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Impacts of Climate Variability on Livelihood of Rural Community and Its' Local Adaptation Strategies: The Case of Kambata Tambaro Zone, Southern Ethiopia

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Abstract:- The study was undertaken in Kambata Tambaro Zone, SNNPR Ethiopia. Geographically, study area is located between 7º08' 00"N -7º30' 00"N latitude and 37º 20' 00"E - 38º 50'00"E longitude. Climatic variability effects are the wide spread issues throughout whole regions of Ethiopia. The climate variability evidence scenarios for the coming years indicate that the issues of livelihoods in over populated areas and the extremely expected drought risks would be challenging for adaptive capacities of population. Structured interview scheduled was used to collect data from 112 respondents who were selected using simple random sampling. The temperature and rainfall data recorded for 25 years from weather stations of study area were used for analysis of climate variability for the study. Majority of respondents in the study area were aware about the climate variability and decline of rainfall and increasing trends of temperature. Respondents were strongly agreed that temperature/heat is rising from time to time when compared with similar season in the past. The amount of rain fall is found to be decreasing and setting time lagging behind in which rain stops earlier than in the past. Similarly, majority of respondents also strongly agreed that rain fall periods in the study area had not been properly supporting full crop growth than earlier times. On the other hand, according to respondents in the study area, crop disease/pest infestation increasing more problem than earlier times and the prices of grain are hiking because of decreased productivity for climate change. Climate variability has impacts on livelihood, heat and drought effects and impacts on agricultural productivity. Different local adaptation strategies were applied by farmers in the study area, like diversification of crops and agroforestry practices.

Keywords:- *Climate variability, Adaptation Strategies, Livelihood.*

I. INTRODUCTION

There is a strong consensus that climate change presents an urgent challenge on the well-being of all countries, particularly the poorest countries and the poorest people in the world (Arndt et al., 2012). In 2007 the World Bank highlighted that there is strong linkage between poverty and climate variability and emphasized the need for increased resources to assist countries with the higher costs of climate risk management and asset rehabilitation due to more frequent and severe natural disasters and to adapt within their core development strategies (Agrawal, 2008). Among African countries Ethiopia is one of the most vulnerable country to climate change due to heavy reliance on climate sensitive rained agriculture, and livestock, high poverty rates, existing stresses on health and wellbeing, conflicts and low adaptive capacity with limited human, institutional, technological and financial facilities (Belachew & Iqbal Zuberi, 2015). In Ethiopia about 80% of the variability in agricultural production is due to the variability in weather conditions (Simane et al., 2013). Moreover, in many developing countries where rain-fed agriculture is the norm, a good rainy season means good crop and livestock production, enhanced food security and a healthy economy (Agrawal, 2008). So that African agricultural sector must adapt to uncertainty and thereby confront a threefold challenge of climate change and variability.

According to the UNDP Climate Change Profile for Ethiopia, the mean annual temperature in Ethiopia has increased by 1.3°C between 1960 and 2006, at an average rate of 0.28°C per decade (sevaldsn, 2001). It is very difficult to detect long-term rainfall trends in Ethiopia, due to the high inter-annual and inter-decadal rainfall variability. Climate change is of critical strategic importance to Ethiopia (Rebecca Harris Sullivan, 2012). It has the potential to hold back economic progress, or reverse the gains made in Ethiopia's development and could exacerbate social and economic problems (IFRC, 2009). The close links between climate and Ethiopia's economy are reflected by the strong relationship between GDP growth rate and rainfall variability. Because Ethiopia's economy and the livelihoods of people are closely linked to agriculture and the use of natural resources like water, land, forests, biodiversity and fisheries (UNISDR, 2009). Adaptation and action towards climate resilience will come in part through focusing on improving performance and management in these areas

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with future climate change in mind (Agrawal, 2008). A further acceleration of climate change will likely lead to the rise of global temperature more than two degrees and related increase of extreme weather events in many parts of world countries like Ethiopia (Simane et al., 2013). Sustainable development can reduce vulnerability to climate change by enhancing adaptive capacity and increasing resilience (Pushpam Kumar et al., 2015). Similarly, climate change can slow the pace of progress towards sustainable development through increased exposure to adverse impact. However, the impacts of climatic and other man-made stresses have been growing continuously at a rate that often exceeds human and ecosystem tolerance levels (Millner & Dietz, 2015). Consequently, many traditional adaptive knowledge and livelihood strategies practiced in local areas of Ethiopia for centuries no longer sufficient (Koh Kheng Lian and Lovleen Bhullar, 2010). Adaptive capacity is often determined by a range of factors, processes and structures such as income, literacy, institutional capacity, social networks, as well as access to information, markets, technology, and services (Belachew & Iqbal Zuberi, 2015). Because the availability of these resources and services is limited in the region, adaptive capacity in the face of climate change is correspondingly low compared to other regions of the country.

Efforts to reduce the vulnerability of rural populations, therefore, must reinforce their risk management and coping capacities by augmenting existing adaptation mechanisms and supplementing them with new options that are tailored to the unique local contexts (Reid et al., 2010). Further weak institutions, limited infrastructure and resource-poor agricultural systems often limited the capacity of local community to address climate change impacts (Nassef, 2012). However, combating climate change and adapting communities to its impacts represents an opportunity for new and more sustainable investments and management choices that can also contribute to improved livelihoods and fighting poverty among communities (Montanarella Luca et al., 2015). Therefore, a better understanding of farmers' perceptions of climate change, ongoing adaptation measures, and the decision-making process is important to inform policies aimed at promoting successful adaptation strategies for the agricultural sector. Therefore, it is time to propose sound climate change adaptation systems that promote environmental and livelihood sustainability in the rural Ethiopia in general and study area in particular to draw conclusions and recommendations for policy implication on the issue of climate change and local adaptation mechanisms.

II. OBJECTIVE OF THE STUDY

The study is intended to address the following objectives:

- To realize the perception of farmers towards climate variability and natural resource management.
- To assess the extent of climate change impacts on the livelihood of rural communities and the natural resource.
- To scrutinize the rural community's adaptation system to climatic change impacts

III. STUDY AREA DESCRIPTION

Kambata Tambaro zone is located in SNNP Regional State, Ethiopia. It is bordered by Hadiya Zone to the North, Wolayita Zone to the South, Halaba Special Wereda to the East and Dewuro Zone to the West. Geographically, the study area is located between 7º08' 00"N -7º30' 00"N latitude and 37º 20' 00"E - 38º 50'00"E longitude (Figure 1). It is found at 298 Km away from Addis Ababa and 125 km from regional capital, Hawassa. It has seven rural administrative Weredas: Kechabira, Kedida, Damboya, Doyogena, Angecha, HaderoTunto and Tambaro and three administrative towns namely Durame, Shinishicho and Hadero town administration. The slopes of the study area were categorized as flat, gentle, moderately sloping and steep slope.

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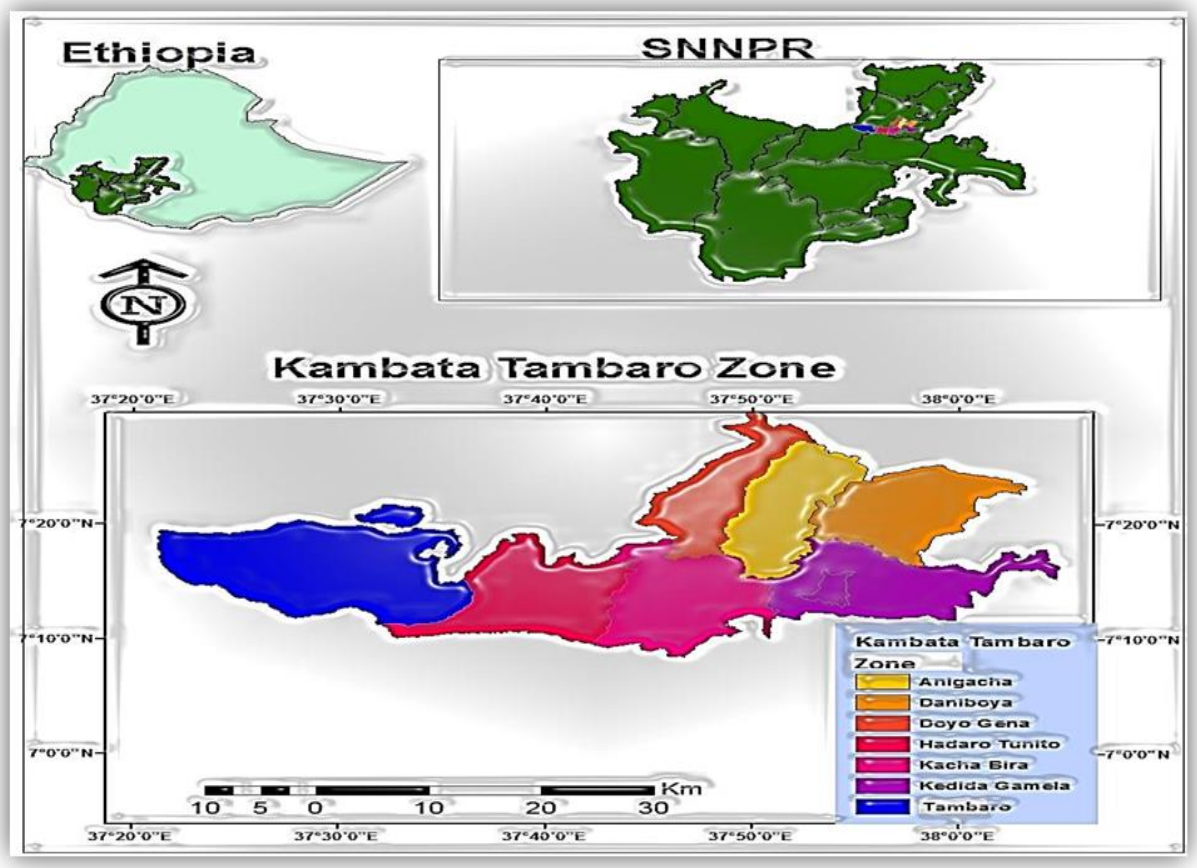

Fig. 1: Location map of Study Area

IV. RESEARCH METHODOLOGY

A. Study Design

The study was undertaken mostly by exploratory survey method. This method was chosen instead of longitudinal approach owing to the study's limitation in terms of both time and money. Unlike the longitudinal approach, cross-sectional survey method is efficient for one-time data collection and analysis.

B. Data Sources

The study was made to use both primary and secondary data sources. The primary data were collected from village elders, zonal and Woreda agricultural and environmental experts, household heads, DAs, religious and social groups**.** Secondary sources of data include Metrological Data, UNDP's Climate Change Country Profile for Ethiopia, IPCC reports, Climate related vulnerability & adaptive capacity in dry land Zones of Ethiopia (Care International), Impacts of climate change on the developing countries and other relevant research reports were used. Twenty-five years' temperature and rainfall data were used for analysis of climate variability in the study area.

C. Data Gathering Instrument

Detailed information on household demographic and socio-economic condition, data on climate change, agricultural production, farming practices and land degradation and climate adaptation system were being collected by questionnaire from 112 purposely selected household heads from the study area. Moreover, the researchers had been used field observations, expert interview and focus group discussion for gathering detailed information concerning climate variability.

D. Sampling Techniques and Sample Size Determination

Two-stage sampling strategies were used to select sample households for the study. First, the researchers had selected sample Wereda from from KT zone for this study. Hence from total of seven districts of KT zone, Hadero *Tunto Zuriya* district was selected by using purposive sampling techniques. And then from total population of the selected Kebeles of Wereda, 5% of the sample population was considered for this study. Hence the sample size of the population was 112 household head.

E. Methods of Data Analysis

Combinations of both qualitative and quantitative methods were employed to analysis the data. Household survey data were coded and entered into computer environment for analysis. Then using Statistical Package for Social Scientists (SPSS), data tabulation, computation of frequencies, descriptive statistics (mean and percentage) and Likert Scale techniques were used. Furthermore, interviews with local people, DAs, meteorological agency experts, environmental protection agents and supervisors as well as field observation notes and FDGs were analyzed qualitatively.

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V. RESULTS AND DISCUSSIONS

A. Demographic characteristics of households

From the total of 112 sample household heads, 93.75% of the respondents are male and the remaining proportions of respondents are female headed households (Table 1).

Sex	***Frequency***	***Percent***	***Cumulative Percent***
Male	105	93.75	93.75
Female	7	6.25	100.0
Total	112	100.0	

Table 1: Sex of household head

Source: Household survey, July 2018

Out of 112 household heads interviewed for the study, 76% of the respondents are at the age groups b/n 30-64 years old and about 10% are between <30 years' age group. The remaining 17% of household heads are greater than 64 years old (Table 2).

Age	**Frequency**	**Percent**
Age <30	10	9
Age b/n 30-64	85	76
Age >=65	17	15
Total	112	100.0

Table 2: Age of Household head

Source: Household survey, July 2018

The family size of the household heads indicates that about 41% of respondents have 5-8 family size. The remaining 34% of the household heads have family size less than 5 (Table 3). The result shows that majority of household heads (74%) have family size greater than 5 that have heavy burden to the economic capability of household heads.

Family Size	***Frequency***	***Percentage***
1-5	38	34
5-8	46	41
>8	28	25
Total	112	100.0

Table 3: Family Size of Household head

Source: Household survey, July 2018

B. Educational status of households

Out of total household heads covered in the survey of this study, 63% of household heads are literate. The result shows that majority of household heads have ability to read and write and some others were attended up to grade 12 educations (Table 4). Thus, they have more access to information about climate variability and its effects on their day to day livelihood.

Variables	***Frequency***	***Percent***
Cannot read and write	31	28
Only read	6	5
Can read and write	34	30
Attended grade 1-12	37	33
Graduate Diploma and above	4	4
Total	112	100.0

Table 4: Educational status of the household head

Source: Household survey, July 2018

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C. Sources of income for respondents

For about 78% of household head in study area, sales of crop production and animals were the main sources of incomes (Table 5). Majority of farmers in study area have annual income ranges between 3,000-6,000 Ethiopian Birr from the above mentioned sources.

Sources of household income	Frequency	Percent
Sales of crop production	12	11
Sales of Animals	3	3
Agro-forestry practices	4	4
Sales of crop and animal production	87	78
Others	6	5
Total	112	100.0

Table 5: Sources of household income

Source: Household survey, July 2018

D. Agricultural practices

Agricultural practices in the area were characterized by small-scale subsistence mixed farming-system, with livestock production as an integral part. Out of the total sampled household heads, 87% of farmers practice household subsistence agricultural practices (Table 6). Commercial crops produced in the study area include cash crops such as coffee and mostly Ginger crops.

Agricultural practices	Frequency	Percent
Household subsistence agriculture	97	87
Commercial and subsistence agriculture	15	13
Total	112	100.0

Table 6: Types of agricultural practices

Source: Household survey, July 2018

E. Climate variability and its consequences

Farmers of study area were interviewed about the manifestations of climate variability in the study area. About 95% of respondents perceived the climate variability problem in the study area (Table 7). This implied that there are climatic variability effects among the farming communities of the area.

Climate variability	Frequency	Percent
Yes	95	85
No	17	15
Total	112	100.0

Table 7: Problem of climate variability

Source: Household survey, July 2018

F. Trends of Temperature in the Study Area

An analysis of temperature records over the last 25 years available from the nearby meteorological station shows that there is gradual increase in both mean maximum and mean minimum temperatures (Figures 2 & 3). The mean average temperature of the study area also shows an increasing trend for past 25 years (Figure 4). Mean maximum temperature has increased by 3.2ºC while average mean temperature increased by 2.5 degree per decades for past 25 years in the study area. The analysis of the data indicates that there are increasing trends of both maximum and minimum temperature in the study area. But the data indicates high variability of temperature. For example, the mean average temperature varies from 18.1ºC in 1992 to 17.35ºC in 1993. Similarly, year 2007 the amount of temperature decline for one year and which in turn rises continuously up to 2016. These statistical changes were then compared with impressions and opinions of local communities in focus group discussions and key informant's interview. The information obtained from such sources revealed similar observations related to the increasing trend of warming conditions. The continuous increasing of temperature in study area has been created strong impact on agriculture production, loss of vegetation covers and animal productivity as reported by the farmers and communities during the focus group discussions.

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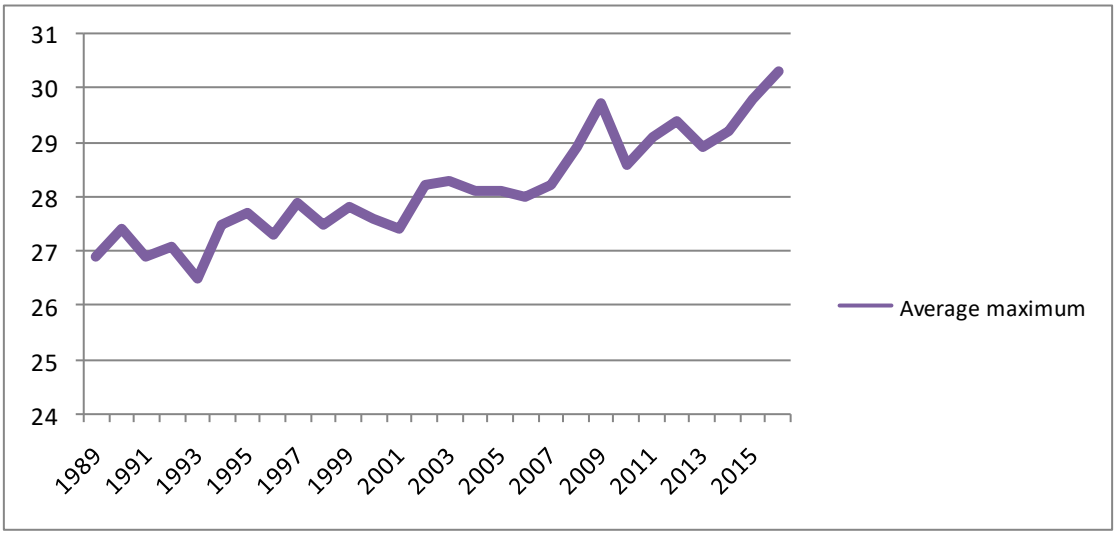

Fig. 2: Average maximum Temperature

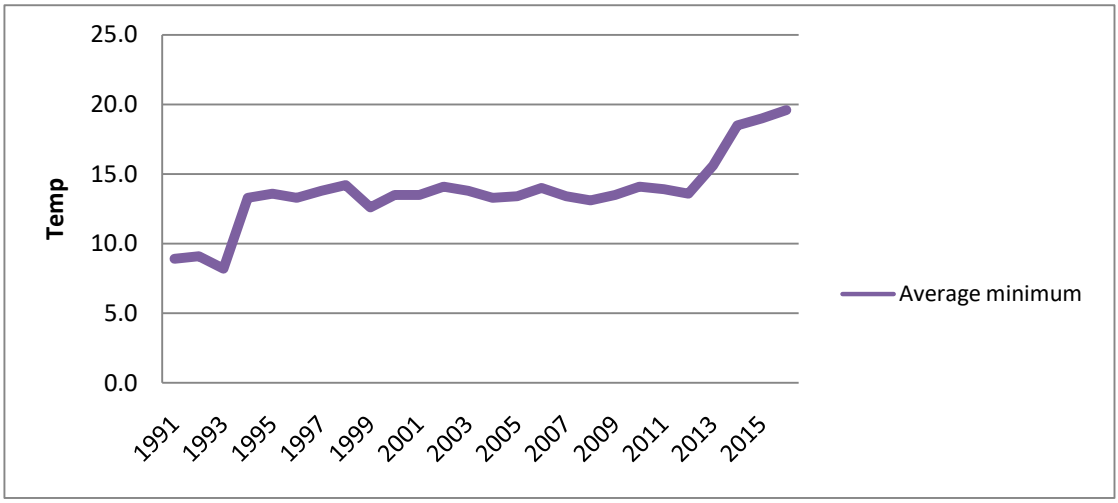

Fig. 3: Average minimum Temperature

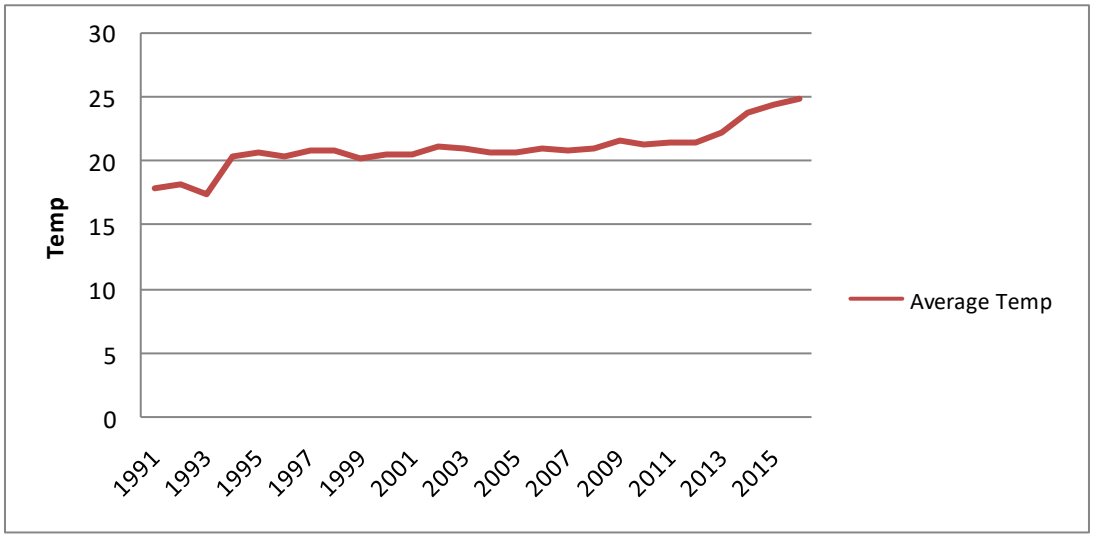

Fig. 4: Mean Average Temperature

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G. Trends of rainfall in the study area

A noticeable variation in precipitation patterns over the last 25 years had been occurred. The mean total annual precipitation in the study area during the last 25 years from 1991 to 2015 was on average only 986.26 in mm which is very low in comparison to the national annual average rainfall of 1800 in mm. A general trend of decreasing mean annual rainfall was observed (Figure 5). The total annual decreases from 1261mm in 1993 to 896.8 mm in 2015. Besides the decreasing trends, there also frequent variation of rainfall distribution was observed over different year rainy seasons in the study area.

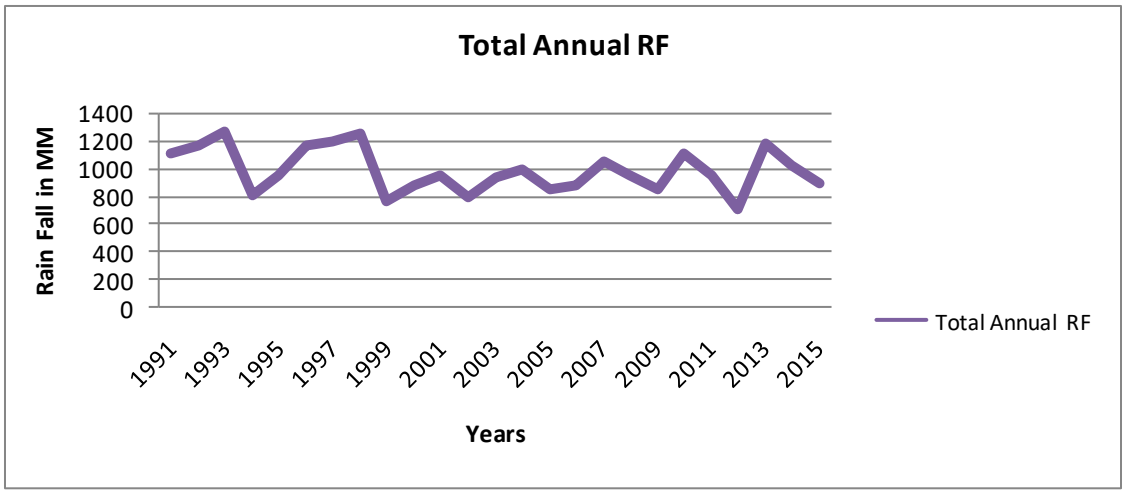

Fig. 5: Trends of total annual rain fall

H. Responses of climate variability

The climate variability perception survey using five point Likert Scale shows that about majority of respondents strongly agreed with increasing of temperature from time to time when compared with similar season in the past in their locality and about 68% of respondents also strongly agreed with decreasing of rain fall amount from time to time and rain stops earlier than in the past time in study area (Table 8). Similarly, about 46% of respondents strongly agreed that rain fall in the study area are failed to properly support the full crop growth. About 85% of the farmers also strongly agreed that cutting tree/deforestation is becoming more severe due to decrease of agricultural production because of climate change and 73% strongly agree to the statement that some community members are changing their place of residence due to poor agricultural production to support their families. On the other hand, about 95% strongly agree to the statement that sources of livelihood of the community are changing due to changing climate conditions. And about 89% of respondents strongly agreed agree that irregularity of rain fall in the rainy season is increasing. About 61% of respondent strongly agreed to the statement of that community members have enough awareness about the climate change impacts while 31% simply agreed. The responses of farmers regarding the statements which signify climatic variability effects shows that there is an issue and critical challenges of climate variability effects on economy and livelihood of rural farmers in the study area.

No	Statement of variables	Scale of agreement (%)				
		5	4	3	2	1
1	Temperature/heat is rising from time to time when compared with similar season in the past.	56	35	4.5	3	1.5
2	Rain fall amount decreasing, setting time lagging behind rain stops earlier than in the past	67.5	20.5	8	3	1
3	Rain fall can't properly support full crop growth period than earlier times.	46	35	10	5	4
4	Crop disease/pest infestation increasing more problem than earlier times	74.3	12.6	8.5	3.5	2.1
5	The prices of grain are hiking because of decreased productivity for climate change.	78	12	5	2.8	2.2
6	Tree cutting/deforestation becoming severe than earlier times due to climate change to compensate the income and livelihoods.	85	10	2.5	1.5	1.0
7	changing their homes due to inability of their agricultural production to support them due to climate change.	21	16	25	15	11
8	Some sources of livelihoods of the community are declining due to changing climate conditions	95	3	1.3	0.5	0.2
9	Irregularity of rain fall in rainy season is increasing	89	5	3	2	1
10	Community members are enough aware of the climate change impacts	60.5	30.5	6	3	1

Table 8: Responses to climate variability by respondents

*5 = strongly agree, 4 = agree, 3 = neutral, 2 = slightly disagree, 1 = strongly disagree.

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VI. IMPACTS OF CLIMATE VARIABILITY

According to the respondents of study area, the effects of climate variability include impacts on livelihood, heat and drought effect, impacts on agricultural productivity and effects on flood and erosion (Figure 6). Majority of respondents reacted that the climatic variability impacts on livelihood and agricultural productivity are the most serious effects than the others in the study area. According to focus group discussion, livelihood of farmers in the study area, as a whole depending on agriculture which is characterized by mixed farming, cereal production, livestock rearing and growing of trees /agroforestry being the main components. Therefore; climate change and variability impacts have seen as a major factor by the farmers in the study area. On the other hand, all the field and home gardens crops are rain-fed and the practices of traditional irrigations system is very limited to smaller area. Thus, climate variability has strong impacts on the agricultural outputs of farmers in the study area.

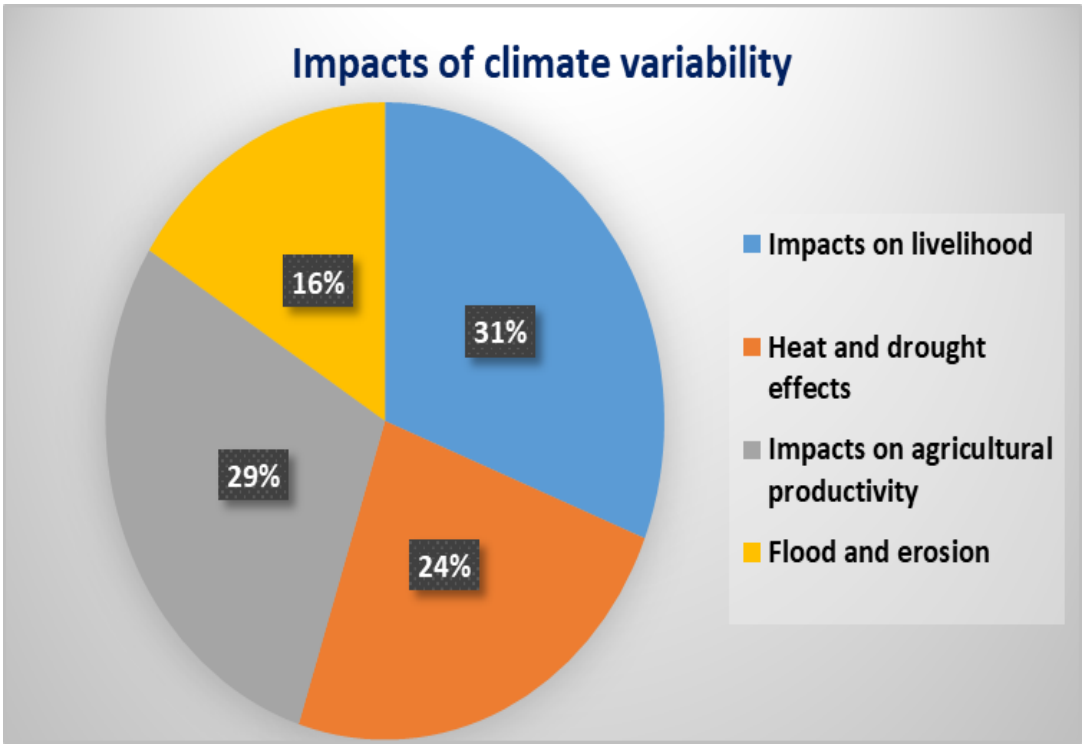

Fig. 6: The impacts of climate variability

VII. CLIMATE CHANGE ADAPTATION STRATEGIES

The farmers have been adopted different strategies to cope up with the consequences of climate change and practicing diverse components in their farming system (Agrawal, 2008). According to focus group discussion, farmers of study area were adopting climatic variability hazards by diversifying crops like *Maize*, *Sorghums*, *Wheat* and *Teff* being the main cops in the study area found to ber affected by climate variability from time to time. Home gardens crops like *Enset* (false banana), and root crops like *Boye*, *Cassava*, *Potato* and *Sweet potato* and others are now taking more areas in the cropping combinations and which are found to be mostly resisting the effects of rainfall variability. Currently agro-forestry practices are the dominant strategy applied by farmers of study area to combat climatic variability effects (Figure 7). Agroforestry practices in the study area include very wide range of plant types for diverse uses getting prominence like *Avocado*, *Mango* and *Coffee* trees are the most common. Other strategies used by farmers include growing local climate variability resistant crops responded by 24% of respondents, shifting economic dependency on farming to other sources of income generation replied by 29% of respondents and migration to urban areas (Figure 7).

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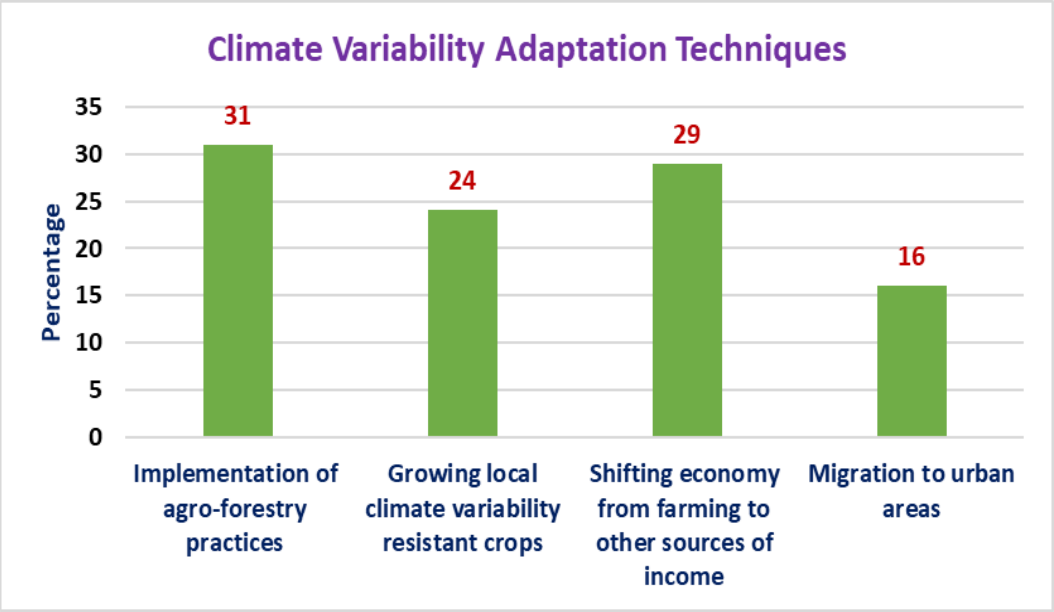

Fig. 7: Adaptation techniques

VIII. CONCLUSION

Experiences described by the respondents and supported by meteorological data revealed that there were changes in climate with negative effects on people's livelihoods in the research area. With limited livelihood options, people in the study area were affected by unseasonal weather events; specially rain fall and temperature variability. The average minimum and maximum temperature in the study area are increasing from time to time for last twenty-five years. On the other hand, the amount of the total average annual rainfall was in decreasing trend for twenty-five with a great variability effects. Agricultural production, important for subsistence livelihoods, is increasingly affected by rainfall effect and frequent drought. Trends of livestock grazing grounds are also under threat due to changing weather patterns and over-exploitation of natural resources. Majority of respondents in the study area (85%) strongly agreed that deforestation is becoming more severe due to decline in agricultural production because of climate change. The study finding shows that climate variability has the impact on livelihood, heat and drought effect, impacts on agricultural productivity and sometimes impacts on flood and erosion. Communities were struggling to adapt to their changing environment with their limited knowledge, poor assets and inadequate external support. Common practices of adaptation of agricultural production were crop diversification and selection of drought resistant crops. Currently agro-forestry practices like the growing of *Avocado* and *Mango* trees are the dominant strategy applied by farmers of study area to combat climatic variability effects.

IX. RECOMMENDATION

To overcome the climate variability effects and livelihood conditions of households in the study area, the following recommendation should be critically considered.

- The climate change adaptation activities should not be considered as an isolated strategy but rather as part of ongoing development initiatives to overcome poverty, marginalization and to buffer against environmental vulnerabilities. Therefore; concerned agricultural and environmental sectors should focus climate variability issues and its related impacts as part of everyday activity.
- Although the climate change effects are more pronounced at a local level, the responses should not be limited to local actions. Rather an integrated approach based on national and district level pro-poor policies and strategies could be used to link with mainstream efforts for planning and equity in distribution.
- Adaptation requirements of poor households are much higher in the study area hence farmers of study area need better access and improved governance of basic services such as agricultural extension, cooperatives, education and health is required to enhance adaptive capacity.
- Immediate support in the areas of crop diversification, water harvesting and sustainable management of natural resources is needed by the individual farmers. Thus, concerned government organs and NGO's should be required to involve in the issues.
- The Irregularity and shortage of rain fall in rainy season is dominantly increasing in the study area. Therefore; there is the need of small scale irrigation development in the study area for sustaining the economy of farmers who are dependent on rain-fed agriculture.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests on this research work.

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