taken to represent these zones and good agricultural potential. It experiences three seasons: Bega, Belg, and Keremt, with the annual bimodal rainfall ranging between 500 and 800 mm. The temperature ranges from 12 to 33°C. Soils are predominantly leptosols (71.8%), followed by vertisols (21%), cambisols (7%), and acrisols (0.2%). There is a population of 365,603 people (51% male and 49% female), of which 82% are Ethiopian Orthodox Christians, 16% Muslims, and a small minority Protestants. Amharic is the most dominantly used language. Agriculture, mainly subsistence-level mixed crop-livestock farming, is the economic backbone (District Agriculture Office, 2019; Molla et al., 2024).

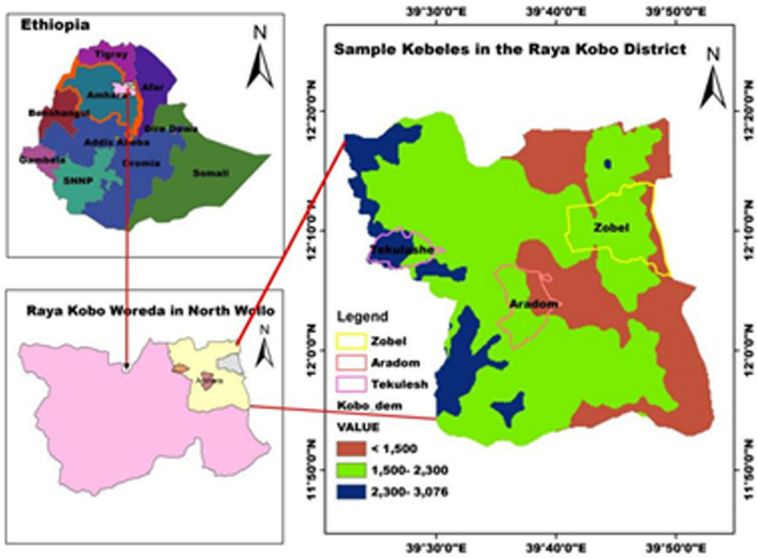

Figure 1: Study Area Map (accessed from https://www.diva-gis.org/gdata)Figure 1: Study Area Map (accessed from https://www.diva-gis.org/gdata)

2.2. Research Approach, and Design

The study employed a mixed-methods research approach. Data on demographic characteristics, livelihood strategies, diversification status, and diversification strategy determinants were quantitatively addressed. Data concerning livelihood challenges and coping/ adaptation strategies were addressed qualitatively. The combination of methods makes it easier to employ a variety of techniques to gather information, gives a more realistic view of the issue, gets rid of flaws, and effectively handles topics of study. A convergent parallel research design was employed as it allows for data collection from both quantitative and qualitative sources concurrently and gives equal priority to quantitative and qualitative data.

2.3. Sampling, Data Type and Data Sources

The study region was purposefully selected as it faces many challenges to people's livelihoods as a result of manmade and natural disasters. With the employment of stratified sampling, it was divided into Kolla, Woina-Dega, and Dega because households in similar agro-ecologies have comparable opportunities and indigenous knowledge to manage resources. Three kebeles overall, one from each agro-ecology, were chosen by a stratified random sampling method.Thus, from Dega Tekulesh, from Woina-Dega Zobel, and from Kolla Aradom were selected (Table 1). A proportional stratified random sampling method was employed to select sample household heads. The following Kothari's sample size determination formula (2004) was employed in that the population is large, and a large sample size is required to analyse the proportion:

$$n = \frac{Z^2 * P * Q * N}{e^2(\mathrm{N}-1) + Z^2 * \mathrm{P} * \mathrm{Q}}$$

Where n represents sample size, z is confidence level, p stands for estimated proportion,

q is 1 – p, N is population size, and e stands for allowable error.

Table 1: Sample kebeles, and number of total and sample households

Agro-ecologies	Rural Kebeles	Total households	Sample Households	Questionnaires Not Returned
Dega	Tekulesh	2139	120	2
Woina-Dega	Zobel	2162	121	3
Kolla	Aradom	2172	122	4
	Total	6,473	363	9

Source: Kebele Administration Office (2022)

The questionnaires were distributed to 363 respondents, but only 354 observations were returned for analysis (Table 1). FGDs were held with purposefully chosen discussants. There were two FGDs per agro-ecology, so six FGDs were totally conducted. Eight household heads participated in each group. Pieces of information were collected from group interviews and KIs. So, participants in local activities and those who had prior experience with interviews were chosen. The discussants were informed and communicated for discussion through Kebele administrators and development agents. In-depth interviews with purposefully chosen life history narratives were conducted to acquire personal histories. Overall, six participants, two from each agro-ecology, were selected. Interviews with purposefully chosen agricultural, health, emergency, and food security experts from the district were also undertaken. These experts work cooperatively with the community and have better experience with climate change, agricultural activities, and livelihood conditions. Totally,three experts, one from each sector, were selected. Interview guides, video recording, and note-taking methods were used during the interviewing of FGDs and KIs. Office data, research reports, and internet sources were secondary data sources.

2.4. Data Analysis Techniques

Household livelihood strategies were presented using descriptive statistics. For identifying factors affecting household choices among the livelihood strategies, an MLR model was employed as the dependent variable which had more than two categories (Table 2). Due to unfavourable conditions, it was difficult to determine the household's annual income from different livelihood sources. Both personal observation and participant data suggested that households couldn't accurately report their annual income from supplemental sources, except for primary ones. The Livelihood Diversification Index was measured by using the SID method due to its simplicity, robustness, and wide applicability. Qualitative data on livelihood strategies, diversification, associated challenges, and coping/adaptation strategies were analyzed thematically, followed by triangulation for validation.

Table 2: Independent and dependent variables under multinomial logistic regression model

DV: Livelihood strategy choices	**Categorical: 1 On-farm 2 Non-farm 3 Off-farm**	
IVs	Variable description and measurement	Expected sign
Agro-ecology	Categorical (1= Dega 2= Woina-Dega 3= Kolla)	+
Sex	Dummy (1 male 2 female)	+
Marital status	Categorical: (1 single 2 married 3 divorced 4 widowed)	+
Age	Continuous (number of years of birth of the HH)	±
Educational status	Continuous (attained educational status in years)	+
Household size	Continuous (number of household members)	+
Crop farm size	Continuous (total farm size in Timad)	+
Land plots	Continuous (number of land plots)	+
Farmland management practices	Dummy (1 yes 0 otherwise)	+
Livestock holding	Continuous (TLU): camel = 1, cattle = 0.7, horse = 0.8, mule = 0.7, donkey = 0.5, sheep/goat = 0.1, chicken = 0.01 (Asfaw et al., 2021)	+
Access to agricultural inputs	Dummy (1 yes 0 otherwise)	+
Access to extension services	Dummy (1 yes 0 otherwise)	+
Access to social services	Dummy (1 yes 0 otherwise)	+
Access to credit services	Dummy (1 yes 0 otherwise)	+
Conflict over resources	Dummy (1 yes 0 otherwise)	_
Coping strategies	Dummy (1 yes 0 otherwise)	_
Adaptation strategies	Dummy (1 yes 0 otherwise)	+
Dependency ratio	Continuous (number of household members aged under 15 & over 64, divided by total members aged 15-64)	_

2.4.1. Multinomial Logistic Regression Model Specification

The choices of livelihood strategies were analyzed using multinomial logistic regression. This model is particularly suitable to explain the socioeconomic, biophysical, and institutional characteristics of the household, especially in analyzing relationships involving multiple mutually exclusive choices and independent variables (Greene 2000). The decision-making process of whether or not to adopt a particular livelihood strategy is framed within a utility or profit maximization model (Deressa et al., 2009). In this context, though the utility or net benefit of a livelihood activity is not directly observable, the effects of

household decisions on livelihood strategies can be inferred from their preferences. The model assumes that utilities Uj and Up are the two preferences represented by βj and βp, respectively. Specification follows a linear random utility/net benefit model, as below.

$$Uj = \beta jXi + \varepsilon j \text{ and } Up = \beta jXi + \varepsilon p \quad (2)$$

Where; Uj and Up are perceived utilities of adaptation strategies j and k, respectively, Xi is the vector of explanatory variables which influenced the perceived desirability of each strategy, βj and βp are the estimated, and εj and εk are error terms assumed to be independently and identically distributed (Greene, 2000). To describe the MNL model implicitly, consider a rational household that seeks to maximize the present value of the expected benefits of production over a specified time horizon, and must prefer among a set of livelihood strategies. The household i decide to choose j livelihood strategy, if the perceived benefit from j is greater than that from other livelihood strategies (say p) depicted as:

$$Uij (\beta j; Xi + \varepsilon j) > Uip (\beta p; Xi + \varepsilon p), p \neq j \quad (3)$$

Where: Uij and Uip = Perceived choice of household to livelihood strategies j and p, respectively; Xi = Vector of explanatory variables that influence the preference for livelihood strategies; βj and βp = Estimated parameters. εj and εk = Error terms. The probability that a farm household head i choose livelihood strategy j among a set of livelihood strategies is defined as:

$$P (y = 1/x) = P (Uij > Uip)/X \quad (4)$$
$$= P [(\beta 1Xi + \varepsilon i - \beta 1pXi - \beta p) > 0/X]$$
$$= P [(\beta 1j - \beta 1p) Xi + (\varepsilon j - \varepsilon p) > 0/X]$$
$$= P [(\beta^* Xi + \varepsilon^* > 0/X) = F (\beta^* Xi)$$

Where P = probability function; Uij, Uik and Xi are as defined above; Uij, Uik and Xi are as defined above; ε* = εj – εp is a random disturbance term; β*= β1j – β1p is a vector of unknown parameters influencing preference of a strategy; F (β*Xi) is a cumulative distribution function of ε* evaluated at β*Xi. The probability that a household would choose livelihood strategy j among the set of multiple livelihood strategies was then be implicitly expressed as:

$$Yi = \beta o + (\beta Ij + \beta 1p) X1 + (\beta 2j + \beta 2p) X2 + - (\beta 3j + \beta 3p) X3 + e \quad (5)$$

Where Yi = Preferred choice of livelihood strategies; β0 = intercept; βj (i-3) and βp (i-3) = estimated parameters; X1-3 = independent variables; j= chosen livelihood strategy; p = other livelihood strategies; i = 1, 2, 3 number of livelihood strategies; e = Error term. The result using the multinomial logistic regression model is a chi-square value of 500.314 with 340 degrees of freedom and a p-value of 0.000. Deviance and Pearson tests have the Chi-square values of 225.666 and 324.229, respectively, with 366 degrees of freedom and significance of 1.000. Pseudo-R-square (Nagelkerke) showed that the model explained 86.8% of the variance of the dependent variable. It correctly predicted 91.2% of on-farm, 91.7% of non-farm, and 74.6% of off-farm livelihood activities. A total of 88.4% of cases were correctly classified, hence showing the efficacy of the model in predicting the dependent variable. No multicollinearity issues were detected among independent variables (Table 12).

The Simpson index of diversity (SID) was used to calculate the livelihood diversification index (LDI) (Eq. 2).

$$SID = 1 - \sum_{i=1}^{N} {P_i}^2 = 1 - \left({P_1}^2 + {P_2}^2 + {P_3}^2 + \cdots + {P_N}^2\right) \quad 6$$

$$SID = 1 - \sum_{i=1}^{20} \left(\left(\frac{C}{Ti}\right)^2 + \left(\frac{VF}{Ti}\right)^2 + \left(\frac{H}{Ti}\right)^2 + \left(\frac{A}{Ti}\right)^2 + \left(\frac{M}{Ti}\right)^2 + \left(\frac{CH}{Ti}\right)^2 + \left(\frac{SG}{Ti}\right)^2 + \left(\frac{NF}{Ti}\right)^2 + \left(\frac{PT}{Ti}\right)^2 + \left(\frac{PI}{Ti}\right)^2 + \left(\frac{GP}{Ti}\right)^2 + \left(\frac{LT}{Ti}\right)^2 + \left(\frac{HC}{Ti}\right)^2 + \left(\frac{OP}{Ti}\right)^2 + \left(\frac{R}{Ti}\right)^2 + \left(\frac{PS}{Ti}\right)^2 + \left(\frac{LB}{Ti}\right)^2 + \left(\frac{FW}{Ti}\right)^2 + \left(\frac{FD}{Ti}\right)^2 + \left(\frac{FO}{Ti}\right)^2 \right)$$

Where N is the total number of income sources, Pi denotes the income proportion of the ith income source. Income components include crop production (C), vegetables and fruits (VF), honey (H), animal fattening (A), milk (M), chicken sales (CH), sheep and goats (SG), non-farm wages (NF), petty trading (PT), property income (PI), grains and pulses trading (GP), livestock trading (LT), handcrafts (HC), renting pack animals (OP), remittance (R), PSNP (PS), local beverages (LB), farm wages (FW), firewood/charcoal sales (FD), and fodder sales (FO) (Saha et al., 2010; Ahmed et al., 2018). The SID value ranges from 0 (complete specialization) to 1 (maximum diversification). The study's reliability was ensured through pretesting and piloting, validation was checked by researchers, readers and experts. Trustworthiness was maintained via credibility, transferability, dependability, confirmability, and member checking. Triangulation incorporated academic literature and qualitative and quantitative data.

3. Results

3.1. Respondents' Demographic Characteristics

Across all studied agro-ecologies, 61.6% of respondents were male and 38.4% female. Age distribution showed 6.2% under 25, 19.5% aged 36–45, 10.7% aged 46–55, 17.8% aged 56–65, and 7.6% over 65. 61.9% were illiterate, 20.6% could read and write, 13.8% were in grades 1–4, and 3.7% were in grades 5–8. Marital status showed 3.9% single, 74.6% married, 9.6% divorced, and 11.9% widowed. Family sizes comprised 23.2% with fewer than 3 members, 33% with 3–6, 29.7% with 7–10, and 14.1% with more than 10 (Table 3).

Table 3: Respondents' demographic characteristics

Demographic variables		Dega N= 118		Woina-Dega N= 118		Kolla N = 118		Total N = 354	
		N	%	N	%	N	%	N	%
Gender	Male	74	62.7	68	57.6	76	64.4	218	61.6
	Female	44	37.3	50	42.4	42	35.6	136	38.4
Age	<25	7	5.9	6	5.1	9	7.6	22	6.2
	25-35	44	37.3	48	41	43	36.4	135	38.1
	36-45	25	21.2	18	15	26	22.1	69	19.5
	46-55	11	9.3	13	11	14	11.9	38	10.7
	56-65	20	16.9	24	20.3	19	16.1	63	17.8
	>65	11	9.3	9	7.6	7	5.9	27	7.6
Education	Illiterate	81	68.6	74	62.7	64	54.2	219	61.9
	Read & write	21	17.8	25	21.2	27	22.9	73	20.6
	Grade 1-4	13	11	15	12.7	21	17.8	49	13.8
	Grade 5-8	3	2.5	4	3.4	6	5.1	13	3.7
	Grade 9-12	-	-	-	-	-	-	-	-
Marital status	Single	4	3.4	4	3.4	6	5.1	14	3.9
		96	81.4	86	72.9	82	69.5	264	74.6
	Married	9	7.6	12	10.2	13	11	34	9.6
		9	7.6	16	13.5	17	14.4	42	11.9
	Divorced								
	Widowed								
Family size	<3	32	27.1	28	23.7	22	18.6	82	23.2
	3-6	35	29.7	39	33.1	43	36.4	117	33
	7-10	34	28.8	33	28	38	32.2	105	29.7
	>10	17	14.4	18	15.2	15	12.7	50	14.1

Source: Survey data (2022)

3.2. Rural Household Livelihood Strategies

The major sources of income for households in the study area are on-farm livelihood strategies, largely crop and livestock production. Table 4 shows the type of crops produced. Producing sorghum is the dominant main livelihood strategy; hence, the region is known as the Sorghum Belt. This would imply that the area is drought-prone since sorghum is adapted to rain scarcity.

Table 4: Crop production types by agro-ecology

Options	Dega		Woina-Dega		Kolla	
	N	%	N	%	N	%
Sorghum	82	69.5	102	86.4	64	56.6
Maize	43	36.4	54	45.8	36	31.9
Teff	32	27.1	50	42.4	59	52.2
Barley	61	51.7	49	41.5	-	-
Wheat	43	36.4	37	31.4	-	-
Chickpea	-	-	31	26.3	36	31.9
Beans	53	44.9	13	11.0	-	-
Peas	49	41.5	45	38.1	-	-
Lentil	55	46.6	47	39.8	-	-
Pulse	54	45.8	39	33.1	-	-
Vegetables	32	27.1	12	10.2	49	43.4
Fruits	20	16.9	13	11.0	42	37.2
Khat	-	-	20	16.9	-	-

Source: Survey data (2022); NB: the total is not 100 percent because of multiple responses.

The study analyzed crop production by harvest seasons: 78.8%, 48.3%, and 39.8% of the households produce 0 to 5 quintals during poor harvests in Dega, Woina-Dega, and Kolla, respectively. In all agro-ecologies (Table 5), the number of households producing 0 to 5 quintals increases during bad harvests, reflecting crop yield failure due to reduced rainfall.

Table 5: Crop production during good, normal, and bad harvesting seasons

	Dega			Woina-Dega		Kolla			
Seasons	Quintal	Count	%	Count	%	Count	%	Total	%
Good harvesting seasons	0-5	10	8.5	4	3.4	5	4.2	19	5
	6-10	27	22.9	11	9.3	7	5.9	45	13
	11-15	33	28	10	8.5	4	3.4	47	13
	16-20	18	15.3	21	17.8	30	25.4	69	19
	21-25	9	7.6	24	20.3	27	22.9	60	17
	26-30	10	8.5	27	22.9	23	19.5	60	17
	31-35	3	2.5	8	6.8	9	7.6	20	6
	≥36	8	6.8	13	11	13	11	34	10
	Total	118	100	118	100	118	100	354	100

Normal harvesting seasons	0-5	30	25.4	12	10.2	12	10.2	54	15
	6-10	60	50.8	26	22	17	14.4	103	29
	11-15	15	12.7	39	33.1	34	28.8	88	25
	16-20	5	4.2	23	19.5	26	22	54	15
	21-25	5	4.2	12	10.2	17	14.4	34	10
	26-30	-	-	2	1.7	6	5.1	8	2
	31-35	3	2.5	4	3.4	6	5.1	13	4
	≥36	-	-	-	-	-	-	-	-
	Total	118	100	118	100	118	100	354	100
Bad harvesting seasons	0-5	93	78.8	57	48.3	47	39.8	197	57
	6-10	15	12.7	28	23.7	26	22	69	19
	11-15	6	5.1	18	15.3	25	21.2	49	13
	16-20	2	1.7	9	7.6	10	8.5	21	6
	21-25	2	1.7	3	2.5	5	4.2	10	3
	26-30	-	-	3	2.5	5	4.2	8	2
	31-35	-	-	-	-	-	-	-	-
	≥36	-	-	-	-	-	-	-	-
	Total	118	100	100	100	118	100	354	100

Source: Survey data (2022)

FGDs characterized harvesting seasons as good, normal, and bad. A good season occurs when rainfall is good in both the Belg and Keremet seasons; yield is high. During a normal season, rainfall is moderate in both periods of time, so harvests are also moderate. In bad seasons, there is an absence of rain, and hence, low or no yields and income collapse, food shortage, food insecurity, poverty, and livelihood vulnerability. Households cope through diversification into non-farm sources of income like remittances and the sale of natural resources like charcoal and firewood. Most households realized poor crop yields in 2022 owing to the insufficient rainfall experienced in 2021. Other factors include the small sizes of farms, climate variability, limited availability and access to inputs, attacks by pests, and shortages of labour brought about by migration and fear of war in late 2021. FGDs noted that those with bigger farms, more than two timad, usually record better yields. Despite these, crop production remained the most relied on for livelihood while livestock rearing supplemented them. Livestock supported crop production through income and food, improving nutrition while enhancing food security, livelihood diversification, and poverty reduction (Table 6).

Table 6: The type of livestock sample households owned

Options	**Dega**		**Woina-Dega**		**Kolla**	
	N	**%**	**N**	**%**	**N**	**%**
Oxen	81	73.6	92	78.0	95	81.2
Cows	42	38.2	54	45.8	53	45.3
Heifers	31	28.2	46	39.0	43	36.8
Calves	35	31.8	48	40.7	46	39.3
Sheep	48	43.6	49	41.5	35	29.9

Goats	60	54.5	60	50.8	41	35.0
Donkeys	40	36.4	52	44.1	62	53.0
Horses	-	-	-	-	16	13.7
Camels	20	18.2	61	51.7	75	64.1
Hens	54	49.1	58	49.2	56	47.9
Chickens	35	31.8	34	28.8	47	40.2
Bee keeping	25	22.7	20	16.9	9	7.7

Source: Survey data (2022); NB: the total is not 100 percent because of multiple responses.

Table 7 presents the number of respondents, and the mean, standard deviation, minimum and maximum TLUs per household. The mean TLU values reflect great variability in the extent of livestock holding between households.

Table 7: Mean of Tropical Livestock Units

Respondents' agro-ecologies	Mean	N	Std. Deviation	Minimum	Maximum
Dega	5.98	118	3.040	1	10
Woina-Dega	7.60	118	2.160	1	11
Kolla	7.54	118	2.241	1	11
Total	7.04	354	2.615	1	11

Source: Survey data (2022)

The livestock industry improves household income, consumption levels, and food security by yielding products like meat, milk, honey, eggs, and skin (Table 8).

Table 8: Sample households' responses about animal products

	Dega		Woina-Dega		Kolla	
	N	%	N	%	N	%
Meat production	55	57.9	55	53.4	29	32.2
Milk production	35	36.8	48	46.6	46	51.1
Honey production	25	26.3	20	19.4	9	10.0
Egg production	51	53.7	59	57.3	51	56.7
Others (specify)	12	12.6	7	6.8	5	5.6

Source: Survey data (2022); NB: the total is not 100 percent because of multiple responses.

FGDs in Woina-Dega reported that livestock contribute to food at the household level, manure for the farms, and energy. KIs from the food security office said that livestock provide income, security during crop failure, and a means of accumulating wealth; thus, they are vital in the development of sustainable livelihoods and as a primary livelihood strategy. However, FGDs in Kolla emphasized that the contribution of livestock production to human consumption is minimal due to climate variability, unreliable rainfall, and fodder shortages, lack of inputs and expertise, and large household sizes. Households were also involved in different off-farm income activities (Table 9).

Table 9: The off-farm income sources of sample households

Options	**Dega**		**Woina-Dega**		**Kolla**	
	N	**%**	**N**	**%**	**N**	**%**
Wage labour/sale of agricultural labour	5	5.2	5	5	4	4.6
Labour payments in kind/harvest share	16	16.5	16	16	14	16.1
Other non-wage labour contracts	13	13.4	12	12	12	13.8
Livestock herding in other farmers' homes	13	13.4	8	8	1	1.1
Keeping people's livestock in one's own home	15	15.5	12	12	14	16.1
Fire wood and/or charcoal selling	33	34.0	38	38	20	23.0
Traditional basket making	13	13.4	17	17	20	23.0
Selling grass/fodder	35	36.1	33	33	43	49.4
Wood selling	27	27.8	31	31	18	20.7

Source: Survey data (2022); NB: the total is not 100 percent because of multiple responses.

FGDs in Dega also reported that the off-farm activities were important sources of employment, income, and livelihoods. Selling grass/fodder and firewood and/or charcoal were the dominant off-farm activities practiced. Households also engaged in various non-farm income sources (Table 10).

Table 10: The non-farm income sources of sample households

Options	Dega		Woina-Dega		Kolla	
	N	%	N	%	N	%
Non-farm wage employment	28	28.9	24	20.3	21	18.9
Non-farm self-employment/ petty trading	23	23.7	31	26.3	34	30.6
Property income/house or farmland rents	11	11.3	28	23.7	25	22.5
Grains and pulses Trading	16	16.5	38	32.2	36	32.4
Livestock Trading	22	22.7	37	31.4	35	32.5
Weaving/spinning	-	-	-	-	30	27
Carpentry/woodworking	13	13.4	19	16.1	17	15.3
Pottery	22	22.7	35	29.7	7	6.3
Blacksmithing/metal working	22	22.7	23	19.5	7	6.3
Traditional healings	9	9.3	8	6.8	8	7.2
Renting out pack animals	-	-	10	8.5	15	13.5
Urban-to-rural migration	11	9.3	10	8.5	6	5.1
International migration	45	38.1	57	48.3	49	41.5

Source: Survey data (2022); NB: the total is not 100 percent because of multiple responses.

FGDs in Kolla and KIs from the district health office emphasized that non-farm income sources improve livelihood security and raise living standards. KIs from the health office and FGDs in Woina-Dega noted that households with several non-farm activities show higher income levels, and therefore, capital accumulation in order to satisfy basic needs and public services access more than by those with limited engagement in this sector. FGDs from all agro-ecologies reported that diversification into non-farm activities helps households cope with poverty and reduce the risks of climate change.

3.3. Livelihood Diversification Status

By using various income sources, household annual income was calculated, and LD status was measured by SID (Eq. 2). The SID results were 0.4512 in Dega, 0.2980 in Woina-Dega, and 0.7358 in Kolla (Table 11). Households in Kolla had a higher SID than those in Dega and Woina-Dega. The various scenarios for contextualizing this situation presented by the researchers are the role of different income variables shaping LD status, better accessibility to infrastructure development, the potential of surface and ground water resources and irrigation infrastructure development, and the role of government and development partners. The estimated SID of households in Woina-Dega was lower than households in Dega because households in Woina-Dega prominently depend on crop and livestock income and remittances. The overall average score of SID was 0.4950, showing that households had a low level of diversification.

Table 11: Households' livelihood diversification status

Agro-ecologies	Mean	N	Std. Deviation	Minimum	Maximum
Dega	.4512	118	.09344	.12	.75
Woina-Dega	.2980	118	.24819	.00	.73
Kolla	.7358	118	.15721	.09	.89
Total	.4950	354	.25394	.00	.89

3.4. Determinants of Diversification Strategies

Other variables being constant, for a unit increase in level of education, the odds of households' engagement in on-farm activities increase by a factor of 3.048 at $P < 0.05$ as compared to off-farm activities (Table 12). KIs noted that those who are better educated have more livelihood options than those who are not educated. Furthermore, other variables being constant, every one-unit increase in crop farm size increases households' participation in on-farm activities by a factor of 1.119 at $P < 0.05$, particularly in comparison to off-farm activities (Table 12). Nevertheless, FGDs reported that large crop farm sizes, which are highly degraded, and even households that cannot obtain additional capital investment, labour inputs, or agricultural inputs such as improved seeds, pesticides, herbicides, and chemical fertilizers suffer greatly.

Farmland management practices positively and significantly determine households' engagement in on-farm practices (Table 12). KI from the agricultural office and FGDs in Dega, Woina-Dega, and Kolla confirmed that those households that properly manage their farmlands, such as soil and water conservation practices, significantly increase farm productivity. Besides, as the number of livestock increases by one unit in TLU, the likelihood of households decisions to engage in on-farm livelihoods increases by a factor of 2.305

at $p < 0.01$ (Table 12). FGDs in all agro-ecologies reported that the higher the livestock holdings, the more income generated from livestock and the more livelihood options available. Access to extension services also increases households' decisions to participate in on-farm activities by an odds ratio of 1.586 in comparison with those households' lack of access to extension services (Table 12). Extension services regarding farmland management and agricultural intensification substantially support rural households' livelihood strategies, as per the KIs. KIs and FGDs also noted that extension services are vital but less accessible in the study areas.

Furthermore, an increase in the number of family members in the household by one unit increases the likelihood of a household's decisions to participate in on-farm activities by a factor of 1.990 (Table 12). FGDs and KIs articulated that the larger the household, the more engaged in various on-farm income sources and the more secured livelihoods. Additionally, the personal observations attested that conflicts provoked psychological distress and increased the risk of death, illegal migration, and vulnerability. Due to interests in power monopoly and control over resources, the Tigraian People Liberation Front (TPLF)-led Tigraian invading forces opened war on the Amhara people at the end of 2021 and 2022. Consequently, private property was looted and destroyed; labourers were slaughtered while the rest of the population was displaced; houses, home gardens, and crops were burned; and explosive weapons devastated forest areas. Public infrastructures were all destroyed. The war resulted in livestock deaths and crop yield declines due to farmers' failure to sow and harvest on time, and all this had a widespread impact on people's livelihoods. The statistical evidence supported these observations (Table 12). FGDs and KIs vehemently condemned the war's overwhelming effect on people's lives and livelihoods.

Table 12: Determinants of diversification strategies

DV	IVs	Coeff.(β)	S.E.	Wald	Sig.	Odds ratio
On-farm activities	Woina-Dega	1.510	0.274	8.194	0.004**	2.104
	Kolla	1.242	0.157	5.807	0.016*	1.036
	Education	1.575	0.817	5.450	0.020*	3.048
	Farm size	0.736	0.061	4.281	0.022*	1.119
	Livestock holding	0.956	0.255	7.741	0.000**	2.305
	Extension services	0.253	0.424	14.572	0.000**	1.586
	Dependency ratio	-1.250	0.611	4.069	0.044*	0.139
	Household size	0.650	0.344	4.298	0.030*	1.990
	Management	0.228	0.788	8.553	0.003**	1.301
	Conflicts	-0.832	0.010	8.416	0.004**	0.137
	Social services	1.040	0.461	4.328	0.037*	1.148
	Credit services	1.636	0.695	5.546	0.019*	1.195

Non-farm activities	Woina-Dega	1.308	0.189	7.038	0.008**	3.906
	Kolla	1.516	0.473	5.970	0.014*	1.155
	Age	0.819	0.839	4.999	0.025*	1.185
	Dependency ratio	-1.919	0.853	10.204	0.001**	0.238
	Ex-post coping	-0.629	0.626	16.617	0.000**	0.132
	Social services	1.492	0.632	11.322	0.001**	1.141
	Credit services	1.429	0.771	9.917	0.002**	1.088

*Significant at 0.05, **Significant at 0.01

It was found that locations in Woina-Dega and Kolla increase the odds of participating in on-farm and non-farm activities, as compared to Dega (Table 12). The participants reported that Woina-Dega and Kolla are better in soil fertility, crop farm size, farm inputs, labour availability, and remittances. FGDs in Kolla described that their locality has potential for ground and surface water resources. Moreover, a one-unit increase in the age of the household head increases the probability of diversification, a fact that as age increases, so do households experience and diversification skills, as compared to off-farm income sources (Table 12). Coping strategies (Table 12) were also identified as a significant predictor of rural household non-farm activities, with an emphasis on ex-post coping with crises. Coping strategies include any approach that households use to retain their consumption, comprising drawing down on savings, using up food stocks, selling livestock, selling farm equipment and farmlands, exploiting natural resources, and unplanned migration. They involved the depletion of resources and a high level of vulnerability for not only current but also future livelihoods, as per KIs from the food security office. Households' coping strategies do not include proper application or sound decisions as per KIs and FGDs.

In addition, access to social services increases the odds of households' decision to engage in on-farm and non-farm income sources by factors of 1.148 and 1.141, respectively, as compared to off-farm income sources (Table 12). However, the personal observation evidenced that education, healthcare, potable water, roads, electricity, banking, telecommunication services, and agricultural training centers are all limited, especially in Dega and Woina-Dega. This became a bottleneck for rural development as per KIs and FGDs. Access to credit services also increases households' engagement in on-farm and non-farm sources of income by factors of 1.195 and 1.088, respectively (Table 12).

4. Discussions

4.1. Rural Household Livelihood Strategies

This study identified crop and livestock production as the most important sources of income for rural households in the study areas. Farming activities, including crop production, livestock husbandry, and forestry, generate significant on-farm income to meet basic needs such as food, housing, health, and education (Teferi, 2013; FAO, 2017; Mera, 2018; Quandt, 2018; Abebe, 2018; Savari et al., 2023; Wassie et al., 2023). Agriculture is highly important for rural job creation, food security, and economic growth; it constitutes 72.5% of household income in southwestern Ethiopia (Abera et al., 2021). Moreover, livestock, apart from being a source of income and food, also serves as a safety net when crops fail and is considered a social prestige symbol (Berlie, 2013). Despite its importance, smallholder farmers face adverse conditions like drought, degradation of land, unpredictable

rain, and lack of available resources, which impede productivity (FAO, 2017).

Besides, off-farm employments are central in household diversification strategies, which have played an instrumental role in improving incomes, food security, and well-being (Jones & Tanner, 2017; Molla et al., 2024). Such examples include labour migration and temporary jobs contributing to the inflow of remittances and the acquisition of skills (Kassa et al., 2017). Selling firewood and charcoal is another important off-farm industry in Ethiopia that has sustained livelihoods (Abebe, 2018). Off-farm income helps farm households with food security, improved health, education, better housing, and less financial stress (Quandt & Paderes, 2023). The initiatives generate job possibilities and alleviate agricultural difficulties (Kassa et al., 2017; Quandt & Paderes, 2023).
This study again evidences the increasing relevance of non-farm income for livelihoods in conflict-and climate risk-exposed regions, such as the district in which this study was conducted. Although farming still provides the main livelihood activity in rural areas, as explained by Imane (2020), non-farming activities offer additional income and decrease financial risks, capital accumulation, and social adaptability. These sources of income help the household cope with poverty, seasonality, and unexpected environmental, economic, social, and political challenges (Kassie et al., 2017; Getnet et al., 2022). On-farm, off-farm, and non-farm activities together support rural livelihoods; they are important for adaptability and in sustainable development. The interdependence of these endeavors underlines the importance of diversified streams of income in securing household financial sustainability (Jones & Tanner, 2017; Quandt, 2019; Wassie et al., 2023).

4.2. Livelihood Diversification Status

This study presented the LD status of the households by computing essential income variables. The SID results were 0.4512 in Dega, 0.2980 in Woina-Dega, and 0.7358 in Kolla. The figures portray that the LDI was higher in Kolla compared with in Dega and Woina-Dega. The average score of LD was low in this study due to inadequate accessibility of livelihood assets. Ayana et al. (2021) found that due to limited income sources, there was a low level of LD in western Ethiopia, which is similar to this study's findings. Correspondingly, the LDI of farmers in West Bengal (Saha & Bahal, 2010) was low (0.46) because of inaccessibility of resources. The estimated values of SID in rural Bangladesh indicated that most households fall under medium and high levels of LD, which contradicts this study. Similarly, highland agro-ecological families (Getnet et al., 2022) had 0.066 times the income diversification of midland agro-ecological households. Other contributions of this study included the indication that income variables such as agricultural and animal output, vegetable and fruit production, non-farm income sources, and PSNP were some of the significant factors contributing to LDI (Ahmed et al., 2018; Ayana et al., 2021; Zeleke et al., 2023).

4.3. Determinants of Diversification Strategies

This study identified level of education as a positive predictor of diversification strategy. Those who are better educated have more possibilities than those who are not educated. Both formal education and workplace skills increase livelihood opportunities, but poverty is intimately linked with low levels of schooling and a lack of qualifications (Savari et al., 2023; Molla et al., 2024). Increasing the education level of the household by one year increases the odds ratio in favour of the household choosing farm or non-farm income sources (Gebru & Beyene, 2012; Quandt, 2018). Farm size positively and significantly influences employment decisions (Adamseged et al., 2019) and farm activities and diversification (Alemu, 2023), which is consistent with the current findings This study also exhibited that farmland management practices contributed to households' engagement

in on-farm practices. Soil conservation practices (Quandt, 2018) positively affect the intensity of farm activities and diversification and households' adoption decisions (Molla et al., 2024). Livestock holding was also one of the variables that positively determined households' decisions to engage in on-farm livelihoods. The more livestock owned, the less likely a household is to be food insecure (Berlie, 2013). Livestock (Molla et al., 2024) had a positive and significant impact on on-farm activities and the intensity of diversification. While few, extension services have a positive impact on family decisions, more so on resource management, entrepreneurship, and agricultural and livestock intensification (Eneyew & Bekele, 2012). Again, since larger households are better equipped to handle agricultural activities (Eneyew & Bekele, 2012; Berlie, 2013; Asfir, 2016), having a family member increases the likelihood of on-farm participation and decreases food insecurity by a factor of 0.621. Conflicts; however, have adverse impacts on daily workers, civilians, and agriculture, hence weakening household assets, public infrastructure, diversification, and productive resources (Amnesty International, 2021). This study has noted that Woina-Dega and Kolla agro-ecologies are important in stimulating on-farm and non-farm activities; however, agro-ecology has a negative correlation with diversification (Eneyew & Bekele, 2012). It follows that a one-unit rise in age improves diversification through a greater likelihood of planting trees (0.5%) and irrigation (0.06%) (Deressa et al., 2009; Adamseged et al., 2019), which is in agreement with the findings from this study. As indicated by the findings of this study, techniques adopted for the coping of shocks (over exploitation of resources and use of unanticipated savings) hurt livelihoods (Scoones, 2013). Access to credit and social services has a good impact on diversification, albeit rural public infrastructure remains insufficient (Getnet et al., 2022).

5. Conclusions

This study assessed livelihood and diversification strategies in households in northeast Ethiopia and has shown that farm and non-farm activities are both important sources of income that together keep rural livelihoods viable. Using the Simpson Index of Diversity, it was found that Kolla has better SID due to better accessibility of assets. In Woina-Dega, the SID was lower in Dega because households' income sources were mainly confined to remittances and crop and livestock production. In general, LD was found to be low across all agro-ecologies. Education, crop farm size, livestock holdings, land management practices, access to extension services, social services, and credit services were noted as positively affecting livelihoods. Higher dependency ratios, resource disputes, pest attacks, and ex-post coping mechanisms were adversely affected the livelihoods and diversification efforts.

6. Recommendations

Diversification increases livelihood resilience and sustainability, which demands cooperation between households and policymakers. Households must focus on adaptation, agricultural intensification, farmland management, asset building, and financial planning. Policymakers need to ensure access to potable water, roads, education, healthcare, electricity, telecommunication, extension services, agricultural inputs, and irrigation infrastructure. The government should also enhance security, reduce vulnerability, and improve access to credit. Though the study falls short of providing a longitudinal perspective, future studies should dwell on longitudinal data in households' livelihoods and diversification strategies.

Acknowledgements

We are grateful to University of Gondar for funding this research project. We are also grateful to our information sources and the editors and reviewers of this paaper.

Authorship Contribution Statement

The first author conceptualized the idea, prepared the original draft, and carried out the data collection, data analysis, and write-up. The second, third, and fourth authors' consulted methods employed, read, edited, and revised the manuscript.

Declaration of Competing Interest

We declare that we do not have financial and non-financial competing interests.

Data Availability Statement

Data will be made available on request.

References

Abebe, A. (2018). Review on Determinants of Rural Livelihood Diversification Strategies in Ethiopia. *Int J Curr Res Aca Rev,* 6(7), 81-6.

Abera, A., Yirgu, T., & Uncha, A. (2021). Determinants of Rrural Livelihood Diversification Strategies among Chewaka Resettlers' Communities of Southwestern *Ethiopia.Agriculture & Food Security*, 10(1), 1-19.

Adamseged, M. E., Frija, A., & Thiel, A. (2019). *Dynamics of Rural Livelihoods and Rainfall Variability in Northern Ethiopian Highlands.*

Ahmed, M. T., Bhandari, H., Gordoncillo, P. U., Quicoy, C. B., & Carnaje, G. P. (2018). Factors Affecting Extent of Rural Livelihood Diversification in Selected Areas of Bangladesh. *SAARC Journal of Agriculture,* 16(1), 7-21.

Alinovi, L., D'errico, M., Mane, E., & Romano, D. (2010). Livelihoods Strategies and Household Resilience to food Insecurity: An Empirical Analysis to Kenya. *European Report on Development,* 1(1), 1-52.

Amnesty International. (2021). *Ethiopia: Summary Killings, Rape and Looting By Tigraian Forces in Amhara.*

Asfaw, A., Bantider, A., Simane, B., & Hassen, A. (2021). Smallholder Farmers' Livelihood Vulnerability to Climate Change-induced Hazards: an Agro-ecology-based Comparative Analysis in Northcentral Ethiopia (Woleka Sub-basin). *Heliyon,* 7(4), e06761.

Asfir, S. (2016). Determinants of Rural Households' Livelihood Strategies: Evidence from Western Ethiopia. Journal of Economics and Sustainable Development, 7(15), 103- 109.

Ayana, G. F., Megento, T. L., & Kussa, F. G. (2021). The Extent of Livelihood Diversification on the Determinants of Livelihood Diversification in Assosa Wereda, Western Ethiopia. *Geo Journal,* 1-25.

Ayele, D. G. (2019). Challenges to Rural Livelihoods: A Case Study of Chichu, Gedeo, Southern Ethiopia. *Journal of Rural and Community Development,* 14(2).

Berlie, A. B. (2013). *Determinants of Rural Household Food Security in Drought-Prone Areas of Ethiopia: Case study in Lay Gaint District, Amhara Region.*

Deressa, T. T., Hassan, R. M., Ringler, C., Alemu, T., & Yesuf, M. (2009). Determinants of Farmers' Choice of Adaptation Methods to Climate Change in the Nile Basin of Ethiopia. *Global Environmental Change,* 19(2), 248-255.

Eneyew, A., & Bekele, W. (2012). Determinants of Livelihood Strategies in Wolaita, Southern Ethiopia. *Agricultural Research and Reviews*, 1(5), 153-161.

FAO (Food and Agriculture Organization of the United Nations). (2017). Drought Response Plan and Priorities. Revised version. Ethiopia.

Gebru, G. W., & Beyene, F. (2012). Rural household livelihood strategies in drought-prone areas: A case of Gulomekeda District, Eastern Zone of Tigrai National Regional State, Ethiopia. *Journal of Development and Agricultural Economics,* 4(6), 158-168.

Gecho, Y., Ayele, G., Lemma, T., & Alemu, D. (2014). Rural Household Livelihood Strategies: Options and Determinants in the Case of Wolaita Zone, Southern *Ethiopia. Social Sciences*, 3(3), 92-104.

Gemechu, T. (2016). Interdependency of Livelihood Strategies on Natural Resources in Bale-Eco Region, Southeastern Ethiopia.

Getnet, M. T., Ketema, M., Alamirew, B., & Demilew, A. G. (2022). Rural Livelihood Portfolios and Determinants of Livelihood Diversification among Rural Households in North-Western Ethiopia. Ethiopian Renaissance Journal of Social Sciences and the Humanities, 9(2), 70-82.

Greene, W. H. (2000). *Econometric analysis* 4th Edition. International Edition, New Jersey: Prentice Hall, 201-215.

Hermans, K., & Garbe, L. (2019). Droughts, Livelihoods, and Human Migration in Northern Ethiopia. *Regional Environmental Change,* 19(4), 1101-1111.

Jones, L., & Tanner, T. (2017). 'Subjective Resilience': Using Perceptions to Quantify Household Resilience to Climate Extremes and Disasters. Regional Environmental Change, 17, 229-243.

Kassa, B., Kassa, B., & Aregawi, K. (2017). Off-farm Participation Decision and its Impact on Crop Yield in Northern Ethiopia. *Journal of Development and Agricultural Economics,* 9(2), 16-25.

Kassie, G. W., Kim, S., & Fellizar Jr, F. P. (2017). Determinant factors of livelihood Diversification: Evidence from Ethiopia. *Cogent Social Sciences*, 3(1), 1369490.

Kothari, C. R. (2004). Research Methodology: Methods and Techniques. Jaipur, India: University of Rajasthan: New Age International. Second revised edition.

Mera, G. A. (2018). *Drought and its Impacts in Ethiopia. Weather and Climate Extremes,* 22(June), 24-35.

Molla, S. D., Zeleke, M. T., & Tamiru, S. M. (2024). *Assessing Livelihood Resilience in Drought-affected areas: Lessons from Raya Kobo district,* Northeast Ethiopia. *Heliyon*, 10(1).

Molla, S. D., Zeleke, M. T., & Tamiru, S. M. (2024). Rural Household Perception of Drought Occurrence and Its Influence on Livelihood Strategy in Northeast Ethiopia. *Advances in Agriculture,* 2024(1), 8860956.

Nasrnia, F., & Ashktorab, N. (2021). Sustainable Livelihood Framework-based Assessment of Drought Resilience Patterns of Rural households of Bakhtegan Basin, Iran. *Ecological Indicators,* 128, 107817.

Quandt, A. (2018). Measuring Livelihood Resilience: The Household Livelihood Resilience Approach (HLRA). *World Development,* 107, 253-263.

_____ (2019). Variability in Perceptions of Household Livelihood Resilience and Drought at the Intersection of Gender and Ethnicity. *Climatic Change,* 152(1), 1-15.

Quandt, A., & Paderes, P. (2023). Livelihood Resilience and Global Environmental Change: toward Integration of Objective and Subjective Approaches of Analysis. *Geographical Review*, 13(4), 536-553.

Saha, B., & Bahal, R. (2010). Livelihood Diversification Pursued by Farmers in West Bengal. *Indian Research Journal of Extension Education,* 10(2), 1-9.

Sati, V. P., Wei, D., & Xue-Qian, S. (2014). *Sustainable Livelihood Strategies and Options: A Case Study of the Upper Minjiang River Basin, Sichuan Province, China. LAP Lambert Academic Publishing.*

Savari, M., Damaneh, H. E., & Damaneh, H. E. (2023). Effective factors to increase rural Households' Resilience under Drought conditions in Iran. *International Journal of Disaster Risk Reduction,* 90, 103644.

Scoones, I. (2013). Livelihoods Perspectives and Rural Development. In Critical Perspectives in Rural Development Studies (pp. 159-184). Routledge.

Wassie, S. B., Mengistu, D. A., & Birlie, A. B. (2023). Agricultural Livelihood Resilience in the Face of Recurring Droughts: Empirical Evidence from Nnortheast Ethiopia. Heliyon, 9(6).

Zeleke, G., Teshome, M., & Ayele, L. (2023). Farmers' Livelihood Vulnerability to Climate-related Risks in the North Wello Zone, Northern Ethiopia. *Environmental and Sustainability Indicators,* 17, 100220.