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SMALLHOLDER FARMERS' LIVELIHOODS AND LOCALLY PRACTICED ADAPTATION STRATEGIES TO CLIMATIC-RELATED STRESSES IN *WOLAITA* ZONE, ETHIOPIA

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ABSTRACT

This study aims to assess smallholder farmers' livelihoods, climate-related influences, and locally practiced adaptation strategies used to adapt to climate-related stresses in the Wolaita zone. Survey data were collected from 400 randomly sampled households from six woredas of Wolaita zone using face-to-face interviews, focus group discussions, and key informant interviews. Descriptive statistics were applied to describe demographic, socio-economic, climate-related influences, and locally practiced adaptation strategies. The results showed that smallholder farmers' livelihoods are primarily agriculture-based and vary greatly across agro-ecologies. Approximately 36% of households' livelihoods depend on agriculture alone; 8% on non-farm activities alone; 5.25% on off-farm activities alone; 22.25% on agriculture plus non-farm activities; 5.75% on agriculture plus off-farm activities; and 23% on agriculture plus non-farm plus off-farm activities. Additionally, very few households (7.25%) received remittances, 17.25% of household heads benefited from the safety net program, and 7% of household heads received direct aid. Recurring climate-related stresses and shocks greatly influence their livelihoods. To adapt to such stresses, 60% of sample households were engaged in various localized adaptation strategies such as: mixing crops and/or livestock (69%); adjusting farm operation times (71.5%); diversifying livelihood activities (68%); using intercropping (48.5%); preferring drought-tolerant crops (43.5%); carrying out temporary migration (41%); using local varieties (36.4%); and using organic manure (34.7%). While there is no significant difference in the absolute level of adaptation across agro-ecological systems, some adaptation strategies are more popular in particular agro-ecological systems. Additionally, qualitative data results show that, despite diverse local knowledge and experience within the local communities to adapt to climate-related stresses, sustainable development interventions have been given no attention. However, the results suggest that primary stakeholders can significantly contribute to the formulation of resilience policies. Hence, there is a need to incorporate local adaptation strategies into adaptation policies that can lead to sustainable development.

Keywords: Local adaptation strategies, Local knowledge, Climate-related stresses, Resilience policy, Smallholder farmers

INTRODUCTION

Adaptation policies and development ideologies worldwide (especially in developing countries) are heavily influenced by politically and economically dominant Western agendas (Mistry and Berardi, 2016). The structures in which adaptation policies and strategies are used and applied are determined by old-fashioned or top-down, state-based government interventions operating at a macro-level while ignoring (neglecting) local knowledge and experiences. Additionally, in these counties, the system (top-down) has traditionally placed greater value on 'outside' knowledge from development professionals over local voices, and this knowledge informs research to build resilience at the expense of local farmers who themselves have much to offer in framing resilience policy (Codjoe et al., 2014; Makondo

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and Thomas, 2018; Ford et al., 2020; Gollin, 2014; Mistry and Berardi, 2016; Deressa et al. 2008, Makondo and Thomas 2018), and this equally applies to Ethiopia. In a similar manner, the study area (Wolaita), like most rural zones in Ethiopia, is subject to top-down policy formulation with limited opportunities to engage with local populations (Deressa et al. 2008; Belay et al., 2017; Cochrane, 2017). This is at odds with conventional thinking that seeks to "value" local knowledge and skills, as evidenced in UNSDG1, Target 1.5 that aims to build the resilience of smallholder farmers and strengthen their capacity to confront ongoing vulnerabilities (UN, 2016c).

The literature increasingly acknowledges the limitations of grand economic, social, cultural, political, and environmental theories to address the complexities of local contexts, which render them less responsive when they ignore or fail to value local knowledge and experiences (Davoudi et al., 2012; Chandler, 2014; Chandler and Coaffee, 2016). It is becoming more evident that some of the more intractable problems of government are being rethought in a people-centered or "bottom-up" way (Chandler, 2016; Fairhead et al., 2017; Amare, 2018). Additionally, studies increasingly agree that there are no one-size-fits-all solutions and that for different smallholder farmers, different adaptation strategies would be plausible (Douxchamps et al., 2016; Takele et al., 2019). On the other hand, smallholder farmers with limited absorptive capacities continuously confront climate-related and environmental stresses, which in turn necessitate innovation and changes in livelihood practices to mitigate damages and take advantage of new opportunities—a requirement for adaptation (Gollin, 2014). While this is true for much of sub-Saharan Africa, it is particularly true for Ethiopia and the study area for this paper, Wolaita, where recurring climate shocks and environmental stresses frequently result in droughts and famine (de Waal, 1991; Makombe et al., 2007; Gollin, 2014; Cochrane, 2017).

While some stresses are widespread and directly affect the whole country, others are more localized with varying impacts depending on the levels of vulnerability in these areas. The *Wolaita* zone is characterized by high fertility, with a total population of 2,610,760 and average population density 450 household heads per square km (WZFEDD 2017/22). Increases in population have resulted in severe shortage of farmland (less than 0.25 ha/household), a high level of rural-urban migration, high level of migration outflow, and limited resource endowment (Rhamato 2007, Eneyew and Bekele 2012, Gecho 2017, Tantu *et al.* 2017, WZFEDD 2017/22, Gazuma 2018, Esayas *et al.* 2018a, b). Economic and socio-demographic changes, together with political instabilities associated with social unrest, greatly affect the livelihoods of vulnerable smallholder farmers in the Wolaita zone. The increasing frequency of livelihood stressors and the inability of government and non-governmental organization (NGO) assistance to keep pace with the growing levels of local need have prompted smallholder farmers to utilize their local knowledge, skills, and experience to adapt to multiple stresses and maintain their meager livelihoods (Belay et al. 2017, Cochrane 2017, Gecho 2017). There is growing evidence to suggest that these farm households have rich local knowledge and engage in local adaptation strategies (Olango et al. 2014, Madalcho and Tefera 2016, Getahun et al. 2020), this knowledge is under-valued for development purposes. Many of these local adaptation strategies have been practiced for a long time, developed through experience, and successfully implemented by the local communities without major influence from external stakeholders. However, these locally practiced adaptation mechanisms are not well recognized and are not considered, in a formal sense, a source of knowledge for designing and planning locally practiced adaptation measures. Because the current system is so focused on policy from the top down that it ignores these local voices. However, the local knowledge-based adaptation strategies carried out by these smallholder farmers can become part of future resilience policies.

Additionally, locally practiced adaptation strategies could help to blend scientific and local knowledge-based adaptation strategies, and also strategically position and coordinate common but differentiated roles of various stakeholders to enhance resilience of local farmers to growing vulnerabilities (Adger et al. 2013, Codjoe et al. 2014, Maldonado et al. 2016, Etchart 2017). Logic would suggest an imperative to understand local dynamics and local knowledge of adaptation strategies at the local levels of society to inform research and development policy (Mukhopadhyay 2009, Thornton and Manasfi 2010, Belfer et al. 2017, Fairhead et al. 2017*)*. Hence, knowledge is contextual and time- and place-specific, which provides the opportunity to respect local adaptations and measure the extent to which these local adaptations are either informing or being informed by what is happening within the country. Therefore, this study aims to answer the question: "How do smallholder farmers continuously adapt to climate-related stresses in the Wolaita Zone, Ethiopia? To answer this question, the following specific objectives were formulated:

- ✓ To assess and document livelihood activities across agro-ecological zones of the study area,
- ✓ To assess the climate-related influences on smallholder farmers' livelihood practices in the study area.
- ✓ Identify locally practiced adaptation strategies that smallholder farmers are currently using to address ongoing vulnerabilities.

METHODOLOGY

This section provides a description of the study area, sampling techniques, methods of data collection, and methods of data analysis.

Description of the study area

The study area, Wolaita zone, is one of 14 zones in Southern Nation's Nationalities Peoples' Regional State (SNNPRS), Ethiopia. It is located 330 km south of the capital city (Addis Ababa) following main road that passes through Hosanna to Arbaminch. The zone is roughly located between 6.51^{O} - 7.35^{0} N and 37.23^{0}-38.14^{0} E, latitude and longitude respectively. It covers a total area of 451,170 hectares or 4511.7 square kilometers. The zone shares borders with Kembata Tembaro and Hadiya zones in the North, Oromia region in the Northeast, Sidama region in the East, Gamogofa zone in the south, and Dawuro zone in the Southwest.

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The zone is traditionally classified into three agro-ecological zones; among them, a large proportion is *Waina-Dega* (midland): cool and sub-humid climate; elevations of 1,457–1,856m above sea level, which accounts for approximately 56% of the area; some areas face additional challenges due to erosion as rainfall patterns change with climate change. Thirty-five percent of the area is described as *Kola* (lowland), which is characterized as a dry and hot climate with an elevation of between 639-1,456m above sea level and limited in terms of seasonality and crop type. The remaining nine percent of the area is *Dega* (highland) with cool and humid climate, an altitude of 1,857-2,855m above sea level and it enjoys more favorable temperatures and rainfall patterns to support a wider range of crops and are less susceptible to seasonal variations. The estimated average annual rainfall for the zone is 801 to 1600mm (WZFEDD 2017/22). The rainfall in the zone has a bimodal distribution pattern. The main rainy season (*Maher*) is between June and September and small rains (*Belg)* is from late February to late March/early April. The annual average temperature of the zone is 21.86°C (Gecho et al. 2014a, WZFEDD 2022). The area is densely populated (the average population density is 450 households per square km), and thus the average land holding is less than 0.25 ha per household (Rhamato, 2007; Gecho, 2017; Tadesse et al., 2017; WZFEDD, 2017/22; Gazuma, 2018; Bedeke et al., 2018).

Wolaita's population is primarily agriculturalists who practice mixed crop and livestock production and live in permanent settlements. Typical holdings comprise, community members maintain fruit orchards, nurseries, medicinal plants, vegetables, root and tuber crops, ornamentals, and spices, as well as open areas for raising domestic animals (Tsegaye et al. 2002, Olango et al. 2014). *Enset* is the staple in the zone and its cultivation is the center of the cropping system on which the entire farming system is based, and the crop is the major food security and livelihood source (Olango et al. 2014). Animal husbandry is also an important economic activity in the area and includes apiculture, poultry, small-ruminants, and livestock rearing. Income from crop production and animal husbandry is supplemented by activities such as handicrafts (blacksmithing, weaving, and pottery) and trade in the area (WZFEDD 2017/22, CSA 2013).

Sampling techniques

The study area, Wolaita zone was purposively selected because this study is part of the Horizon 2020 Marie Curie research and innovation program that aims to promote resilience through education. The program is located in the Wolaita zone in Ethiopia, Southern Nations Nationalities and People Region (SNNPR). The study was carried out by staff from Woliata Sodo University, which is an 'applied university' that is situated in the area and is mandated to provide third level education and research for the betterment of the population locally, regionally and nationally. The zone comprises 16 administrative woredas (Ethiopian administrative divisions managed by a local government, equivalent to a district) and 6 registered town administrations, with a total of 373 kebeles (the smallest unit of local government in Ethiopia): 294 rural and 79 urban kebeles. Given the increasing frequency of climate-related livelihood stressors, this study purposively selected 6 woredas (two woredas from each agro-ecological category) to examine locally practiced adaptation strategies and their corresponding resilience capacities. Two kebeles were purposefully selected from each of the six woredas to represent three different agro-ecological areas, a range of different-sized villages, the main livelihood practices, and the local adaptation mechanisms experienced. Four hundred sample households were selected from the 12 kebeles using a systematic random sampling technique on the basis of probability proportional to size (PPS). The unit of analysis for the study is the "household," and a sampling frame was developed using the list of households that were obtained from the kebele administrations.

Having identified livelihood practices, climate-related influences, and locally employed adaptation mechanisms among smallholder farmers through questionnaires the study sought to determine the rationale for smallholder farmers to employ local adaptation strategies. This latter data were more qualitative in nature and data were elicited employing focus group discussions (FGDs) and key informant interviews (KIIs). Participants for all FGDs were selected by kebele leaders, who were requested to choose from the more progressive smallholder farmers in their respective areas. The participants for KIIs were selected from farmers and stakeholders charged with supporting agricultural development in the zone. The selection of farmers was based on a purposive sampling of participants with knowledge of the area and their farming experience, along the lines of selecting FGD participants (see above). Then a total of 12 household heads were selected—4 from each of the highland, midland, and lowland kebeles. Development agents, as well as district and zonal agriculture officials, were among the five participants chosen from government institutions at the zonal and district levels (those involved in agriculture, natural resource management, and environmental protection). A total of 17 individuals were selected and included in KIIs.

Methods of Data Collection and analysis

A standardized survey questionnaire, with both close and open-ended questions, was developed and training was provided to six experienced enumerators to administer the study using digital data collection tools (ODK). The questionnaire was pre-tested with 60 smallholder farmers to test its validity and reliability to collect socioeconomic characteristics of the selected households. The improved version of the questionnaire was uploaded to a mobile application with an android version for data collection. Finally, the survey questionnaire was administered to 400 households, and data were collected face-to-face using a closed and open-ended questionnaire by enumerators under the close supervision of the researchers from November 1, 2020, to November 20, 2020. Consultative briefings were held prior to the discussion sessions to discuss the general purpose of the study, relevant local issues, and the agenda for discussion. The meetings included the study's principal investigator (PI), as well as research assistants, extension workers, agricultural professionals, administrative officials, and kebele managers (the gatekeepers who have close knowledge of participants). Subsequently, this study

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organized six FGDs with a maximum of eight participants (two in each of the highland, midland, and lowland areas). Checklists were used to carry out FGDs; each meeting lasted about 1.5 hours on average, and the responses were recorded with a digital recorder and later transcribed for analysis. Field notebooks, a digital camera, and a smartphone with GPS and a compass were all used tools during these times. The data collected in this manner resulted in numerous audio recordings and digital photographs.

Interviews with farmers took place at different sites, including villages and communal sites. A face-to-face interview technique was adopted to provide real-time clarification of interview questions and to respond to any queries participants might have. Participants were asked open-ended questions relating to: their current livelihood experiences; various on-going changes in livelihood practices as observed by the local communities; localized adaptation strategies practiced by other farmers based on the local context; and their intentions to retain adaptation practices for their livelihood resilience. Interviews with farmers were conducted on the same days as FGDs and were facilitated by researcher and research assistants. Upon the completion of FGDs and KIIs with farmers, the expert interviews were used to collect data from governmental institution participants, starting with kebeles, woredas, and zonal agricultural officials. Extension agents, woreda agricultural officials, and zonal agricultural officials were interviewed in their respective local offices. Using checklists, the researcher and research assistants assisted with the interviews. The collected survey data were transported to SPSS version 26 and edited, classified, and coded for analysis. Before conducting the analysis, the data were checked for omissions, errors, outliers, and misspecifications. Following corrections, quantitative data from a household survey were analyzed using descriptive and inferential statistics. The qualitative data obtained from FGDs and KIIs were stated in narrative form, and finally, the interpretation of the results was used for triangulating the study results.

RESULTS AND DISCUSSION

4.1. Introduction

This section presents and discusses the results of the livelihood strategies of households that were interviewed and is divided into five sub-sections that describe the demographic characteristics of study respondents, the socio-economic characteristics of smallholder households, the institutional capital of study respondents, climate-related influences on the livelihoods of smallholder households; and locally practiced adaptation strategies in the study area.

4.1.1. Demographic characteristics of smallholder farmers in the study area

The respondents (n=400) were divided among Highlands[1], Midlands[2] and Lowlands[3] to represent populations from varying agro-ecological areas of the Wolaita Zone. Table 4.1. Presents categorical variables of the demographic characteristics of the respondents in each of three agro-ecological zones of the study area.

Table 4.1. Demographic characteristics sample households

Demographic Characteristics		Overall		Highland		Midland		Lowland		χ^2
		N	%	No	%	No	%	No	%	
Sex	Male	357	89.25	144	88.3	78	91.8	135	88.8	
	Female	43	10.75	19	11.7	7	8.2	17	11.2	0.730
Marital Status	Married	357	89.3	144	88.3	78	91.8	135	88.8	
	Divorced	9	2.3	6	3.7	1	1.2	2	1.3	3.182
	Widow	34	8.5	13	8	6	7	15	9.9	
Religion	Protestant Christians	262	65.5	96	58.9	55	64.7	111	73	6.980**
	Orthodox Christians	138	34.5	67	41.1	30	35.3	41	27	
Education Level	Cannot read and write	45	11.3	8	4.9	6	7.1	31	20.4	
	Read and write	70	17.5	30	18.4	14	16.5	26	17.1	30.905***
	Primary school	166	41.5	67	41.1	43	50.6	56	36.8	
	Secondary school	97	24.3	47	28.8	14	16.5	36	23.7	
	Certificate and above	22	5.5	11	6.7	8	9.4	3	2	

The survey results show certain similarities across respondents in the respective agro-ecological zones: approximately 90% of households were headed by a male, and a similar percentage (90%) were married. The respondents are predominantly Christian, with approximately two-thirds Protestant and the remaining one-third Orthodox Christians. In terms of education, approximately 30% of the

[1] According to Ministry of Agriculture of Ethiopia, Agro-Ecological Zones classification (1998): Highland (*Dega)*- cool and humid climate; altitude 2300/2400-3200m elevation above sea level, average annual temperature 17.5/16.0-11.5 (°C), and average annual rainfall 1200-2200mm.

[2] Midland (*Woinadega*) - cool sub-humid climate; altitude 500/1800-2300/2400m elevation above sea level, average annual temperature 20.0-17.5/16.0 (°C), and average annual rainfall 800-1200mm.

[3] Lowland (*kola*) - dry and hot climate; altitude 500-1500/1800m elevation above sea level, average annual temperature 27.5-20.0 (C°), average annual rainfall is 200-800mm.

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respondents had no formal education, 40% had only completed primary school, and the remaining 30% had completed secondary level education or higher. The data suggests that highland and midland household heads have received a better education than lowland household heads. The majority of parents claimed that their children attend school, which according to Uddin et al. (2014) should have positive implication to promote technologies and innovation to enhance environmental and agricultural management and adaptation to climate. The age of the head of household together with the household size are presented in Table 4.2.

Table 4.2 Age and family size of households in the study area

Variables	**Total**			**Highland**			**Midland**			**Lowland**		
	N	**Mean**	**Std.**	**N**	**Mean**	**Std.**	**N**	**Mean**	**Std.**	**N**	**Mean**	**Std.**
Age	400	50.7	11.972	163	50.687	11.916	85	51.671	10.764	152	50.17	12.694
Family size of HHHs	400	6.04	1.542	163	5.89	1.587	85	6.07	1.478	152	6.18	1.523

The mean age of household heads is 50 with little variation across agro-ecological areas, however there is a wide variance in ages as evidence by the standard deviation in that study area as a whole and in each of the agro-ecological areas. A closer review of the data shows that ages ranged from 30 to 86.

The family size of households studied was generally higher than the national and regional averages. Table 4.2 shows that the mean household size is 6 in all agro-ecological areas with a standard deviation of 1.542. This is significantly higher than the national average of 4.3 and the regional average of 4.5 (CSA, 2010). However, it should be noted that more recent demographic statistics are estimates linked to the last census that took place in 2007. Further investigation of the study's data shows that 85% of the population had a family size greater than the national and regional average and this was common for all agro-ecological areas. While larger family units may have an advantage in providing additional farm labor (Silvestri *et al.,* 2012), it will undoubtedly leads to increasing pressure on scarce land availability in the future.

4.1.2. Socio-economic characteristics of households in the study area

This sub-section provides an overview of the socioeconomic characteristics (land holding, livestock ownership, possession of assets and tools, annual income, and saving habits) of the smallholder farmers in the study area.

Land holdings

Land accessibility is the primary factor determining production practices and livelihoods of rural farm households. It is a very serious issue in the Wolaita Zone, as almost all the available farmland is already cultivated and there is limited possibility for further expansion. Ethiopia has a complex land ownership system. The State is the legal custodian of all lands; however, ownership is conveyed through leases of various durations. In the case of farmland, land farmed can be either owned (through inheriting from parents) or rented/shared. It should be noted that land can be inherited, sold, rented, or communally shared in a similar fashion to a freehold system. Currently, the serious land shortages in the study area lead farmers to adopt different land tenure arrangements. Farmers who lack adequate land to generate income and produce enough food for their families may enter into land rent-in agreements and/or take land for share cropping (a type of farming activity in which farmers cultivate small plots of land from a landowner or farmers with limited labor and financial capacities and farm inputs in return for a portion of their crop to be given to the landowner at the end of each farming season). Farmers with limited financial or labor capacity, on the other hand, give land for share cropping or rent land to others on a contractual basis for agreed time periods, and at the end of the agreement season, the sharecropper would pay the owner a share of the crop at the end of the season, typically one-half to two-thirds. Female-headed households, as well as those facing shortages of manpower, lack of oxen, and shortages of cash, and those owning large farmlands, give their farmland to others for sharecropping or renting it out. The issue of sharecropping or renting was raised in the focus group discussions (FGDs) and key informant interviews (KIIs). This was illustrated by one of the older FGD participants, Shyamba Kebele, in the following quote:

> *In Wolaita culture, women are not allowed to be involved in farming operations. If her spouse is dead, divorced, or she has a poor social network (no strong family network), she is compelled to give her farmland to nearby or other farmers on a contractual basis or give it to sharecropping to take half of the farm products. By doing so, she sustains her family.*

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In our area, sharecropping is widely practiced; farmers are giving their land to sharecrop or rent for a variety of reasons, such as lack of cash, labor, oxen, poor health conditions, and old age.[4]

Table 4.3 displays the size of the land holdings of sample households in the three agro-ecological zones of the study area.

Table 4.3 Landholding of households

Agro-ecological zone of the *Kebele*		**Own land (ha))**	**Rented in (ha))**	**Rented out (ha))**	**Shared in (ha))**	**Shared out (ha)**
Highland	Mean	0.57285	0.17	0.0276	0.7270	0.3160
	Std. Deviation	0.392792	0.570	0.18635	1.16693	1.11244
Midland	Mean	0.61324	0.14	0.0941	0.3529	0.1647
	Std. Deviation	0.416201	0.460	0.31334	0.66737	0.63334
Lowland	Mean	0.69490	0.13	0.0263	0.6908	0.5263
	Std. Deviation	0.534747	0.523	0.18902	1.13630	2.68599
Total	**Mean**	**0.62781**	**0.15**	**0.0412**	**0.6337**	**0.3638**
	Std. Deviation	**0.458609**	**0.529**	**0.22146**	**1.07558**	**1.82665**

The average landholding of households studied was 0.63 ha. However, average landholding varies across agro-ecological areas; in the highland, midland, and lowland areas the average holding sizes were 0.57 ha, 0.61 ha, and 0.69 ha, respectively (Table 4.3). The relatively larger mean landholding size in the lowlands is largely attributed to lower population densities due to challenging growing conditions, and extended dry periods compared to both the highlands and the midlands. Landholding size in the Wolaita zone has decreased over the years due to intergenerational subdivisions of agricultural land (Gecho, 2017, WZFEDD, 2017/22, Gazuma, 2018).

The issue of farm size was raised in the focus group discussions (FGDs) and key informant interviews (KIIs). Participants were asked how land can be inherited/transferred and why farmland size is declining in the study area. The results suggested that the main reasons for the progressive reduction in the size of holdings, include: providing agricultural land to family-forming male children (mainly through sharing the land cultivated by their parents) due to the risk of losing holding rights encouraged this intergenerational sub-division of farmland; periodic adjustments of farmland to accommodate the landless; and the scarcity of non-farm employment opportunities were the main reasons that resulted in a progressive decline in the size of holdings in the study area. The problem is further compounded by the limited access to intensification technologies and credit in the Wolaita zone. This was illustrated by one of the older FGD participants, Woshi Gale Kebele, in the following quote:

We have a fixed amount of land that was passed down from our forefathers, and we will also pass it on to our children. If they are numerous, I will have to divide it again and again to share their portion based on their numbers. If it continues in this manner, the amount of land that each child will inherit will be reduced from generation to generation. Simply put, you can imagine how this fixed amount of land would decrease from generation to generation if it continued in this manner and how it could support the families' livelihood. Additionally, non-farm employment opportunities are limited, and even the few that are available in our zone are unable to meet the existing and continually growing adult population. As a result, these adults are obliged to take their share from their parents in order to support their families. This is not only my case; the situation is similar in the whole Wolaita Zone.[5]

Livestock ownership

Keeping livestock is one of the important livelihood activities carried out by smallholder farmers in the study area. Table 4.4 presents the households that owned livestock in the three agro-ecological zones in the study area.

Table 4.4 Households owned livestock

				Highland		Midland		Lowland		χ^2
		Overall	%	No	%	No	%	No	%	
Having Livestock	Yes	379	94.75	151	37.75	82	20.5	146	36.5	2.486
	No	21	5.25	12	3.0	3	0.75	6	1.25	
		400	100	163	40.75	85	21.25	152	37.75	

The survey results showed that approximately 95% of sample households in the Wolaita zone had livestock of some kind during the survey period. During the survey period, sample household heads were asked how many animals they have, what types of livestock they have, and why they are keeping livestock.

[4] Focus group discussions on the 24th June 2021 at Shyamba kebele (own translation)

[5] Focus group discussions on the 27th June 2021 at Woshi Gale kebele (own translation)

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Table 4.5 Household heads owned different types of livestock

Types of Animal	Overall		Highland		Midland		Lowland		χ^2
	No	%	No	%	No	%	No	%	
Milking Cows (Currently)	232	58.0	97	59.5	40	47.1	95	62.5	5.593*
Milking Cows (Not Currently	147	36.8	56	34.4	30	35.3	61	40.1	1.227
Oxen	257	64.25	102	62.6	52	61.2	103	67.8	1.365
Bulls	113	28.3	44	27	27	31.8	42	27.6	0.674
Heifers	138	34.5	52	31.9	34	40	52	34.2	1.630
Calves	203	50.75	68	41.7	45	52.9	90	59.2	9.837*
Sheep	163	40.75	70	42.9	36	42.4	57	37.5	1.081
Goats	62	15.5	1	0.6	6	7.1	55	36.2	81.855***
Donkey	91	22.75	25	15.3	16	18.8	50	32.9	14.743***
Chicken	150	37.50	32	19.6	34	40	84	55.3	42.894***

During the survey period, approximately 58% of households in the study area had milking cows, 36.8% of households did not have milking cows, 64.25% of households had oxen, 28.3% of households had bulls, 34.5% of households had heifers, 51% of households had calves, 41% of households had sheep, 15% of households had goats, 22% of households had donkeys, and 37.5% of households had chickens. Major types of the livestock kept by smallholder farmers in the study area are cattle, sheep, goats, and chicken. While there were no significant differences between locations with respect to the ownership of livestock; however, the type of livestock varied across agro-ecological areas. A significant difference in cattle ownership was not noticed among highland, midland, or lowland households. The proportion of sample households owned milking cows and calves are significantly varies in the three agro-ecological systems of the study area; in highland agro-ecological systems 59.5% of households own milking cows, 41.7% owned calves; in the midland agro-ecology 47.1% households own milking cows, 52.9% owned calves; and in lowland agro-ecology 62.5% households own milking cows, 59.2% owned calves. Lowland households, on the other hand, rear more goats, donkeys, and chickens than both highland and midland agro-ecological systems. This could be because those livestock can withstand drought and other environmental challenges. In the Wolaita zone, livestock keeping benefits rural households in various ways, including as a source of income (cash earnings from the sale of their products and the animals themselves to cover various affairs, support household expenses, purchase other farm inputs, pay taxes, pay debts, and pay children's school fees), milk, eggs, meat, drought power, transportation, and organic manure (for use on homestead farms of *enset*, coffee, etc.). Additionally, rural households frequently use livestock as a measure of wealth, i.e., it serves as a significant store of wealth (saving). The variation in livestock ownership was attributed to easier access to grazing areas as well as the comparatively low population density when compared to both highland and midland areas. According to the FGD findings, land shortages caused by population growth have increased farmland demand in the study area while decreasing the amount of feed and grazing land for livestock. As a result, most livestock keepers have decided to reduce their herds. However, this has had an impact on livestock production and productivity in the study area. The following was explained during FGDs about the impact of grazing land shortages on livestock production:

> *……… changes in land use and a decrease in farmland size in the study area have greatly contributed to the decrease in productivity and production of livestock. To a great extent, this has been fostered by population growth and weather variability, which have increased the demand for food, and farmland is becoming too small to feed the existing population. This has triggered local communities to expand their farming activities within the communal grazing land and even their small portion of land used for grazing, which has created a shortage of grazing areas for livestock. Since there is a shortage of grazing land as well as drinking water because of the drought, many livestock owners have decided to reduce their herds of cattle. This has big implications for animal productivity, which is a major part of our livelihood in the area because in recent years we have observed a decrease in cattle production.*[6]

4.2. Smallholder farmers' livelihoods

Agriculture is the primary source of livelihood for the vast majority of farm households in all agro-ecology practiced mixed farming systems. Due to severe land scarcity, high population pressure, and recurrent drought, farm households in the study area widely engage in and pursue diverse livelihood practices. Table 4.6 shows the livelihood strategies of smallholder farmers in the study area.

[6] *Focus group discussions on June 27, 2021, at Amplo Koysha Kebele (own translation)*

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Table 4.6 Smallholder livelihoods

Livelihoods	Overall		Highland		Midland		Lowland		χ^2
	No	%	No	%	No	%	No	%	
Agriculture	143	35.75	76	19	38	9.5	29	7.25	
Non-farm activities	32	8	15	3.75	4	1	13	3.25	
Off-farm activities	21	5.25	4	1	5	1.25	12	3	
Agriculture, non-farm activities	89	22.25	47	11.75	15	3.75	16	4	79.941***
Agriculture, off-farm activities	23	5.75	3	0.75	2	0.5	18	4.5	
Agriculture, non-farm, off-farm	92	23	18	4.5	21	5.25	64	16	
Remittance	29	7.25	9	5.5	13	3.25	7	1.75	10.485**
Safety net	69	17.25	19	11.7	12	3	38	9.5	10.553**
Direct aid	28	7	14	8.6	3	0.75	11	2.75	2.218

Source: survey result, 2020. **, ***, significant at 5% and 1%

As the survey results revealed, approximately 35.75% of the sample households depend on agriculture alone for their livelihoods. Aside from agriculture, some of the sample households totally relied on non-farm activities for a living, and a significant proportion of them also participated in one of these non-farm activities during the survey year. For instance, 8% depend on non-farm activities alone; 5.25% depend on off-farm activities alone; 22.25% depend on agriculture plus non-farm activities; 5.75% depend on agriculture plus off-farm activities; and 23% depend on agriculture plus non-farm plus off-farm activities. Additionally, the survey results showed that very few households in the sample, only 7.25%, received remittances, 17.25% of household heads benefited from the safety net program, and 7% of household heads received direct aid because of their age, lack of productive assets, and health problems. The aggregate results, on the other hand, show that the sources of livelihood, remittance receipt, and the number of safety net program beneficiaries differ significantly between highland, midland, and lowland households.

Crop production

Crop production is one of the important livelihood activities carried out by farmers in the study area. The major crops grown in the Zone are divided into three categories: cereals (maize, sorghum, barley, wheat, *teff*), pulses (haricot beans, peas), and root crops (sweet potato, Irish potato, *enset*, taro). Fruits, vegetables, and coffee are also grown around the homestead. *Enset* is an STAPLE in the Wolaita food economy. Table 4.7 presents the crop types produced and crop production of sample households in the study area.

Table 4.7. Crop types produced and crop production

Crop Types	Overall		Highland		Midland		Lowland		X^2
	No	%	No	%	No	%	No	%	
Enset	367	91.8	163	100	83	97.6	121	79.6	48.180***
Taro	242	60.5	89	54.6	68	80	85	55.9	17.232***
Haricot	241	60.25	64	39.3	69	81.2	108	71.1	52.924***
Maize	223	55.8	21	12.9	61	71.8	141	92.8	214.661***
Coffee	169	42.25	37	22.7	59	69.4	73	48.0	53.315***
Wheat	147	36.75	125	76.7	22	25.9	----	----	204.482***
Teff	145	36.25	32	19.6	38	44.7	75	49.3	33.383***
Beans	138	34.5	137	84.0	1	1.2	0	0	298.922***
Potato	122	30.5	56	34.4	23	27.1	43	28.3	1.968
Banana	90	22.5	15	9.2	26	30.6	49	32.2	27.892***
Peas	73	18.25	56	34.4	16	18.8	1	0.7	59.889***
Barley	66	16.5	64	39.3	1	1.2	1	0.7	103.482***
Avocado	59	14.75	13	8	24	28.2	22	14.5	18.251***
Cassava	42	10.5	0	0	0	0	42	27.6	76.566***
Beetroot	43	10.75	43	26.4	0	0	0	0	70.052***
Carrot	36	9	36	22.1	0	0	0	0	57.520***

The data results show a huge variety of crops cultivated in the study area across the households studied. Approximately 92% of households produce *enset*, 60.5% taro, 60.25% haricot bean, 55.8% maize, 42.25% coffee, 36.75% wheat, 36.25% *teff*, 34.5% beans, and 30.5% potato. According to survey results, most crops such as *enset*, taro, haricot, coffee, maize, *teff*, potato, banana, and avocado are widely produced in the three agro-ecological systems of the study area. However, disaggregated data revealed that almost all crop production was agro-ecology-specific and varied with agro-ecology (Table 4.4). For instance, in highland, the most prevailing crops are

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enset 100%, beans 84%, wheat 76.7%, and barley 39.3%; in midland, *enset* 97.6%, haricot 81.2%, taro 80%, maize 71.8%, coffee 69.4%, and *teff* 44.7% are dominant crops; and in lowland, maize 92.8%, *enset* 79.6%, taro 55.9%, *teff* 49.3%, and coffee 48% are dominant crops.

Furthermore, participants in focus group discussions and key informant interviews were asked about the purpose of production, the situation of crop production, vegetation cover, and the trees growing in the zone as a whole. According to qualitative findings crop production was mainly for home consumption, with only a small amount of marketing surplus to cover social affairs, household expenses, supporting children's schooling, paying taxes and debts, and purchasing farm inputs. As the interview results confirmed that crop production in Wolaita zone is entirely rain-fed, except in very specific and small areas such as Ampo Koyisha kebele in Humbo woreda and Shayamba kebele in Damot Sore woreda, where small-scale irrigation is practiced. Wolaita has a bimodal rainfall pattern that extends from March to October. The first rainy period (*Belg*) lasts from March to May and is used to cultivate long-cycle crops, whereas the second rainy period (*Kremt*) lasts from July to October, with a peak in July/August. During the focus group discussions and interview, the following issues were discussed: crop production status and situation, as well as the purpose of production. One of the village elders from Zalla Shasha Kebele, who owned considerably larger farmland as well as supplementary grazing grounds, described the purpose of crop production in the area as follows during FGDs:

> *We are producing crops mainly for home consumption because we have a very limited (fixed) amount of land that is extensively cultivated. We have no extra means of expanding our farmland; we cultivate the same area year after year, and the harvest produced is even insufficient for our family members' consumption. We occasionally sell a small amount of our produce to cover certain social affairs, and even this is insignificant for other purposes. However, relatively few farmers with larger farmland produce more and sell crops.*[7]

In addition, FGD and KII participants were asked questions regarding crop production and vegetation cover conditions in the zone. They forwarded the following summary of previous and current crop production and vegetation coverage status in the zone as a whole:

> *Previously, vegetation cover in the Wolaita zone was abundant all year, with eucalyptus, pines, acacia, Cordia Africana (Wanza) trees, and massive sycamores coexisting with Enset. However, because of high population pressure, increased demand for farmland, and weather variability, vegetation cover has been significantly reduced. In addition, in highlands leafy green vegetables such as, maaxiyaa, dengo, dankala and bulo santa; tubers and root crops like banga kolta (white tuber crops), geze donuaa (indeginous fiber like hairy potato); spices such as debuwa, keffia, and zinbanua (coffee flavouring spice), guchecha (indigenous lemon grass), kareta/botta sawua (blak/white cumin), and medicinal herbal plants such as, agupia (Artemicia Africa), talotia, natira, and gagabisaa, were commonly cultivated around farmsteads. These spices and herbs were commonly cultivated by women, and sometimes they were used as an income source to cover miscellaneous household expenses. Zalla Shasha Village Elder.* [8]

> *In the past, Wolaita was a nice place. Most of the areas were green, and our farmstead area was full of 'enset', coffee, and other traditional vegetables and spices....agriculture production was very good. The abundant food we had is becoming scarcer; plenty of crop and livestock products have drastically decreased; our farmland has been exhaustively utilized and its size and productivity have decreased; our cereal harvests are low; before a few years, high-yielding 'enset' offered some opportunity for food security in such situations because of its drought-resistant properties. But nowadays even 'enset' exists around a very few houses in a limited highland and midland area. Additionally, our population has increased, and love within the community has disappeared. We are currently in big trouble.*[9]

Food availability in the study area

[7] Focus group discussions on the 22th June 2021 at Zalla Shasha kebele (own translation)
[8] *Interview with Village Elder on June 26, 2021 at Zalla Shasha Kebele (Own translation)*
[9] *Interview with Village Elder on June 28, 2021 at Shyamba Kebele (Own translation)*

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Heads of households were asked whether the foods they produce are sufficient throughout the year, or they experience food shortages during particular months of the year, and how they cope with or adapt to these food shortages. Table 4.8 displays the food availability situation in the study area.

Table 4.8 The food availability situation in the study area.

Food Availabilities		Overall		Highland		Midland		Lowland		χ^2
		N	%	No	%	No	%	No	%	
Food shortage months	March, April, May, June	400	100	163	100	85	100	152	100	
Enough food available months	July, August, September, October	274	68.5	106	65	79	92.9	89	58.6	31.412***
	July, August, September, October, November	126	31.5	57	35	6	7.1	63	41.4	
Surplus food available months	November, December, January, February	274	68.5	106	65	79	92.9	89	58.6	31.412***
	December, January, February	126	31.5	57	35	6	7.1	63	41.4	

According to the survey results, nearly 100% of respondents stated they face severe food shortages for four months (March, April, May, and June) in the year; 68.5% said they have sufficient food in July, August, September, and October; 31.5% replied they have enough food in July, August, September, October, and November; 68.5% said they have surplus food in November, December, January, and February; and 31.5% said they have surplus food in December, January, and February. This suggests that many farm households in the study area could not produce sufficient food for home consumption, and food is not evenly available within the communities throughout the year. The variation in food availability was common for all three agro-ecological systems in the study area.

The issue of food availability, shortages, and the way farm households adapt to these challenges were discussed during FGDs and KIIs. The findings revealed that agro-ecological diversity, small farmland size and poor quality, high population pressure, unfavorable climatic conditions, and a lack of capacity to afford improved technology were all significant contributors to insufficient food availability in the study area. One of the senior agricultural development agents from Damot Gale Woreda described the overall situation in the Wolaita zone as follows:

> *Harvesting and the immediate post-harvesting period are normally the times when all have a sufficient food supply. Planting and pre-harvest times are particularly challenging for us, and food shortages are widespread not only in our kebele but throughout the Wolaita zone. To the best of my understanding, farmers' reliance on a single crop of 'mehez' every year has, of course, significantly contributed to the generally longer duration of food shortages at the household level.*[10]

Additionally, the KII participants were asked how farm households in the study area were adapting to these food shortage periods. The following was explained during the interview: how the farm households were adapting to these food shortage months locally. The Woreda Agricultural Officer had the following remarks:

> *……..in the past, agricultural production in Wolaita was very good. We had enough food, crops, and livestock, among other things. However, what has occurred in recent years is rather astonishing; many things have changed. The abundant food we had is becoming scarcer; lots of crop and livestock products have severely decreased; the onset of rain is unexpected and very irregular; as a result, food availability in Wolaita has greatly decreased. Farmers are coping with such problems by selling assets, which often begin with chickens and small ruminants, then progress to young bulls and heifers, and eventually to the renting out of agricultural land or the sale of cows or oxen. During these months, seed reserves might be used for food. In desperate situations, farmers might be forced to sell dwellings or household utilities. Such measures reduce the capacity of households to produce, thereby increasing their vulnerability to subsequent food shortages. Another common adaptation mechanism in our community, but one with long-term adverse consequences for household livelihoods, was borrowing in cash and in kind. The debt was paid back with the next harvest or by selling assets if crops failed. All farmers do not respond in the same way to food shortages.* [11]

[10] *Interview with a senior agricultural development agent (ADA) on June 21, 2021, at Damot Gale Woreda (own translation)*
[11] *Interview with Woreda Agricultural Officer on June 21, 2021, at Damot Gale Woreda (own translation)*

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4.3. Climate-related influences on livelihoods

In the study area, agricultural activities, demographic, socio-economic, and climate-related conditions have all been continuously changing, and the situations are not at odds. Climate-related changes, in particular, have posed great challenges, become serious issues, and greatly affected livelihood systems in recent years. The influence of the local climate and associated changes in smallholder farmers' livelihood practices were perceived to have mostly negative consequences at the household and community levels. Table 9 below displays the negative influences of climate-related changes on smallholder farmers' livelihoods across the three agro-ecological zones of the study area.

Table 9 Climate change-related influences on livelihoods

Climate related information	**Overall**		**Highland**		**Midland**		**Lowland**	
	No	**%**	**No**	**%**	**No**	**%**	**No**	**%**
Crop production decline	371	92.75	153	93.9	75	88.2	143	94
Increased level of temperature	362	90.5	147	90.2	74	87	141	92.8
Increased frequency of drought	358	89.5	129	79	80	94	149	98
Shortage of water for home/animal consumption	337	84.25	132	81	69	81.2	136	89.5
Changing rain patterns	329	82.25	124	76	79	93	126	82.9
Food price increase	311	77.75	118	72.4	77	90.6	116	76.3
Livestock production decline	292	73	93	57	65	76.5	134	88
Crop pests and diseases	150	37.5	35	21.5	29	34	86	56.6
Livestock disease increase	125	31.25	42	25.8	23	27	60	39.5

According to the survey results, the majority of sampled households perceived the various impacts of climate-related changes in the study area. Approximately 92.75% of sample households believed that crop production decreased; 90.5% believed that temperature levels increased; 89.5% perceived an increased frequency of drought occurrence; 84.25% reported a shortage of water for home or animal consumption; 82.25% perceived changed rain patterns; 77.75% believed that food prices increased; and 73% believed that livestock production declined; 37.5% believed that crop pests and diseases increased; and 31.25% believed that livestock disease increased.

It is widely reported by local community members that there have been significant changes in the average weather in recent years. Indeed, the participants in the focus group discussions in all the study *kebeles* reported that long dry spells and shifting rain patterns, coupled with a small amount of rain, have been occurring regularly in recent years. These recurring climate shocks and environmental stresses, as stated during the focus group discussion, frequently result in droughts and famines in the study area in general and in some Woredas (Humubo, Damot Woyde, Kindo Koysha, and Duguna Fango) in particular. Long dry spells are not a new phenomenon, but the magnitude of these events has increased in recent years when compared to the previous 20–30 years. In the past, long dry spells used to occur every decade in the area, but in recent years, long dry spells have been occurring at two- to three-year intervals and sometimes every year. The Wolaita Zonal Agricultural Officer had the following remarks:

> *For the last 30 years, we have seen more recurrent and long dry spells, such as in 1984–1995, 1997–2003, 2010, 2012, 2016–17, and 2018–2021, resulting in decreased food production, increased food shortages, livestock disease and death, crop failure, and a variety of human diseases. Additionally, in the study area, floods occurred because of abnormal rains in the years 1994, 1998, 2001, 2002, 2014, and 2018 and caused floods, landslides, and the displacement of significant numbers of households in some Woredas. Farmers in Wolaita have been suffering from hunger and food shortages almost continuously at 8–10-year intervals since the mid-1980s because of drought. In recent years, this interval has also been reduced to 1 to 2 years. There have been few "good years" in the following decades. Crisis interventions by the government and NGOs have occurred almost every two years or so, and several farm households are highly dependent on food aid and other public support programs.*[12]

The results confirm that local communities have placed a greater emphasis on climate-related stresses because their livelihoods are inextricably linked to agriculture and are severely impacted by climate-related changes. They also stated that they are adapting to these stresses and shocks on a local level. Table 10 below provides the readers with a general picture of the proportion of households adapting to climate-related influences among the three agro-ecological zones in the study area.

[12] *Interview with Zonal Agriculture and Natural Resource Officer on June 16, 2021 at Zonal Agriculture and Natural Resource Office (Own translation)*

Table 10 Households adapted climate-related influences

Households using local knowledge-based adaptation strategies	Overall		Highland		Midland		Lowland		X^2
	No	%	No	%	No	%	No	%	
Yes	239	59.75	95	58.3	49	57.6	95	62.5	
No	161	40.25	68	41.7	36	42.4	57	37.5	0.780
Total	**400**	**100**	**163**	**100**	**85**	**100**	**152**	**100**	

The results showed that approximately 60% of households had adapted their livelihoods to address these stresses, and the remaining 40% had not. It also indicated that there is a slightly higher percentage of households that have engaged in adaptation strategies in lowland and highland areas. However, there is no significant variation in the levels of adaptation among highland, midland, and lowland households.

4.4. Locally practiced adaptation strategies

On the other hand, the majority of households are adapting their livelihood practices, albeit in different ways, to maintain or enhance their livelihoods. They are using a variety of context-specific local adaptation strategies that they have developed over time. Table 11 below presents a broad range of fourteen adaptation strategies employed by smallholder households in the study area, again by agro-ecological system.

Table 11 Local knowledge-based adaptation strategies

Local adaptation strategies by farmers	Overall		Highland		Midland		Lowland	
	No	%	No	%	No	%	No	%
Crop–livestock diversification and other good practices (mixed cropping, crop rotation, mulching)	228	57	85	52	65	76.5	78	51.3
Adjusting farm operation time	214	53.5	51	31.3	33	38.8	130	85.5
Using local varieties/ indigenous species (both crop and livestock)	202	50.5	78	47.8	57	67	67	44
Preferring drought-tolerant crops	187	46.75	73	44.8	48	56.5	66	43.4
Intercropping and crop rotation	168	42	66	40.5	39	45.9	63	41.4
Changing cropping patterns based on local predictions of climate	165	41.25	65	39.9	40	47	60	39.5
Using organic manure (compost, domestic wastes)	159	39.75	75	46	31	36.5	53	34.8
Diversification of income-generating activities (non/off-farming activities)	150	37.5	60	36.8	38	44.7	52	34.2
Using indigenous techniques to pest control	141	35.25	54	33	40	47	47	30.9
Shading and sheltering/ tree planting	127	31.75	34	20.8	45	52.9	48	31.6
Mortgaged/Sold Assets	105	26.25	35	21.5	19	22.4	51	33.6
Borrowed money or food from relatives or friends	75	18.75	21	12.9	25	29.4	29	19
Went for food for work programs	15	3.75	1	0.6	3	3.5	11	7.2
Temporary/Seasonal migration	10	2.5	0	0	1	1.2	9	5.9

NB: some households practice more than one local adaptation strategies.

The study found that smallholder farmers were employing a wide array of adaptation options. Table 11 presents fourteen locally practiced adaptation strategies employed by smallholder farmers in the study area, again by agro-ecological areas. While there is no significant difference in the absolute level of adaptation across agro-ecological areas, it is clear from Table 11 that some adaptation strategies are more suited to particular agro-ecological areas. Examples include the relatedly high frequency of crop-livestock diversification (using different crop/livestock varieties, resilient crop varieties have been introduced, mixed cropping) 86%, using local varieties/ indigenous species (both crop and livestock) 70.5%, using organic manure (compost, domestic wastes) 54.7%, and adjusting farm operation time 53%; among highland households. Midland households have a high level of diversifying income-generating activities (petty trading and hawking, motorbike renting, artisan work, e.g. weaving, carving (blacksmith), basket weaving, bakery, and other handicrafts) 91.8%, crop-livestock diversification (using different crop/livestock varieties, resilient crop varieties have been introduced, mixed cropping) 88%, adjusting farm operation time 73%, and intercropping and crop rotation (growing two or more crops in proximity in the same field) 67%. Among lowland households, the high levels of preferring drought-tolerant crops 97%, adjusting farm operation time 89%, diversification of income-generating activities (non/off-farming activities, selling charcoal, firewood) 81%,

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and temporary/seasonal migration (wage labor) 70.5% are widely used (farmers may seek casual work opportunities in exchange for cash or food during a drought, if agricultural production is negatively affected).

When one examines these locally practiced adaptation strategies closely, it is clear that some types of adaptation strategies are better suited to specific-context and agro-ecology. There were some similarities in the types of local adaptation strategies used by smallholder farmers in the highlands and the midlands. Local adaptation strategies in lowland households, on the other hand, differed significantly from those in highland and midland agro-ecologies. The possible reasons were that agricultural activities, livelihood strategies, and the demographic and socio-economic characteristics of households largely varied with agro-ecologies and were determined by the local context. This is consistent with earlier research findings of (Amare and Simane, 2017; Asrat and Simane, 2018; Aniah *et al*., 2019; Getahun et al., 2021).

In a similar note, the WZACO officer had the following remarks regarding different types of changes and local adaptation strategies practiced in the area:

> *Climate, agriculture, socioeconomics, and the environment have all changed dramatically in the Wolaita zone over the last 30 years. Everything is unpredictable, and farmers are struggling to survive with these growing changes in the three (highland, midland, and lowland) agro-ecological zones of the study area. Farm households are participating in various types of activities to adapt to these challenges. In the highland areas, for example, they are diversifying their farming activities by planting local crops, engaging in additional income-generating activities such as petty trading and hawking, motorbike renting, artisan work such as weaving, carving (blacksmithing), basket weaving, bakery, and other handicrafts, and maintaining farmland fertility (using organic, etc.). In the midlands they are diversifying their income-generating activities (petty trading and hawking, motorbike renting, artisan work, such as weaving, carving (blacksmithing), basket weaving, bakery, and other handicrafts); and sometimes they are migrating temporarily or seasonally in search of additional work. The challenges in lowland areas are far more severe than in highland and midland areas. However, the farmers in this area are also fighting to survive. They are planting drought-tolerant crops (cassava, sweat potato, haricot, and taro); adjusting their farm operation time; and being greatly involved in additional income-generating activities (non/off-farming activities, selling charcoal, and firewood); temporary or seasonal migration (wage labor); mortgaged or sold assets (contracting farmland, selling small ruminants); and going to food for work programs to adapt to these stresses.*[13]

Some of these locally practiced adaptation strategies are agriculture-based and more common in highland agro-ecology; however, in midland agro-ecology, both agriculture-based and non-agriculture-based adaptation strategies were widely used. In lowland agro-ecology, non-agriculture-based adaptation strategies are more commonly used. The magnitude of practicing agriculture-based local adaptation strategies decreases as we go from highland and midland to lowland agro-ecology. The relative humidity and low temperature in highland and midland agro-ecologies are more conducive to diversifying or practicing mixed farming activities than in lowland areas. In the case of lowland areas, crop diversification and continuous cultivation were limited by physical factors.

Albeit local knowledge-based adaptation strategies are widely practiced in the study area, the results of qualitative data from FGDs revealed some challenges encountered by the local people regarding the use and application of local adaptation strategies to adapt to multiple stresses. These challenges include: the poor reputation of local knowledge, the absence of knowledge sharing culture; the ongoing socio-economic transformation, the loss of traditional culture and practices, disappearance of local seeds, exclusion of local knowledge in the formal adaptation practices. This was illustrated by one of the farmers in Shyamba kebele in the following quote:

> *My son, the problems that hinder us from using our local knowledge are so many modernity, even extension services that is not considered our knowledge and experience, and little cooperation among different social groups within us. In most cases we are forced to take extension packages (like fertilize, improved seed, and etc.) without our willingness. Because it does not considered our ability to afford, and even our farmland size and type. If we refuse we will be considered as against government policies. With fear of that we took it and sell it back or keep it without using it. We have never been consulted on anything they do. Even when things are important to us, our knowledge, abilities, and experience are almost completely ignored. We will contribute more if they consult us because we know our specific contexts and how we have survived in various situations. Our experience will be extremely beneficial to them.*[14]

Conclusion and Recommendations/ future policies

This study identified smallholder farm households' livelihood strategies, climate-related influences on livelihood activities, and locally practiced adaptation strategies in the study area. As the study findings indicated, agriculture (mixed crop and livestock production) is the basis of livelihoods, and its activities greatly vary due to agro-ecological diversification in the study area. Additionally, in the face

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[13] Interview conducted on 25th June 2021 with Wolaita zone Agriculture and Crop production Officer (Own translation)

[14] Interview conducted on 20th December at Shyamba kebele (Own translation)

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of limited household agricultural resources and low production, non-farm income sources play an important role in increasing household income in the study area. Aside from agriculture, a significant proportion of households engaged in a variety of non-farm activities to supplement their income and adapt to various shocks and stresses. Recurring climate-related stresses and shocks frequently occur in the study area and greatly influence the livelihood activities of farm households. Reduced crop production, rising temperatures, frequent drought occurrence, scarcity of water for human or animal consumption, changing rain patterns, an increase in food prices, a decline in livestock production, an increase in crop pest and disease prevalence, and an increase in livestock disease prevalence are among the most commonly perceived impacts of climate change-related impacts in the study area, according to findings.

On the other hand, the majority of households are adapting their livelihood practices, albeit in different ways, to maintain or enhance their livelihoods. The study found that smallholder farmers were employing a wide array of localized adaptation options. While there is no significant difference in the absolute level of adaptation across agro-ecological areas, some adaptation strategies are more suited to particular agro-ecological areas. Examples include the relatedly high frequency of crop-livestock diversification (using different crop and livestock varieties; resilient crop varieties have been introduced; mixed cropping); using local varieties and indigenous species (both crop and livestock); using organic manure (compost, domestic wastes); and adjusting farm operation time; among highland households. Midland households have been diversifying income-generating activities (petty trading and hawking, motorbike renting, artisan work, e.g., weaving, carving (blacksmithing), basket weaving, bakery, and other handicrafts), crop-livestock diversification (using different crop and livestock varieties; resilient crop varieties have been introduced; mixed cropping); adjusting farm operation time; and intercropping and crop rotation (growing two or more crops in proximity in the same field). High levels of preference for drought-tolerant crops, adjusting farm operation time, diversification of income-generating activities (non/off-farming activities, selling charcoal and firewood), and temporary/seasonal migration (wage labor) are widely used among lowland households (farmers may seek casual work opportunities in exchange for cash or food during a drought if agricultural production is negatively affected). Although these localized adaptation strategies carried out by smallholder farmers can become part of future policies, they are not well recognized and considered (in a formal sense) as sources of knowledge and information for designing and planning resilience policy formulation. Because the current system is very much focused on policy from the top down that it ignores these local voices.

In light of the above findings, this study recommends the system should consider the local climatic, cultural, and social dynamics that need to be interpreted as context-specific to make sense of the regional and national resilience polices on practice. Because the dynamic contexts, complexity and local specificity of the current challenges facing livelihood and the many roles it is being asked to fulfil require more inclusive, flexible modes of governing the generation, integration and sharing of knowledge. Moreover, primary stakeholders (farmers) need to be recognized and respected as equal co-authors of knowledge generation, and all kinds of knowledge, both formal and informal, need to be brought together in innovation processes are crucial for livelihood adaptations to become sustainable and resilient.

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