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SMALLHOLDER FARMERS' ADAPTATION STRATEGIES AND SOCIOECONOMIC DETERMINANTS OF CLIMATE VARIABILITY IN BOSET DISTRICT, OROMIA, ETHIOPIA

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ABSTRACT

The study aimed at examining the ongoing adaptation strategies used by smallholder farmers in response to climate variability in Boset district. It also assessed the socioeconomic factors that influence choice of adaptation strategies of smallholder farmers to climate variability risk. For attaining the objectives of the study, both primary and secondary sources of data were employed. The primary data were obtained through household questionnaire, key informant interviews, focus group discussions and observations while secondary data were acquired through desk review. Questionnaires were distributed and filled by 328 respondents and they were identified through systematic random sampling technique. Descriptive statistics and binary logistic regression model were applied in this study as the main analytical methods. The findings of the study reveal that the sample households have utilized multiple adaptation strategies in response to climate variability such as cropping early mature crops, planting drought resistant crops, growing mixed crops on the same farm lands and others. The results of binary logistic model revealed that education, sex, age, family size, off farm income, farm experience, access to climate information, access to farm input and farm size were significant and key factors determining farmers' choice of adaptation strategies to climate variability in the study area. To enable effective adaptation measures, Ministry of Agriculture and Natural Resource with its regional bureaus and offices and concerned non–governmental organizations should consider climate variability in their planning and budgeting in all levels of decision making.

Keywords: Adaptation strategies; Boset district; climate variability; smallholder farmers.

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1. INTRODUCTION AND BACKGROUND

The Scientific Community of Climate Change, Intergovernmental Panel on Climate Change (IPCC), in its 5th Assessment Report revealed that global warming is a real, rapidly advancing and a widespread threat facing humanity, biodiversity and environment as a whole [1,2]. Climate change and variability are probably the most complex and challenging environmental problem affecting the whole nations in different magnitudes. World Bank [3] states that for over 86% of rural communities in third world countries agriculture is the main source of their livelihood which is very sensitive to small deviation and variability of climate. It is common to observe deviation of rainfall from the normal situations and life threatening events like forest fire causing elements, flooding, droughts as the result of warming of the earth [4], which further leads to low agricultural outputs exposing the mass to risks. Available evidence shows that impacts of climate variability are a global issue, but the most adverse effects will be felt mainly by developing countries due to their low level of coping and adapting capabilities [5]. "Developing countries are especially vulnerable to climate variability because of several predisposing factors such as; poverty, geographic exposure, heavy dependence on rain fed agriculture and issues of poor governance and social infrastructure" [6]. This implies that the existing development related problems in third world counties are aggravating climate variability induced risks.

In African continent, the already existing interrelated and complex problems like little ability of adaptation, low level of economic status, malfunctioning of institutions, vicious circle of poverty, rain-fed based agriculture increase the vulnerability of the continent to climate variability impacts and making its situations very acute [7,8]. Furthermore, Saguye [9] states that smallholder farmers of several regions practice their agricultural activities in peripheral areas and fragile environment which are characterized by rugged topography, landslides, low fertility of soils or areas subjected to flooding or shortage of water and therefore they are vulnerable and frequently affected by weather extreme events. The success of climate change adaptation practices of smallholder farmers is a function of different elements such as level of education and information of the communities, equipment, biophysical settings, social linkage and availability of different services that encourage and enhance the capacity of smallholder farmers to adopt new technologies (Zizinga et al., 2017) [10]. According to Teklewold et al. [11], smart adaptation practices need to be identified in this period as climate variability and change are undermining the productivity of rain fed farming practices.

Though the impacts of climate variability are much greater on rural farming communities, who primarily obtain their basic necessities from the environment, it is supposed to have significant socioeconomic and environmental impressions on Ethiopia [9]. The impacts of climate variability which mostly manifested by erratic rainfall, temperature intensification, flooding and droughts have led to a decline in agricultural production and cereal production in Ethiopia and is expected to decline still by 12% under moderate glob-al warming [12]. As stated by World Bank [3], the potential growth of Ethiopian economy has been affected by about 38% as a result of erratic rainfall which can be further aggravated by the by additional events of climate variability. According to available evidences, rainfall dependent Ethiopian agriculture will further impacted as a results of climate variability induced events such as outbreak of invasive species, widespread of diseases and pests, increased frequency of droughts, shortening of growing periods and flooding (NMA 2007), [13]. As these events combined with the fragmented and little adaptive capacity plus tropical character of the country, climate variability put Ethiopia under immense pressure.

The adaptation methods most commonly identified by scientific community of the area include: use of new crop varieties and livestock species that are more suited to climate variability, irrigation, crop diversification (intercropping and rotation), mixed crop livestock farming systems, diversifying from farm to non-farm activities, saving in cash and kind for instance, jewelry, changing use of capital and labor, increased use of water and soil conservation techniques, changing planting dates and shading and sheltering tree planting [14,15,16,10]. In fact, the adaptation strategies employed by rural smallholder households are different based on the agro climatic ecology practiced in different areas.

In *Boset district*, farming patterns are gradually changing and faced with perceived climate variability risk and its negative consequences on the livelihoods of smallholder farmers in district. It is often assumed that, climate variability is the sole driver of changes in land use decisions of farmers. Further, rural people in *Boset district* are reporting more frequent water shortages, droughts, flooding, crop failures, food insecurity and the herd size has been declining from time to time due to shortage of animal feed caused by the recurrent drought prevailing at *Boset* have become a recurrent feature of their life [17]. These imply that

work on identifications of feasible adaptation mechanisms particularly in resource poor rural farming communities. Although *Boset district* highly experiencing climate variability, farm level empirical data that show how rural smallholder farmers are responding to the effects of climate variability are limited. In line with this, Teklewold et al. [11] argue that empirical evidence with respect to effects of climate variability and its adaptation practices is limited. The authors also recommend that identification of adaptation strategies should consider the agro ecological nature of the area. As per the knowledge of the researchers, in addition, no earlier study was conducted on the smallholder farmers' adaptation strategies and socioeconomic determinants of climate variability in study area which has potential for the development and adoption of adaptation strategies package in context of smallholder farmers.

Therefore, the overall objective of the study is to analyze smallholder farmers' adaptation strategies and socioeconomic determinants of climate variability in Boset District, Oromia, Ethiopia. Specifically, the current study aims to (1) assess the existing adaptation strategies used by smallholder farmers in response to climate variability risk in the *Boset district* and (2) examine socioeconomic determinants that influence choice of adaptation strategies of smallholder farmers to climate variability risk in *Boset district*.

2. BRIEF DESCRIPTION OF THE STUDY AREA

Boset district is located at about 125 km East of Addis Ababa, capital city of the country. It is in the Central Rift Valley system of Ethiopia and situated in the central part of Oromia National Regional State. As indicated in Fig. 1, the district is found in between 8° 25' – 8°50'North latitude and 39°15' – 39°50'East longitude and shares boundaries with Fentale, Adama and Lume districts, Amhara Regional State and Arsi zone. Only 1% of the district is high land while midland and lowland cover 20% and 79% of the total area, respectively. The altitude ranges from 1600 – 1800 meters above sea level [18]. The major climatic condition of this district is tropical (*kola*). The temperature of the district is intensified by rift valley floor topography. As a result, the mean annual temperature over the vast (90%) part of the district ranges 20 – 25$^{°C}$ and the mean annual rainfall of 600 mm – 900 mm. The farmers generally grow maize, teff, common beans, sorghum, haricot and barley. In addition, cattle, goats, donkey, and chickens are the major livestock raised by smallholder farmers in the study area.

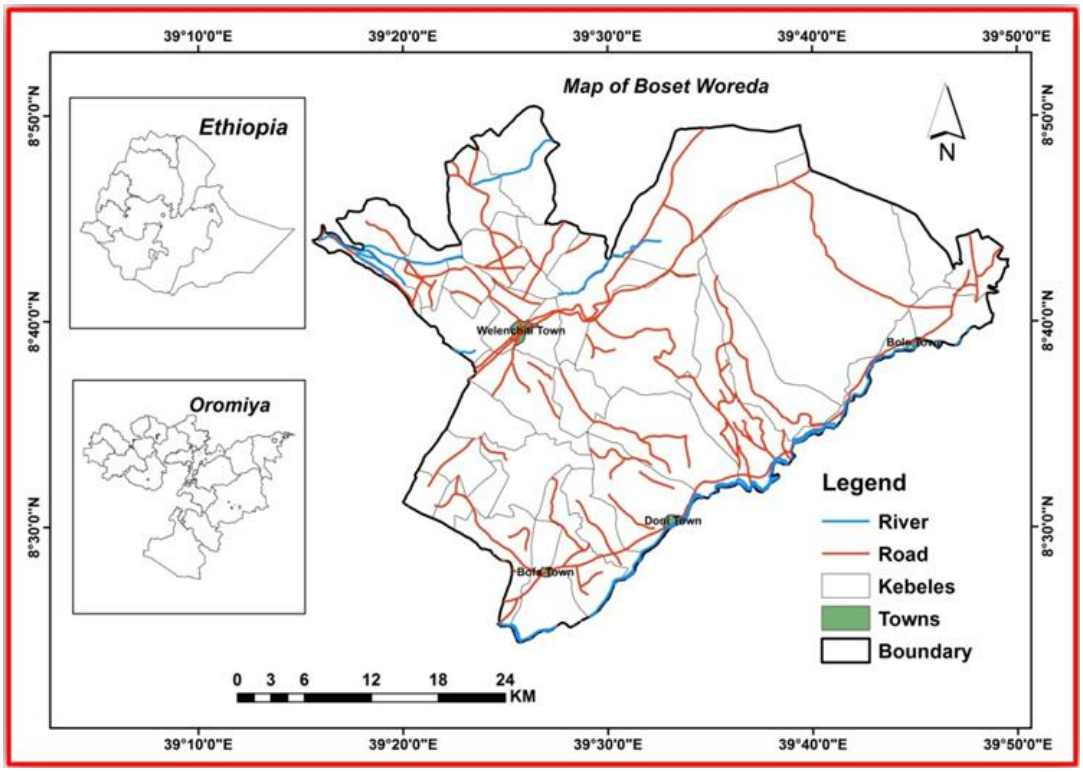

Fig. 1. Location map of Boset district

Source: Developed using EthioGIS data (2007) using ArcGIS software 10.3 version

3. METHODOLOGY

3.1 Research Design and Data Sources

In order to undertake this study, social survey design was employed. This design gives a group of people a survey with lots of questions, and the participants answers the questions. It is easy, simple and inexpensive, and researchers can get hundreds of people to complete the survey in a relatively short period of time. This design is used to identify climate variability adaptation strategies and analyze the factors that influence choice of adaptation strategies of smallholder farmers. Primary data such as, demographic, socioeconomic, ongoing adaptation activities to climate variability and socioeconomic factors that influence selection of adaptation strategies to climate variability were collected through questionnaire, focus group discussion, key informant interview and observation. The study had begun with secondary data analysis through the detailed review of related literatures. In this regard, different books, published and unpublished documents, journals, articles and research papers were reviewed to get information on theoretical and empirical framework of the study.

3.2 Sampling Techniques and Sample Size

Three sampling stages were applied in this study. At first stage, among the existing rural kebele administrations of *Boset district*, 10 have been identified purposively which are affected by climate variability manifested in the form of drought and high rainfall variability. In addition, the mentioned *kebeles* are also receiving all rounded aid from relief agency of the district. At the second stage, from the 10 purposively identified *kebele* administrations, four *kebele* administrations have been selected by simple random sampling technique. The selected *kebeles* were *Rukecha Bokure, Butta Donqore, Borchota* and *Marko*. Simple random sampling technique is assumed to provide minimum bias by giving all individuals an equal chance to be chosen. Moreover, the sampling is assumed to give advantages of ease of use and its accurate representation of the larger population. At the third stage, systematic random sampling was employed to identify individual samples for the study. The numbers of households in each kebele were *Rukecha Bokore (453), Buta Donkore (165), Borchota (662), Marko (535)* having the total households of 1815. Therefore, taking into consideration the probability proportional to size of households in each kebeles, researchers used 328 households as a total sample size which was calculated through Yamane's [19] sample size determination formula as follows:

$$n = \frac{N}{1+N(e)^2}$$

Where n is the sample size, N is the total number of households, and e is the margin of error designating to be 0.05 by 95% level of significance.

$$n = \frac{1815}{1 + 1815\ (0.05)^2} = 328$$

The study has employed a number of primary data collections methods such as questionnaire, key informant interviews, focus group discussions and personal observation.

3.3 Data Collection Tools

Household questionnaire survey was distributed for sample households of 328 and incorporated both close-ended and open-ended questions. A pretesting of the questionnaire was performed to avoid missing any important information. By doing so, ambiguous words and inappropriate questions were deleted and replaced, clarity of statements was improved, and grammar and interpretation of instructions were checked. Thus, for data collection, four enumerators who have experience in data collection, know the study area well and speak language of the community were recruited, oriented by the researchers and employed. Delivery of questionnaires using qualified enumerators and collecting them on the same day from the respondents enabled the researchers to acquire 100% response rate. Furthermore, the overall objective of the study was also described to the smallholder farmers which ensure commitment and maximum involvement in the study.

Four focus group discussions were also conducted as data collection method in which seven members were involved in one group. In this case, developmental agents, experienced elders, relief agency workers and household heads were participated in the discussions. The discussion took about one and half an hour in each group to obtain participants' impressions, interpretations, and opinions freely. Furthermore, considering their knowledge and exposure they have, nine participants of key informants were selected (3 from district agriculture office, 2 from elders and 4 from household heads) and the whole process of the activity was directed by the researchers. In addition, field observation was also made by the researchers in collaboration with district agriculture office experts and natural resource conservation office experts. Guided by experts, the researchers observed areas vulnerable to climate variability impacts and adaptation activities practiced by the stallholder farmers.

3.4 Methods of Data Analysis

The qualitative data gathered through key informant interviews, focus group discussions and observation were analyzed through narrative method by classifying and organizing into specific patterns on the basis of their similarities and differences. The data collected through questionnaire for quantitative analysis were summarized, coded and manipulated by using the Statistical Package for Social Sciences (SPSS) version 20 for analyzing adaptation strategies of smallholder farmers and assessing socioeconomic determinants using binary logistic regression model. The specified regression was used to analyze socioeconomic determinants/factors of adaptation mechanisms because the dependent variable i.e., adaptation strategy to climate variability is dichotomous in nature and can be represented by dummy variables taking the value of '1 if a household adopt' and 0 otherwise. A farmer is considered to be an adaptor of climate variability, if farmer employed at least two of the adaptation strategies such as early and late planting, use of drought resistant crops, soil and water conservations cropping of mixed crops on the same farm lands, conservation farming and irrigation farming. Thus, the logistic regression equation is represented as:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \ldots + \beta_{13} x_{13}$$

In this model, Y is a dichotomous dependent variable (smallholder farmers using any adaptation technology or not) $x_1 - x_{13}$ are independent variables and $\beta_1 - \beta_{13}$ are set of coefficients for interpretation. The identification of independent variables used in the study was influenced by reviewed literature and the knowledge about adaptation to climate variability in Boset district as summarized in Table 1.

4. RESULTS AND DISCUSSION

4.1 Characteristics of the Respondents

The data in Table 2 reveals that majority (78%) of the respondents were male headed households which is similar report with CSA [20] and significant number (37%) of them fall in age group of 36 – 45 years. The majority (8.84%) of the female respondents were also in the same age category. As it is indicated in Table 2, the mean and standard deviation of age of sampled households were 45.5 and 12.5 years respectively which shows that the mean age of sampled households are in active and productive ages indicating that they can point out the ongoing adaptation activities in response to climate variability in their surroundings. As it has been presented in Table 2, majority (69%) of the respondents had 4 – 7 family members having minimum and maximum of 1 and 13 members respectively implying that they have large family members. Based on the finding of the study, the surveyed households had averagely about six family members which is greater than the national average family sizes of five members as reported by CSA [20]. This had its own impact on application of climate variability adaptation strategies as active and large families have economic advantage for increasing the agricultural production and productivity by participating on adaptation strategies.

Table 1. Description of independent variables used in the binary logistic regression

Code	Description of independent variables	Measurement	Expected Sign
x_1	Farm income	Continuous	+
x_2	Education level of household heads	Continuous	+
x_3	Age of the household heads	Continuous	-
x_4	Farm experience	Continuous	+
x_5	Family size	Continuous	-
x_6	Sex of household heads	Dummy	+
x_7	Off farm income (annual income)	Continuous	+
x_8	Access to extension services	Dummy	+/-
x_9	Access to climate information	Dummy	+/-
x_{10}	Access to credit	Dummy	+/-
x_{11}	Farm size of households	Continuous	+
x_{12}	Access to farm input	Dummy	+/-
x_{13}	Access to market	Dummy	+/-
	Number of observations	328	

Table 2. Age, sex and family size of the surveyed households

Age in Years	Sex						Mean	SD	Family size	N	%
	Male		Female		Total				Below 4	43	13
	N	%	N	%	N	%			4 – 7	226	69
Below 26	4	1.2	1	0.3	5	1.52	45.5	13	7 – 11	53	16
26 – 35	34	10	8	2.44	42	12.8			Above 11	6	2
36 – 45	121	37	29	8.84	150	45.7			Minimum		1
46 – 55	63	19	22	6.71	85	25			Maximum		13
Above 55	35	11	11	3.35	46	14			Mean		5.7
Total	257	78	71	21.7	328	98.8			SD		2.2

N stands for number of respondents, SD is for standard deviation and % is for percent
Source: Survey result, 2020

As it is depicted in Table 3, for about 62% of the respondents, farm production was the major source of income which is followed by sale of charcoal (14%) and petty trade (9%). There were also households who supply their labor and rent their land as sources of income. Other sources such as fattening of goats and sheep as well as gaining different subsidiary from different institutions were used as source of income for surveyed households. For instance, religion institutions were supporting sampled households by paying school payments to their children, giving different cereals like *teff*, *maze* and soap, edible oil and also house furniture. The data in Table 3 reveals that majority (42.1%) of the respondents cannot read and write and significant number (40.7) of the sampled households also can only read and write implying that about 80% of the surveyed households did not attend formal education. However, access to education has immense role to adopt the new farm technology and other climate variability adaptation strategy to improve rural farm production and productivity.

4.2 Adaptation Strategies to Climate Variability

In rural area smallholder farmers have utilized multiple adaptation strategies to withstand the problem which results from persistent climate variability. In *Boset district*, semi-arid agro climate is dominant with unpredictable and highly varied amount of rainfall. Accordingly, to understand the adaptation strategies of climate variability being practiced in the study area, information has been compiled from sampled smallholder households and presented in Table 4. As it depicted in the table, about 96.3% of the sample households have utilized different adaptation strategies like cropping early mature crops, planting drought resistant crops and using intercropping. Accordingly, majority of the surveyed smallholder farmers (66%) used intercropping, 61% were planting early mature crops, 57% practiced planting drought resistant crops, 36% mixed crop livestock farming systems, 28% used non-farm activities and others which were also observed by the team.

The identified strategies were also mentioned again and again by almost all participants of focus group discussions indicating that their responses are similar with the results obtained from household questionnaires. The discussants also explicitly demonstrated that smallholder farmers of the area were using multiple activities in response to climate variability. Agreeing with the results of household questionnaires and focus group discussants, key informant interviewees also mentioned some of the adaptation strategies being implemented by the communities in the study area like renting out land, receiving food aid from government and NGOs, wise storage of seeds until cultivation and storage of livestock fodder. The finding of the study is consistent with the studies conducted by Belay et al. [16] in Arsi Negelle district, Ethiopia and Yamba et al. [10] in

Table 3. Major sources of income and level of education

Major sources of income	N	%	Level of education	N	%
Sale of farm production	203	62	Cannot read and write	138	42.1
Sale of charcoal	46	14	Able to read and write	133	40.7
Supplying their labor	26	8	Primary education	42	12.8
Petty trade	30	9	Secondary and above	15	4.4
Land rent	13	4	Total	328	100
Others	10	3			

Source: survey results, 2020

Table 4. Climate variability adaptation activities used by farmers of the study site

Types of Adaptation Strategies	*Percentage Responses
Planting early mature crops	61
Planting drought resistant crops	57
Intercropping	60
Mixed crop livestock farming systems	36
Use of non-farm activities	28
Migrating from dry to wet land near the river banks	26
Rain water harvesting	23
Use of water and soil conservation	16
Irrigation	10
Others	8

** Percentages were resulted from multiple responses*
Source: survey results, 2020

Bosomtwe district, Ghana. The adaptation practices identified by the studies were change of crop variety, irrigation, increasing farm inputs, planting date adjustment, soil and water conservation, integrating crop with livestock and tree planting.

4.3 Socioeconomic Factors that Influence Choice of Adaptation Strategies

Poor adoptions of farm technology like access to farm inputs, credit, market, and irrigation are commonly observed in smallholder traditional farming system of Ethiopia particularly in rural areas. Persistent climate variability combined with poor adaptation strategies is a serious problem of rural based farming communities. Logistic model was applied in this study to identify the factors of poor adaptation strategies and the result of the model is presented in Table 5.

Sex of Household Head: The sex of the household head significantly and positively affects adaptation strategy selection of the smallholder farmers having value of B=0.466, df=1, sig=0.088, Exp(B)=1.593. The odds ratio of 1.593 shows that under constant assumption, climate variability adaptation strategies are higher by a factor of 1.593 as the household head is male. Similarly, the summarized results of focus group discussions held at different sites also indicate that culturally females are mostly engaged in activities like, child bearing, and constructing grass-thatched housing and other home works rather than taking part in farm activities.

Education of Household Head: As it can be observed from the regression table, education is significant explanatory variable having positive coefficient (B=0.406, df=1, Sig=0.043, Exp(B)=1.501). The odd ratio of 0.999 indicates that under constant condition, the adaptation of climate change strategies increases by a factor of 0.999 as the educational status of household head increases by one year of schooling. This is supported by the fact that education helps to increase farmers' ability to obtain and process information relevant to the climate variability adaptation strategies. The findings indicated that farmers with high education level were more likely to adapt as compared to farmers with low education status which is supported by the results of key informant interviews and focus group discussions. Similar findings were also reported by Ndungu and Bhardwaj [21] who observed that "higher level of education leads to an increase in the probability of adopting new technologies since it increases one's ability to receive, decode, and understand information relevant to making innovative decisions".

Age of Household Head: This variable is significant and related negatively with the farmer's adaptation to climate variability (Table 5). This trend has significant implication for climate variability adaptation strategies as elderly people might be less interested in adapting new production systems. The odds ratio of 0.958 shows that under constant assumption of climate variability, adaptation strategies decreases by a factor of 0.958 as the age of household head increases by one year. The results are in line with findings of Ndamani and Watanabe [22] who found out that the likelihood of adaptation to climate change and variability decreases in older farmers as they generally lack interest and incentive to adapt.

Family Size: Having the statistical value of B=-0.041,df=1,Sig=0.049, Exp(B)=1.042, family size is negatively related to climate variability adaptation strategy which is in contrary with findings of Yirga [23] who states that "household size is a proxy to labor availability, and thus a larger family size is more likely to adapt since farmers can take up labor intensive adaptation measures". This holds true when the family members are engaging in the farming activities which is not the case in study site as reported by survey results and discussions. This is most probably because the household members in the

study area are more of children who are not ready for actively involving in farming activities.

Off-Farm Income: This variable is significant to predict the model and related positively with the smallholder farmers adaptation strategy to climate variability. This has significant implication for climate variability adaptation strategies as having diversified income sources may improve capacity to practice climate variability adaptation strategies. The odd ratio of 1.00 shows that, under constant assumption climate variability adaptation strategies increase by a factor of 1 as the off-farm income increases by one birr. The results correspond with findings by Mutung et al. [24]. The summarized results of key informant interviews and focus group discussions also demonstrate that farmers with diversified income do not fear to take risks and they are more likely to employ new and variety of adaptation strategies in response to climate variability.

Farm Experience: This variable is related positively with the smallholder farmer's adaptation to climate variability as presented in Table 5. This trend has significant implication for climate variability adaptation as experienced farmers might be very interested in adaptation to different agricultural practices and strategies. The odds ratio of 0.974 shows that under constant assumption adoption to climate variability strategies increases by a factor of 0.974 as the experience of household head increase by one year. The results corroborate to findings by Ndungu and Bhardwaj [21] and Maddison [14] who indicated that "farming experience increases the probability of adoption of climate change and variability adaptation strategies and argued that experienced farmers have better knowledge and information on changes in climatic conditions and crop and livestock management practices".

Farm Size: Availability of adequate farm size is highly important when farmers are ready to adopt new technology. Farm size is positively related to the adoption to climate variability adaptation strategies. The positive relationship shows that the odds ratio in favor on the probability of adopting climate change adaptation strategies increase. The odds ratio of 1.052 for availability of farm size implies that, other things being constant, adoption of climate variability adaptation strategies increases by a factor of 1.052 as farm size increases by one unit. As presented in the group discussions, farm size limits most of the farmers' activities as the size of farmland is limited.

Access to Climate Information: The odds ratio result of the data collected in the study area revealed that adoption of climate variability adaptation strategies increases by a factor of 2.6 as smallholder farmers accessed to climate information (Table 5). Generally, the likelihood of adapting to climate variability like intercropping, planting early mature crops, water and soil conservation, harvesting rain water and others is higher for those households who received climate information than those who did not. This is because access to climate information increases farmers' awareness and knowledge on the changing rainfall and temperature patterns as well as the possible climate variability response strategies which have been acknowledged during focus group discussions and interviews. Study done by Maddison [14] noted that "awareness and knowledge of precipitation and temperature by farmers is key in climate change and variability adaptation and decision-making process".

Table 5. Binary logistic regression model output

Variables	B	S.E.	Wald	Df	Sig	Exp(B)
Sex of household head	0.466	0.273	2.913	1	0.008*	1.593
Education of household head	0.406	0.21	3.742	1	0.043**	1.501
Age of household head	-0.042	0.029	2.149	1	0.043**	0.958
Family size of household head	-0.041	0.096	0.183	1	0.049**	1.042
Off farm income	0.000	0.000	0.822	1	0.036**	1.000
Farm income	0.000	0.000	0.265	1	0.057ns	1.000
Farm experience	0.026	0.028	0.886	1	0.006*	0.974
Access to credit	0.196	0.354	0.304	1	0.051ns	0.822
Access to extension services	0.114	0.298	0.147	1	0.452ns	1.121
Access to Climate Information	0.953	0.343	7.737	1	0.005*	2.594
Access to farm input	0.815	0.263	9.625	1	0.002*	2.259
Access to market	0.112	0.339	0.109	1	0.241ns	0.894
Farm size	0.051	0.155	0.108	1	0.042**	1.052
Constant	1.04	0.867	1.439	1	0.23	2.828
Chi^2 (13) 13.082		Pseudo R2		0.474		

** Significant at 0.01 and ** significant at 0.05 level while ns represent non-significant*
Source: compiled from survey results, 2020

Access to Agricultural Inputs: This Variable is related positively with the smallholder farmers' adaptation strategy to climate variability having value of B=0.815, df=1, Sig=0.002, Exp(B)=2.259. It has significant implication for climate variability adaptation strategies as more access to agricultural input may improve their understanding and choice of climate variability adaptation strategies. The odd ratio of 2.259 shows that other things remain constant climate variability adaptation strategies increase by a factor of 2.259 as the smallholder farmer accessed to agricultural input by one unit.

5. CONCLUSIONS AND RECOMMENDATIONS

Persistent climate variability and its poor adaptation strategy strongly affect the agricultural production and productivity as well as human health. The study concludes that smallholder farmers of Boset district were applying various adaptation strategies to minimize adverse impacts of climate variability thereby enhancing their resilience. The study also concludes that sex, education, age, family size, off-farm income, farm experience, access to climate information, access to farm input and farm size were statistically significant and influenced the adoption and practices of adaptation measures to climate variability of smallholder farmers in the study area. The Agriculture office of the district and the meteorological department should ensure accurate, reliable and modified weather information for rural stallholder farmers. Establishment of weather advisories has crucial role for smallholder farmers and information can be packaged and disseminated to the rural farming communities through extension service, leaders of district and *kebeles*, brochures, flyers, and local radio, among others. This process should also apply for development of adaptation strategies packages. Farmers should be empowered to adopt recommended adaptation strategies through organizing their active family members, farmers association and supporting the association through agricultural extension training which paves the way for resilience of the farmers. To enable effective adaptation measures, non–government organizations operating in the area as well as the government must consider climate variability in their planning and budgeting at all levels of decision making.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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