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Climate Change Impacts on Agriculture and Adaptive Strategies of the Farming Community in Offa Woreda, Wolaita Zone SNNPR

Tibebu Tera[1] --- Zin abu Wolde[2]
[1]*Terepeza development association Sodo Ethiopia*
[2]*Departement of Plant Science, Wolaita Sodo University, Dawuro Tarcha Campus*
(*Corresponding Author)*

ABSTRACT

Agriculture is the sector mainly susceptible to the climate change impact. Climate change shock is more sever in the countries like Africa, where agriculture is for the daily survival, and where adaptive potential is low. Therefore, it is essential to increase the understanding of the real climate change dynamics on agricultural tricks and on the societies at the lower levels. This study uses the Offa Woreda, Wolaita Zone in southern Ethiopia and examines the local climatic trends and its shock on the agriculture in the region. The study uses semi-structured interview, structured questionnaire and FGDs to collect data from local society, and government experts, whereas the secondary data collected from published and unpublished materials, and systematically analyzes by using quantitative analysis. The result shows that the trend of gradual and extreme weather change has unenthusiastic shock on the agricultural tricks in almost all selected households in the study area particularly low land but has a positive role in some midland kebeles where agriculture was constrained by low temperature. To adapt the shock, societies use diversification, drought tolerant varieties, early maturing varieties, disease resistance varieties, mulching, flood control measures, irrigation, water harvesting, start trading, and family planning. Awareness raising, credit, dissemination of technology and provision of safety nets to some lowlanders are among the coping/adaptive strategies provided by the government institution, but not sufficient and sustainable to cope/adapt with climatic variation vagaries. Though most households in the selected kebeles of the study area are vulnerable to climatic crisis, the severity is acute for the poor, landless, children, women, large sized family.

Keywords: Climate, Additive strategy, Agriculture, Climate shock, Drought tolerant.

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1. INTRODUCTION

Climate change shocks are one a kind of the main global problems while its effect is more pronounced in a country where the adaptive competence is low especially underdeveloped and developing countries [6] principally attributed to their; low adaptive capacity, over dependence on agricultural sector, marginal climatic character and existence of many other stressors [7]. Agriculture specifically is whispered to be mainly susceptible sector to climate changes mainly because of the fact that, climate change directly affects the vital agricultural production inputs such as, rainfall and temperature [9].

Farming households' particularity in underdeveloped and developing countries where their livelihood occupied in subsistence is highly expose to climate change shocks. Because, it causes an increase in crop failure and enhance diseases incidence, unwanted sale of livestock in minimum price and other valuable assets. Ethiopia, most of the time defined by high unpredictability of climate [15] despite about 85% the population is directly dependent on agricultural related activities.

However, above 90% delivery of food comes from rain fed agriculture that is overwhelmingly dependent on normal amount, duration, distribution and timely onset/offset of the rainfall. Consequently, rainfall shortage and or unpredictability doesn't only mean failure crop yield, but challenge in livelihood and survival of the society [1]. The farming community is therefore likely to use different possible adaptive strategies of reducing the effect of climate change on crop production [3].

Adaptive mechanism are the approaches uses the communities take action on climate change effects in agriculture all the way through either self-directed or planned to current situation adaptation [5] whereas coping mechanisms are considered as actual short-term responses to crisis on agricultural systems in unfavorable conditions [3].

There are few attempts made to understand climate change impacts and adaptive strategies of farming community but there is limited information about climate change impact and adaptive strategies of the farming communities. Therefore, this study was initiated to address climate change impact on agriculture and adaptive strategies of the farming community in Offa Woreda, Wolaita Zone SNNPR.

2. METHODOLOGY

2.1. General Descriptions

Offa woreda is found in Wolaita Zone, SNNPR. It is located at 370.71'E and 60.83'N having altitudes ranging of 1200-2000 masl. The total area is 38537 hectare. The amount of rain fall and range of temperature were 800-1400mm and 14-340C respectively.

It is found 29 km west of the zonal capital, WolaitaSoddo and 183 km from the regional city, Hawassa. The total population of Offa Woreda in 2007 census was 127387. Agricultural system of the Offa woreda is defined by mixed farming system, livestock production, and crop production. The dominant corps in the area coverage, production and consumers number in the study area is: maize, haricot bean, teff, and root crops like cassava and sweet potatoes.

2.2. Methodology

Descriptive research approach was conducted to assess the climate change impacts and the adaptive strategies of farming community in Offa woreda from April -June 2012 using quantitative and qualitative data.

Structured &pre-tested questionnaire, interview and FGDs were used to generate information on demographic, socio-economic, climate change impact, agricultural production and adaptation strategies. From which twenty one kebeles of the woreda, four kebeles/districts were selected purposely and the numbers of households were selected by systematic stratified sampling and other additional stake holders were included. The households were selected from 4 kebeles/districts among 21 kebeles/districts of the woreda.

Namely: Geleko, Wachika-Esho, Sere-Esho, and Busha. Structured questionnaires were prepared for 160 households, 6 focused group discussions with 30 participants and 6 interviews' with 15 respondents, according to Kothari, [16]. Therefore, the totals of 205 respondents were selected.

The collected data from sample units was edited, and analyzed by tabular analysis using descriptive statistics, which is mainly describing climate change impacts and the farming community adaptive strategies. The qualitative data was reported in words, in the forms of descriptions. A statistical data base was built using the Microsoft Excel and other different computer program (SPSS version.15 analytical tool) was used after introducing and editing the information collected through the codification, cleaning and verification of the questionnaire

3. RESULTS AND DISCUSSION

3.1. Climatic Trends in the Study Area

Results of this study revealed that, early offset and delayed onset of rain, and erratic precipitation, are the major climatic shocks in Offa woreda, despite their frequency and extent of their impact varies in time (Figure 2). Accordingly, 50 %($p<0.001$) of the households confirmed that there was significant increase in the temperature in the last 20 years in the study area (Table 4). This is in line with Harun-ur-Rashid & Islam, [14] who stated that, increased frequency of unseasonal rainfall, prolonged drought, temperature increment, and unevenly distribution of seasonal rainfall is more acute in developing countries.

About 61.9 % ($p<0.001$) of households (Table 4) responded that there was observed climate change in the study area,which coincides with 2003, 2005, 2008 and 2011 famines and crop biodiversity loss [2]. The recent relatively major droughts and rain delay events that hit the study site and marked in the minds of all respondents in the focused group discussion and interviews were 1991-92, and 1999-2000, drought as well as 2002 heavy rainfall. The heavy and unseasonal rain years also include 1994, 1998, 2000, 2006 & 2008 [2]. In addition, extreme weather conditions and lack of separate alteration between seasons were observed unlike the weather in former times (Farmers of sampled households of Offa woreda).

3.2. Outcome of Climate Change

3.2.1. Outcome of Temperature and Recurrent Drought

About 33.75% ($p<0.01$) of the households selected revealed that, the outcome of recurrent drought is very high, while 15.63% ($p<0.01$) confirmed that, is low (Table 4). This outcome is might be associated with crop failure, increased incidence of plant and animal diseases especially the high occurrence in the prevalence of malaria and epidemics of livestock.

Table-4.climatic trends and agricultural productivity within the last 20 years in Offa woreda

Variables	Low	High		Very high	Chi-square (Sig.)
	%	%	%	%	
Increased temperature	1.25	9.35	39.4	50	65.034(***)
Increased recurrent drought	15.63	28.75	21.87	33.75	78.989(**)

**, ***Significant at 0.1% and 1% level of significance

3.2.2. Outcome of Rainfall and Flood

About 45.62% ($p<0.001$) of the respondents believed that, agricultural productivity is decreasing from year to year along with the changing climate (Table 5). It is evident that, under "business as standard set-

up", agricultural productivity in wide-ranging could decline along with climate change especially in the areas of rainfall dependent agriculture.

About 77.53 %(p<0.001) of the households believed that, decreased seasonal rainfall and also 61.87% (p<0.001) and 65% (p<0.001) of the households respectively determined, abnormal onset/or offset of the rainy season are causing high effects on the outcome of agricultural productivity [20]. The households further expressed that, climate change was becoming the imperative rather than the exemption leading to crop failures (FGDs). In this study, 70.72% (p<0.001) of the households confirmed that, flood is causes high effects on agricultural productivity and livelihood of the community, this consistent with [15].

The findings of interviews and focused group discussions shown that, drought and late rainfall onset causes soil drying and difficult to plough that could deteriorate the forage problem that exacerbates weakness and death of oxen which is the engine of subsistent farming as well as other livestock the result of increase of disease and shortage of forage, fodder and grass.

3.3. Crop Yield and Livestock Production in the Last 20 Years

About 62.5% (p<0.001) of the households confirmed that in the last 20years the crop yield was decreased. Accordingly, 70.63% (p<0.001) of the households (Table 5) believe that the livestock production was decreased in the last 20 years this finding was coincided [2].

Table-5. Household response on crop yield and livestock production in Offa woreda in the last 20year

Variables	**Remain the same**	Decreased	Increased	Chi-square(Sig.)
	%	%	%	
Crop yield	20.63	62.5	16.87	62.667(***)
Livestock production	20.63	70.63	8.74	26.182(***)
Average agricultural productivity (in 20 years)	36.25	45.62	18.13	83.622(**)

Significance at 5%, 1% and 0.1% level

3.4. Poverty

The 69.4% (p<0.001) of the households confirmed that climate change is one of the major contributors to poverty (Table 6). In this regard, the local government and NGOs were working together to reduce poverty by enhancing awareness of the community about improved agricultural technology.

3.5. Migration

About 43.75% (p≤0.05) of households think that climate change has lower impact on migration (Table 6). However, the woreda statistical data of 2011 indicates that 14.5% of the people were migrated to the nearby woreda like Dana, Boreda, MirabAbay and aboard of the country to work as permanent and daily labor/causal in towns. Case studies in Bolivia, Senegal and Tanzania, which were extremely prone countries to climate change, show that people affected by environmental degradation rarely move across borders, rather, they adapt to the new circumstances by moving to nearby places for short period, often to cities. This implies that the affected people often move temporarily as a positive response when there is a disrupted rainfall pattern and the changes in temperature associated with climate change.

3.6. Disease Incidence

About 60% ($p<0.001$) of the sampled households believe that increasing crop and livestock disease incidence in the study area is highly associated with the climate change, while 3.13% ($p<0.001$) do not accept climate change being the cause of disease incidence (Table 6).

3.7. Divorce

Finding showed, 45% ($p<0.01$) confirmed that family divorce related to climate change is low, while 1.3% ($p<0.01$) climate change has higher family integrity (Table 6).

Table-6. Households response on the of impact of climate change

Variables	Low	Medium	High	Very high	Chi-square (Sig.)
	%	%	%	%	
Degree of poverty	1.25	6.85	69.4	22.5	53.723(***)
Migration	43.75	10	30	16.25	45.768(*)
Disease increased	3.13	13.13	60	23.74	45.725(***)
Increases divorces	45	35	13.13	6.87	46.524(**)

*, **, *** Significance at 5%, 1% and 0.1% level

3.8. Most Vulnerable Social Groups to Climate Change Impacts

To identify the most vulnerable sector to climate change impacts, 15 key informants were selected (Table 7). About 27% of the key informants suggested that children, poor and landless, were considered as the most vulnerable groups to climatic shocks (Table 7). On the other hand, key informants suggesting women and large sized families to be the most vulnerable were equally 13%. The argument was that, the poor and landless people usually depend only on their limited income generated from working as casual laborer and thus have low potential to absorb climatic shocks. However, those with land and some asset will have better resilient capacity to the impacts of climatic shock by selling the available assets, taking credits and leasing part of their land. Similarly in India [17].

Moreover, the more susceptibility of youths compared to elders is explained by the difference in landholdings since elders have inherited land to their offspring, they are generally better in landholding and have better immunity to cope with climatic shocks. In Ethiopia flexibility to multiple income sources is limited due to limited employment opportunity and its low return [4].

To lessen the problem of landlessness, the government is however conducting relocation programs as well as apportions freely obtainable common lands, where people move their livestock during water and pasture shortage [2].

The defenselessness of women to climate change was explained from their imprisonment at home caring for children and family members, poor nutritional status, and long distance travel to collect water. According to interviewee of the experts of agricultural, “Women’s proximity to family members and detention at home makes them expose the most. The correlation between climatic impact and defenselessness of widows or divorced women, in particular, is much stronger, since women farmers typically achieve lower yields than men, which make them more vulnerable to production and income shocks [11].

Though the constitution of Ethiopia has recognized the right of women and their role in sustainable development since 1995, women’s equity in socio-economic sectors in the woreda is still low.

According to a head of 13 families' interviewee from Sere-eshoKebele, "we are always vulnerable because our family size can reach up to 10 to 15 persons per household, whereas the asset available can't exceed 8 livestock and 1 hectare of land. The growing resource scarcity and the more dependency ratio worsened the susceptibility of large sized households to crisis, as stated by Vincent, [21].

Table-7. Interview results on the most vulnerable social groups

Vulnerable group	Poor	Landless	Children	All groups	Women	Large sized families	youths	Elders	men
Woreda Cabinets	X	X	0	0	0	0	0	0	0
Farmers	0	0	X	0	X	X	0	0	0
Elder peoples	X	X	X	0	X	X	0	0	0
Young peoples	0	X	X	0	0	0	0	X	0
NGOs	X		X	0	0	0	0	0	0
Total (N=15)	3	3	4	0	2	2	0	1	0
Percent P= $^{n}/_{N}\ x100\%$	*20*	*20*	*27*	0	*13*	*13*	0	7	0

N=total number of key informants which is 15

3.9. Farmers' Perception about the Causes of Climate Change

Accordingly 62.53% ($p<0.001$) replied that, deforestation is the main causes of climate change, while 7.5% ($p<0.001$) do not agree with such opinion. On the other hand, 58.76% ($p<0.001$) believe that, climate change is the punishment of God to the people for their sin (Table 8).

Table-8. Households responses on the causes of climate change

The main cause of climate change	Low	Medium	High	Very high	Chi-square(Sig.)
	%	%	%	%	
Deforestation	7.5	3.75	17.5	62.53	161.159 (***)
God's punishment	5.63	12.5	23.13	58.76	78.25(***)

***Significant at 0.1% level

3.9.1. Crop Selection and Diversification Strategy

Accordingly 81.25% ($p<0.001$) stated that cultivating drought tolerant species particularly cassava, sorghum, and taro help to adapt climatic condition (Table 9). About 83.13% ($p<0.001$) broken up to early maturing varieties like haricot bean and maize varieties, while some local and long maturing varieties of maize and teff are also abandoned [15, 18].

About 71.87% ($P<0.001$) of households replied that, mostly they use annual crops while 3.13% ($p<0.001$) rarely use annual crops. According to California Agricultural Statistics Service, [8] climate change impacts much more slowly on perennial crops as compared to annuals. About 38.73% ($p<0.05$) of households have lesser emphasis on vegetables production, while 4.4% ($p<0.05$) believe that, vegetable production has no contribution to adapt the impacts of climate change (Table 9).

Table-9. Households response on adaptive strategies of farmers on crop selection

Variables	No	Low	High	Highest	Chi-square (Sig.)
	%	%	%	%	
Use of drought tolerant varieties	0	0	18.75	81.25	3.604(***)
Use of early maturing varieties	0	0	16.87	83.13	19.916(***)
Use of perennial crops	1.25	15	51.88	31.87	57.266 (***)
Use of annual crops	0	3.13	25	71.87	75.797 (***)
Use of vegetables	4.4	38.73	25.00	31.87	87.919(*)

**, ***Significant at 5%, 1% and 0.1% level

3.9.2. Agricultural Systems

3.9.2.1. Introduction of Agro-Forestry and Wind Break

About 38.13% (p<0.001) of households consider agro-forestry have low contribution in adapting climate change. On the other hand, 28.75%, (p<0.001) of the households highly believe that wind break trees can be used as a strategy to resist climatic shock, while 37.79%, (p<0.001) have lower consideration on wind breaks as adaptation mechanism (Table 10).

Table-10. Responses of households on the role of agro-forestry and wind breaks in reducing climatic change impacts

Variables	No	Low	High	Highest	Chi-square (Sig.)
	%	%	%	%	
Use of Agro forestry	1.87	38.13	26.3	33.7	72.852 (***)
Use of wind breaks	8.13	37.79	24.4	28.75	80.788 (***)

*, **, ***Significance at 5%, 1% and 0.1% level of significance

3.9.3. Water Harvesting, Irrigation and Mulching

Despite 48.13% (p<0.001) of households consider water harvesting activity as less important, however 12.5% (p<0.001) confirmed that water harvesting has highest contribution to adapt climate change impacts (Table 11). It is evident that, enhancing the productivity of water can be promoted through water harvesting or management of rain water [1].

The current study results indicated that 38.13% (p<0.001) of households perceive that, mulching has slight role as adaptation mechanism, while 28.13% (p<0.001) consider mulching as best option of climate change adaptation measure (Table 11). The majority, 38.13% of the households' perception associated with the existing mulching practices on root crops. About 11.25% (P<0.001) of the sampled households highly accept the use of irrigation as adaptive mechanism, while 67.5% (P<0.001) do not at all approve the use irrigation (Table 11) as a strategy, since it requires significant changes in farm layout and adequate capital [10].

Table-11. Response of households on water management practices

Variables	No	Low	High	Highest	Chi-square (Sig.)
	%	%	%	%	
Use of Irrigation	67.5	14.38	11.25	6.87	21.471(***)
Water harvesting	48.13	23.74	15.63	12.5	51.922 (***)
Mulching practice	2.5	38.13	31.25	28.13	58.989(***)

*, **, ***Significant at 5%, 1%, and 0.1% level

3.9.4. Flood Control Measures

About 61.87% (p≤0.05) of the respondents believe that introduction of flood control measures in has highest contribution to adapt climatic shock (Table 12). This may be the case of active group participation of the community in the study area to keep the land from degradation and maintain its fertility.

3.9.5. Intercropping and Use of Agricultural Chemical Inputs

About 70.63% (p<0.01) of the household responded that intercropping is one of the best agricultural practice to enhance long-term sustainability of soils and improve resilience to climate change (Table 12). It is evident that, intercropping improves the individual smallholder's income through reducing effect of price fluctuations, and minimizes impacts of climatic variations [12].

Accordingly 83.75% (p<0.001) of households revealed that farmers in the area have diversified their crops during the last 20 years (Table 12), with understanding that, use of different crop species increases fertility of soil and diversifies crop yield [19].

About 55% (p<0.001) of households confirmed that, the use of chemical inputs has lower contribution to avert the negative impacts of climate change while 26.87% (p<0.001) support chemical use as adaptive mechanism (Table 12). This may be related to the recent fertilizer price increase which is the second top challenge for the farmers in the study area next to water shortage. Hargrove, [13] has similarly stated that the unprecedented rise in fertilizer prices in the international market affects poor farmers in developing countries, particularly farmers in Sub-Saharan Africa.

Table-12. Responses of households on flood control, agricultural chemical inputs and intercropping

Variables	No	Low	High	Highest	Chi-square (Sig.)
	%	%	%	%	
Use of agricultural chemical inputs	0	55	18.13	26.87	40.860 (***)
Use of flood control measure	0	11.25	61.87	26.88	48.840 (*)
Use of similar species	0	83.75	11.87	4.4	43.611 (***)

*, **, ***Significant at 5% .1% and 0.1% level

3.9.6. Limiting Family Size

According to the current study, 55.63% (p<0.001) of households (Table 13) confirmed that, limiting family size has high contribution to adapt climate change. This is associated with educating women about birth control options and ensuring women access to family planning services.

Table-13. Response of households on role of family size reduction as adaptation measure

Variable	No	Low	High	Highest	Chi-square (Sig.)
	%	%	%	%	
Limiting family size	0	*8.12*	*55.63*	*36.25*	*55.159 (***)*

***, **, ***Significant at 5%, 1% and 0.01% level

3.9.7. Diversification of Livelihood

3.9.7.1. Increasing Number of Animals and Trading

About 45% (p<0.001) of the households consider, increasing number of animals is one of the adaptation strategies to climate change. However, 6.25% (p<0.001) reject because of the needs for

additional fodder, forage and grasses to feed the animals. On the other way, 47.5% (p<0.001) of the households consider trading to have low contribution to adapt climate change, despite 20% (p<0.001) consider it as main strategy of adaptation (Table 14).

3.9.8. Selling Homemade Handcrafts and Working as Casual Laborer

About 32.5% (p<0.001) of the households see working as casual laborer as a strategy of adaptation. On the other hand, 32.5% (p<0.001) of the households responded that, selling handcrafts such as artisans work, weaving cotton, blacksmith, traditional healing, and pottery have low contribution to climate change, (Table 14), although 9.8% of the people in the Woreda is still engaged in these activities [2]. Beside this, 5.5% of rural households are being supported by the remittance of their children who are out of their family and working in different parts of the country and abroad [2].

Table-14. Household responses on the role of livelihood diversification to reduce the impact of climate change

Variables	low	Medium	High	Highest	Chi-square(Sig.)
	%	%	%	%	
Selling hand crafts	12.5	32.5	31.25	23.75	65.769 (***)
Trading	13.75	47.5	18.13	20.64	65.374 (***)
laborer	12.5	32.5	31.25	23.75	62.754 (***)
Increasing livestock	6.25	11.25	45	37.5	68.599 (***)

*, **, ***Significant at 5%, 1%, and 0.1% level

4 .CONCLUSIONS AND RECOMMRNDATION

This study showed that, the increasing trend of climate change and its impact on agriculture of the study area is exacerbating the impact to different socio-economic activities of the society.

Though, the gradual change is fostering crop production, livestock and other related things to the study area, consequently exacerbate societal vulnerability. On the other hand, the frequent rain delay, erratic precipitation, drought, temperature increment, heavy and unseasonal rainfalls are also grave concerns for all societies in the Woreda. Based on this the following recommendation were made;

- With the ever increasing weather unreliability the involvement of institutions, farmers and other concerned bodies on early warning and robust contingency planning is crucial.
- Improving the efficiency of inorganic fertilizer and promoting sustainable cropping practices is crucial to reduce social vulnerability.
- Sustainable on land diversification should be promoted to adapt with the future likely climate change impacts.
- Promotion of development programs and addressing vulnerable groups through development of better proxy indicators of societal vulnerability.

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