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Effects of Climate Change and Variability on Coffee Production and Adaptation Mechanisms: The Case of Small-Holder Farmers at Dara Woreda, South Ethiopia

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Abstract
This study was carried out with the objective of examining the extent of climate variability and its effect on coffee production and identifying determinants for farmers' decisions to undertake adaptation measures in Dara woreda. A multistage sampling technique was employed to select peasant association. Qualitative data were gathered through focus group discussion, key informant's interviews and quantitative data were also collected from 145 sample households. Logit model was used to identify the determinants for farmer's decisions on adaptation measures, while linear regression and Pearson's correlation were used to identify relationships and effects of climatic variables on coffee production. The results of this study reviled that, 93% of the respondents perceives the existence of reduction in rainfall, while 85% believes an increase in temperature over the last 20 years. The analysis of linear trend also show not only inter-annual and seasonal variability, but also a decreasing trend of rainfall in the area. The meteorological data also confirmed the increase in both maximum and minimum temperatures. Similarly, the annual yield of coffee productivity showed a decreasing tendency in the area for the period 1995-2014. Besides, the results of linear regression showed that, the amount of rainfall received and increased temperature significantly affected coffee production. Similarly Pearson's correlations indicated negative relationship between temperature and coffee yield, and strong correlation between rainfall and coffee yield. On the other hand, results of the logit regression model illustrated that; education level, farm size, access to credit service and family size being the major determinants for the farmers' decisions on adaptation measures in the area. Thus it would be vital to acknowledge the impacts of climate variability on coffee production in Dara woreda and considere the determinant factors to implement appropriate adaptation measures in order to address the impacts of climate change and variability in the area.
Keywords: adaptation, climate variability, climate change, Dara woreda, logit model
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1. INTRODUCTION

1.1. Background

Agriculture is the foundation for the Ethiopian economy, and the overall economic growth of the country is highly correlated to the success of the agriculture sector. Agriculture accounts for about 43% of the country's Gross Domestic Product (GDP), 90% of exports, and 85% of employment (ATA, 2016). However the impact of impact of climate variability on agriculture is quite significant.

Gurung, (2008) stressed that agriculture has already suffered from the negative economic and ecological consequences of climate variability. Accordingly, the effect is expected to continue and rural communities are increasingly becoming vulnerable to climate induced hazards, especially in developing countries. Moreover, (IPCC, 2007) projected that yields of crops in some countries could be reduced by as much as 50% by 2020, with smallholders being the most affected. This prediction and expectation coupled with the current situation worries all citizens especially in developing countries.

Consequently, the government considers agriculture as the major source of overall economic growth in its different growth strategies including the Growth and Transformation Plan (GTP). In the GTP, for example, the ambitious overall economic growth objective bases itself on agricultural sector, since the sector is believed to carry the overall socioeconomic burden of the country.

The principal development programme of GTP was therefore focusing on maintaining rapid and broad-based growth to eventually reduce poverity through the overall growth of agricultural sector. The issue of climate variability thus stands at the center of this transformation agenda, as climate is the major environmental factor that affects nearly all agriculture related human activities (ATA, 2016).

The climate change as rise in temperatures and erratic rain fall on wide spread infection of coffee berry disease may already be affecting coffee production in Ethiopian. Rising temperatures and erratic rain fall are threatening sustainable coffee production by enabling outbreak of diseases and infestations of insect pests that decrease the quality and yield of coffee berries (Kifle, 2015). Therefore, this study was prepared to assess the effects of climate change and variability and adaptation mechanisms of the study area.

1.2. Objective of the study
The general objective of this study is to assess the effects of climate change and variability on coffee production and adaptation mechanisms in Dara woreda, SNNPR of Ethiopia.

2. METHODOLOGY
2.1. Description of the study area
Dara is one of the administrative woreda of Sidama, Sothern Nations Nationalities and Peoples' Region of Ethiopia. The woreda administration Kebado which is located at 87 km southeast of the regional capital Hawassa and at 355 km South of Addis Ababa. Geographically located at 6^{0} 30'N latitude, 38^{0} 25' E longitudes. The Woreda receive a mean annual rainfall varying from 1000mm-2800mm and mean maximum and minimum temperature of 26 ^{0}C and 10 ^{0}C. The altitude ranges from 1554 - 2149 masl (SAZ, 2005). It has a total population of 155,265, of whom 76,475 are men and 78,790 women (CSA, 2010).

2.2. Methods of Data Collection
Both quantitative and qualitative data were gathered from primary and secondary sources. Quantitative data were generated through randomly selected household by employing structured interviews in two PAs namely Setamo and Kumato. Relevant secondary data such as: population of the study kebeles, metrological data of the last two decades and coffee yields for a period of 1995-2014 were collected from records, reports and other published and unpublished documents from the concerned offices. Qualitative data were also gathered through focus group discussion, key informant's interviews, informal discussions with farmers, and personal observations.

2.2.1. Key Informant Interview (KII)
The key informants were selected from each of the selected kebeles. Accordingly, six key informants from each kebeles were selected making a total of 12 based on; how long they lived in the village; the experience and position in their local village with consultation of development agents.

2.2.2. Household Survey (HS)
Structured questionnaires for the household survey were developed based on the available information from development agents, experience and knowledge of the researcher and administered by face to face discussion with the household head.

2.2.3. Focus Group Discussion (FGD)
The focus group discussions were conducted with two groups comprising of six members representing six villages in each kebele. In this regard, two focus group discussions were attended by 12 people experienced and elder personnel's.

2.3. Sampling Procedures and Sample Size
A multi-stage sampling technique was employed to select peasant associations (PAs) and sample respondents. In the first stage, Dara woreda was purposively selected because of its coffee production potential.

In the second stage, categorization of selected kebeles was done in consultation with woreda agricultural office, NGO staffs working in the area and available documents which provide information about coffee production practice of the area. Furthermore, numerous rules-of-thumb have been suggested for determining the minimum number of subjects required to conduct regression analyses. These rules-of-thumb are evaluated by comparing their results against those based on power analyses for tests of hypotheses of multiple and partial correlations. Accordingly, in this study sample size selection is based on the rule of thumb $N \geq 50+8m$, where, N, is sample size and `m` is the number of explanatory variables (Xi) where i=1, 2…8. Based on this rule the researcher took a total sample of 145 respondents from the selected two PAs. The sample of respective households is also selected random from the two strata i.e. 101 households from high potential area and 44 households from medium potential area.

2.4. Method of Data Analysis
Both descriptive and econometrics data analysis techniques were used to analyze the quantitative data in this study.

2.4.1. Descriptive Statistics
Various descriptive statistics tools such as, tabulation, graphs or diagrams and charts were used. Appropriate statistical tools such as mean, percentage and frequency of occurrence were used for the study of effects of climate variability on coffee production.

I.Determination of trends in rainfall

Seasonal and annual patterns were computed from monthly rainfall data, by using parametric trend analysis technique (linear regression). The rainfall data was disaggregated into two growing seasons February to May (FMAM) and June to September (JJAS). The main growing season is JJAS (June, July, August, September) while the second growing season is FMAM (February, March, April, May). The linear equation was used to describe the changes in rainfall.

y = aX+b -- Equation (1)

Where, y = the rainfall amount in millimeters, a = the rate of change (slope) of rainfall over the period and b= the intercept on y-axis.

II.Determination of trends in temperature

Seasonal and annual trends of maximum and minimum temperatures were computed from monthly temperature data. Trend and patterns determined by parametric trend analysis technique (linear regression). The linear equation was used to describe the changes in temperature.

y = aX+b -- Equation (2)

Where, y = the temperature amount in °C, a= the rate of change (slope) of temperature over the period of 1995-2014 and b= the intercept on y-axis.

III.Determination of rainfall variability

Coefficient of variation gives an estimate of the degree to which rainfall important for agriculture is either stable or changing.It was calculated as:

$CV = \sigma/\mu$ --- Equation (3)

CV is used to classify the degree of variability of rainfall events as less, moderate and high. When CV<20% it is less variable, CV between 20% and 30% is moderately variable, and CV greater than 30% is highly variable Gebremichel *et al.* (2014).

2.4.2. Econometric Analysis

Econometric model was used to identify the effects of climate variability on coffee production by using regression models, while logistic regression model was used to analyze the determinants/factors of adaptation mechanisms. Coffee yield time series (kg/ha) (dependent variable) and climate parameters (independent variable) were used as inputs in the analysis of regression models.

I. Multiple Linear Regression (MLR)

The Regression analysis was used to analyze the statistical dependence of yield (dependent variable) on climate parameters; rainfall and temperature (explanatory variables) and estimate or predict the mean or average value of the dependent variable on the basis of the known or fixed values of the explanatory variables.

An option to the regress command called beta, which would give the standardized regression coefficients. The beta coefficients were used to compare the relative strength of the predictors within the model. The beta coefficients are the coefficients that would obtain if the outcome and predictor variables were all transformed standard scores, also called z-scores, before running the regression.

II. Logistic model

Logistic regression has been used extensively in the health sciences since late 1960s to predict a binary response from explanatory variables (Lemeshow, 1988). The response (dependent variable) is binary or dichotomous variable taking two values, i.e. 0 if the household adopt and 1 otherwise (not adopt). Estimation of this type of relationship requires the use of qualitative response models. This means that the dependent, regress and is qualitative in nature unlike regression models that their dependent variable is quantitative.

The dependent variable i.e., adaptation strategy to Climate variability is dichotomous in nature and can be represented by dummy variables. When dealing with a dichotomous dependent variable our main interest is to assess the probability that one or other characteristics is present (Mukherjee, 1999) . In this study a dichotomous dependent variable adaptation strategy to Climate change and variability can be taken as dependent variable and has been represented in the model by dummy variable taking the value of 0 if a household adopt and 1 otherwise. Therefore for this study household participation in adaptation strategy (Yi) depend on the various explanatory variables X_1, X_2, X_3, X_4, X_5………………Xn which can be modeled as

$$Yi = \alpha + \beta_1 X_1 + \beta_2 X_2 + --- + \beta_n X_n + U_i$$ -- Equation (4)

Where; Yi: is household participation in adaptation strategy to Climate variability

Xi: explanatory variables which have associations with adaptation strategy

Ui: is the error term.

$\beta_1, \beta_2 \ldots \beta_n$: are slope coefficients of the explanatory variables in the model.

The various appropriacy fit measures were checked and validated to confirm that the model fits the data. The likelihood ratio test statistics exceeds the Chi-square critical value at less than 1% probability level.

This implies that the hypothesis, which says all coefficients except the intercept is zero, was rejected. The value of the Pearson Chi-square test shows the overall appropriacy of fit of the model at less than 1% probability level.

3. RESULTS AND DISCUSSION

3.1. Result of meteorological data analysis

3.1.1. Annual rainfall variability and trends

The average annual rainfall of Dara Kebado woreda ranges between 1000 and 2800 mm (Fig. 1). However, the rainfall has experienced inter-annual variability over the past 20 years (1995-2014). The Analysis of linear trend of annual rainfall indicates decreasing trend with about 47.7 mm every year especially between 1995 and 2015, in which the inter-annual patterns and rainfall distribution also showed annual amounts below the average since 2010 (Fig. 1).

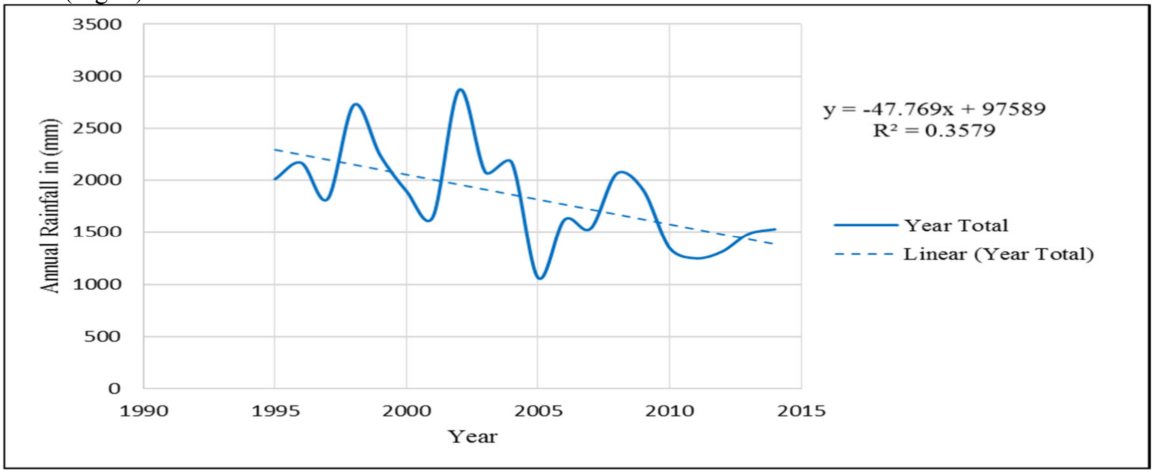

Figure 1: Inter-annual Rainfall Trends at Dara woreda

In this study, the rainfall data was disaggregated into two growing seasons *belg* (February to May) and *meher* (June to September),in which both exhibited variations in seasonal amount of rainfall and monthly spread.

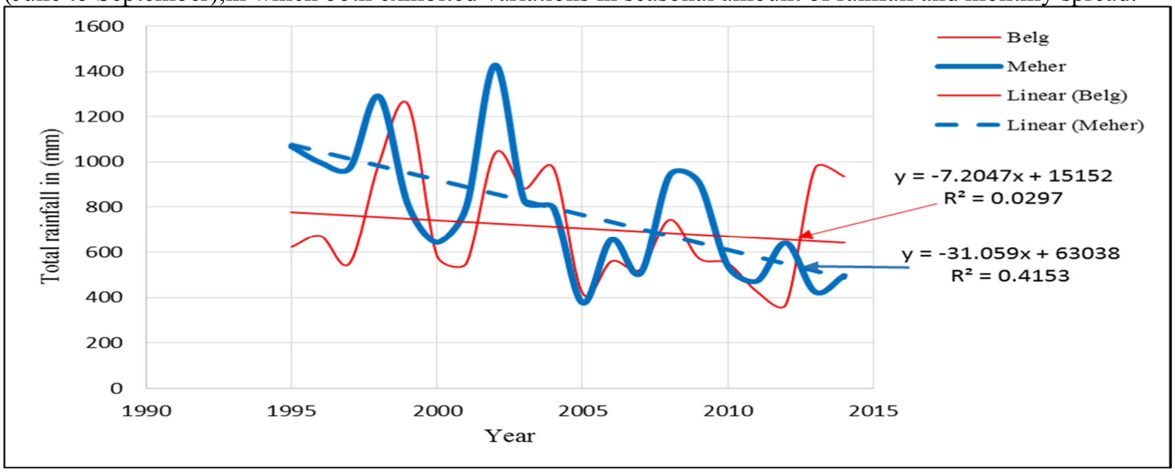

Figure 2: Belg and Meher Rainfall Trends at Dara woreda

According to the analysis result of this study, both *belg* and *meher* rains showed declining trend by about 7mm and 31mm every year respectively during the past two decades (Figure 2), while year to year variability (CV %) of rainfall of *meher* and *belg* seasons were 37% and 35% respectively, which indicates highly variability of rainfall.

3.1.2. Annual temperature variability and trends

The analysis of temperature data obtained from National metrological agency (NMA) indicated that, the maximum and minimum temperature is increasing annually by 0.035 ^{0}C and 0.30 ^{0}C respectively (Figure 3). The above result is compatible with a national study which found out a consistent rising trend in minimum and maximum temperatures over the past fifty years (McSweemy, 2010). The observed weather data not only reveals the direction of change in temperature but also variation across the years. In addition to increasing trend in temperature, there is also annual variation in the form of cumulative monthly average temperature (Fig. 3).

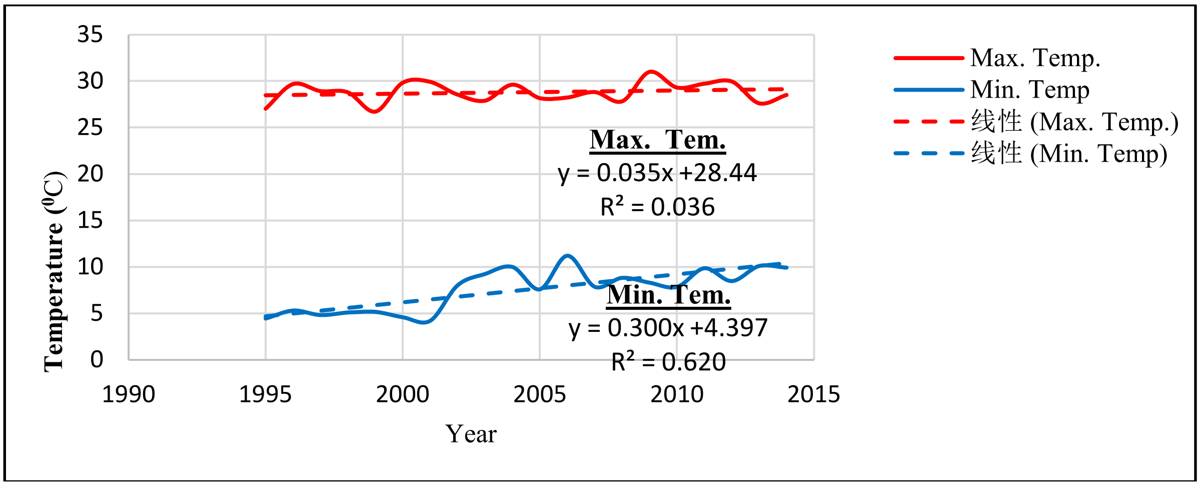

Figure 3: Maximum and Minimum Temperature Trends at Dara woreda

The maximum temperature of the study area was increasing but not siginificantly (P< 0.422), but the minimum temperature increasing significantly (P< 0. 0.001). Studies indicated that African highlands have increasing T_{min} (New et al., 2006; Omondi et al., 2014). Ethiopia has also experienced increases in T_{min} of between 1˚C and 1.4 ˚C per decade (Mekasha et al., 2014). A warming trend of 0.32˚C and 0.21˚C per decade for cool nights has been observed in Ethiopia and Kenya, respectively (Mekasha et al., 2014; Omondi et al., 2014).

In addition, Jaramillo et al. (2013) calculated temperature increases of 0.05˚C per decade for a coffee region in Kenya (Kiambu District) over the period 1929–2009. In Colombia, which is the second largest producer of C. arabica in the world, an average yield declined of 30% since 1990 due to T_{min} increases (FAOSTAT, 2014, Quintana-gomez, 1999).

3.2. Effects of climate change and variability on coffee production (1995-2014)

The amount of rainfall received (RF, P<0.002) and minimum temperature($T_{min,}$ P< 0.04) significantly affect coffee production in the study area. The result of the regression analysis indicates that minimum temperature has negative effect on coffee production, while rainfall has positive impact (Tab. 1)

Table 1: Effect of temperature and rainfall variability on coffee production

Yields	Coef.	Std. Err.	t	P>t	Beta
T_{min}	-20.08954	9.039529	-2.22	0.040*	-.362
RF	.0977776	.0275035	3.56	0.002**	.579
_cons	589.8502	100.8622	5.85	0.000	.

*Significant at < 5%, ** significant at < 1%

R-squared = 0.5847 Root MSE = 53.851 F (2, 17) =11.96

Adj R-squared=0.5358 Prob > F=0.0006 Number of obs =20

In this study, rainfall has the largest (+) Beta coefficient, .57 (in absolute value), and temperature has the smallest (-) Beta, -.36. Thus, a one standard deviation increase in rainfall leads to 0.57 standard deviation increase in coffee yield, while a one standard deviation increase in temperature leads to -0.36 standard deviation decrease in coffee production, with the other factors held constant. This result corresponds with studies in Mexico and Tanzania (Luedeling, 2012, Gay et al. 2006).

3.2.1. Relationship between temperature, rainfall and yields

Pearson correlations was used to determine relationship between minimum temperature and annual rainfall with production of coffee (kg/ha) in the period 1995-2014 (Tab. 2). Correlation between temperature and coffee yield was significant (p < 0.017), which was strong and negative (r = -0.525) suggesting that, an increase in minimum temperature significantly decreases yield. These results also in line with research according to the (Lobell et al., 2013) which shows that, increase in minimum temperature have a more pronounced impact on coffee yield.

Table 2: Correlation relationship between temperature, rainfall and yield

		Yield	RF	T_{min}
Yield	Pearson Correlation	1	.681**	-.525*
	Sig. (2-tailed)		.001	.017
	N	20	20	20
RF	Pearson Correlation	.681**	1	-.282
	Sig. (2-tailed)	.001		.228
	N	20	20	20
T_{min}	Pearson Correlation	-.525*	-.282	1
	Sig. (2-tailed)	.017	.228	
	N	20	20	20

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

The correlation between rainfall and yield indicates that the relationship was significant $p < 0.001$, with "r" value of 0.681, indicating strong positive relationship. Research, also show that drought is a major climatic limitation for coffee production and also causes the coffee husk to stick to the bean hindering maturation and thus fewer coffee berries are harvested (DaMatta et al.2008).

The annual yield of coffee production for the period 1995-2014 significantly decreasing ($P< 0.050$). This is likely to occur due to the increase in minimum temperature and the decreasing trends of rainfall in the study area, although, other factors such as pest and disease stress are thought to contribute to the lower yields and quality of coffee Jaramillo, et al. (2011). The findings presented in Tanzania, indicates that increasing T_{min} have a more pronounced impact on coffee yield and strong parallels with other global studies investigating the effect of climate change on temperate fruit (Luedeling, 2012; Lobell et al., 2013) and on tropical crops (Peng et al., 2004; Nagarajan et al., 2010).

Rapidly rising T_{min} are driving changes to chilling requirements and phenology, with the greatest impact on fruit production in warm climates (Luedeling, 2012). The result also correspond with those of Gay et al. (2006), who demonstrate that temperature, and particularly warm minimum temperature, is the most detrimental climatic variable for coffee production in Veracruz, Mexico.

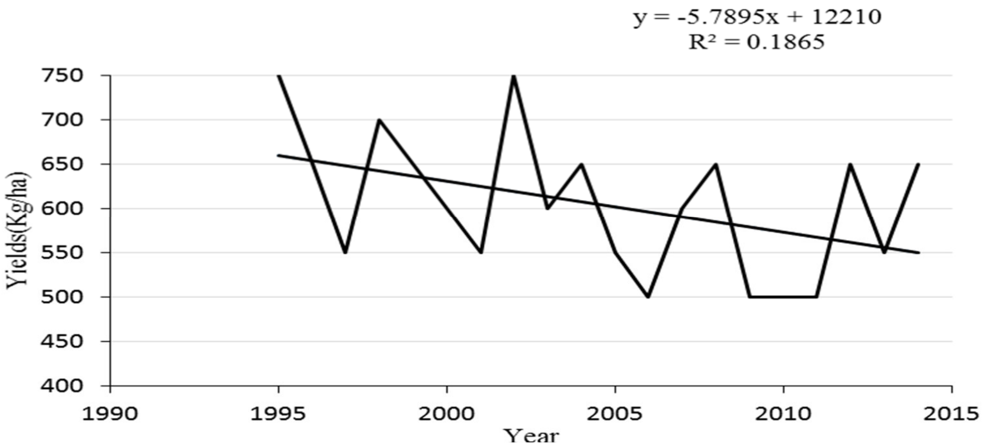

Figure 4: Trends of coffee yield (1995-2015) at Dara woreda
Source: Dara woreda agricultural office

3.3. Smallholder farmers perception to climate change and variability

The perceptions of farmers on changes in temperature and rainfall variability during the last 20 years (1995-2014) was in line with empirical analysis of temperature and rainfall data trends of metrological station. The result indicates that about 7% and 85% of the respondents perceive an increment in the level of rainfall and temperature respectively, while about 93% and 15% of the respondents perceive a reduction in the level of the rainfall and temperature respectively within the last 20 years (Fig.5). From the result it could be concluded that the majority of the farmers in the study area observed a decrease in rainfall but an increase in temperature.

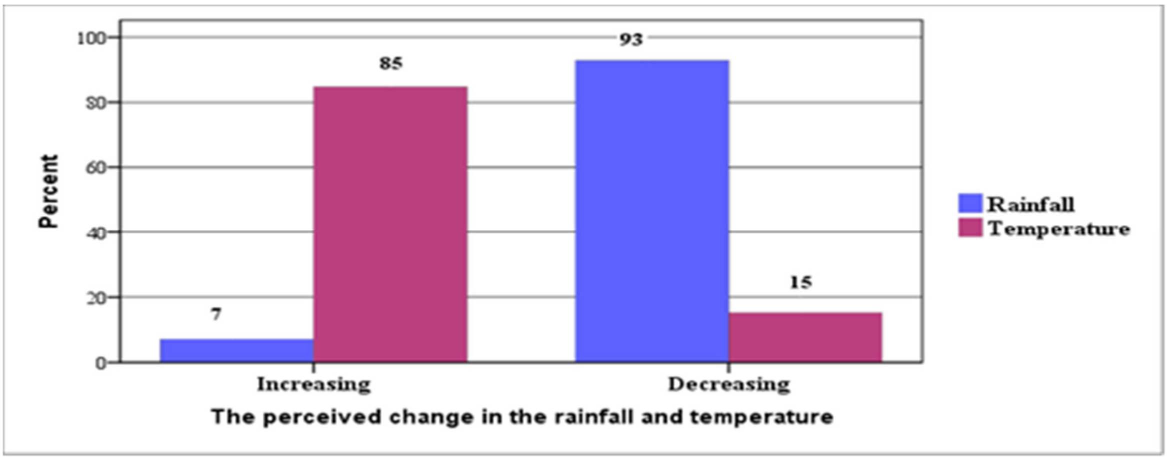

Figure 5: Perceived change in rain fall and temperature by in Dara Woreda

The result of this study also showed the idicators of climate variability and associated effects on coffee production (Figure 6). In this regard, about 72% of the respondents confirm an increase in occurrence of unseasoned rainfall, and about 61% observed unusual heavy rainfall. On the other hand about 78% of the respondents revealed reduction in the amount of rainfall.

About 53% of the respondents proved the increase in frequency of frost incidence and 58% of the respondents proved the incidence of coffee disease.

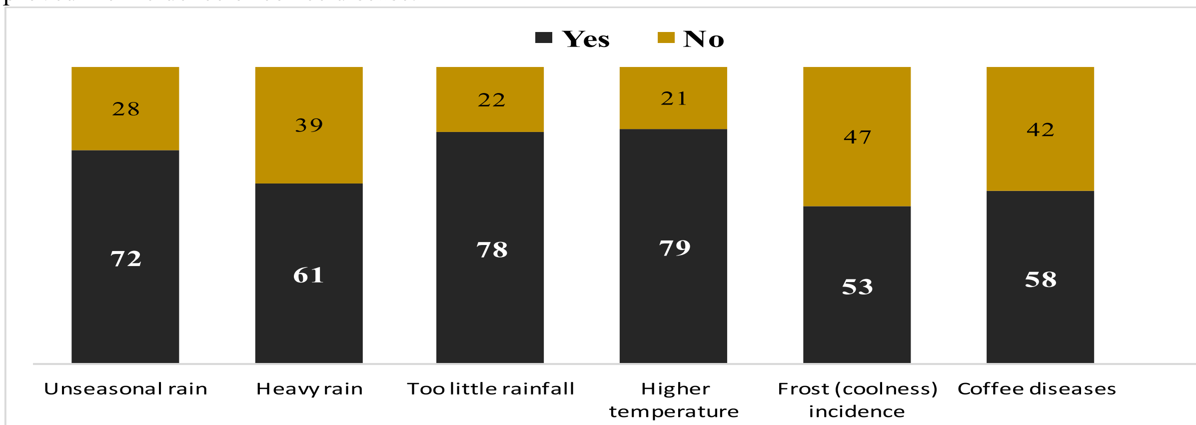

Figure 6: Indicators of climate variability and associated effects in Dara woreda

The above survey data results about the climate change and variability as well as associated effects in the last twenty years is complemented by the observed metrological data.

3.4. Farmers perception on the impact of climate change on coffee production

Based on their response the intensity of different climate related problems which could impact on the households' in farming activity is shown in (Figure 7).

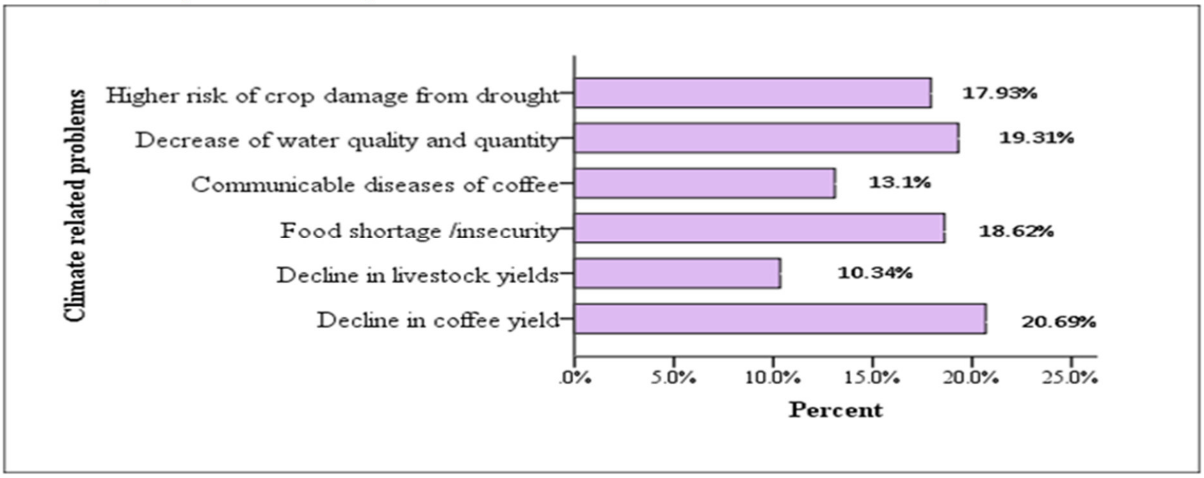

Figure 7: Climate change related problems at Dara woreda

Accordingly 20.69% of the respondents perceive that, declining in coffee yield is the most severe climate related problem followed by decrease of water quality and quantity indicated by 19.31%.

3.5. Technical support and adaptation decision of farmers in Dara woreda

Technical support to implement adaptation strategies to climate change and variability includes: training the farmers to strengthen their knowledge regarding to climate change and capital support such as equipment needed for small scale irrigation and others (Fig. 8). It was shown that, about 64.86% of the respondents received technical support which could help them to apply adaptation measures to climate variability to strengthen their effort in taking adaptation measures. Accordingly, about 75% of the respondents had already taken adaptation measures (Fig. 8).

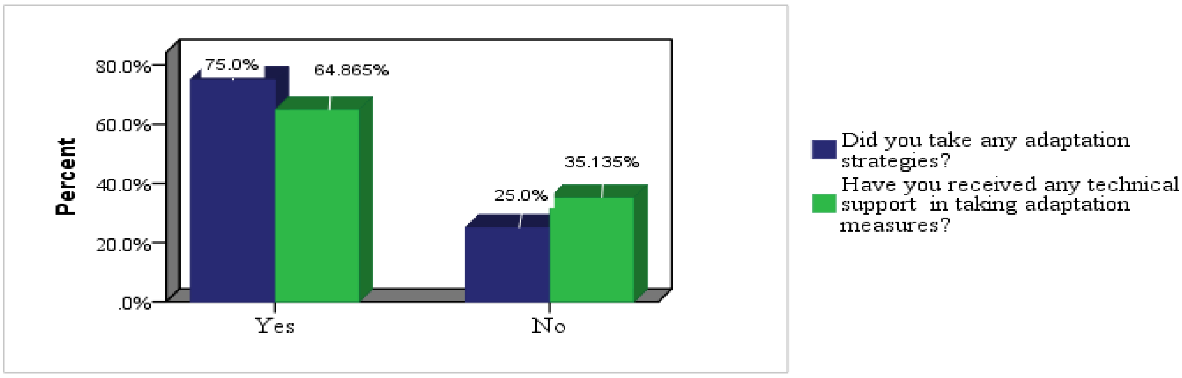

Figure 8: Technical support and adaptation decisions at Dara woreda

3.6. Farmers Adaptation strategies to climate change and variability

Farmers were asked which climate change and variability adaptation measure they have been using so far. Thus, the result of their response was shown using a pie chart(Figure 9) which indicates, the farmers' taken adaptation strategies to reduce the impact of climatic change. In this case soil and water conservation is highly preferred climate change adaptation strategy as it is indicated by 25.14%. Whereas, mixed farming (by 16.10%) and improve coffee variety (by 15.76%). Off-farm employment and planting of trees was also employed by farmers in the study area as effective strategy to adapt the effect of climate change and variability (Fig. 9).

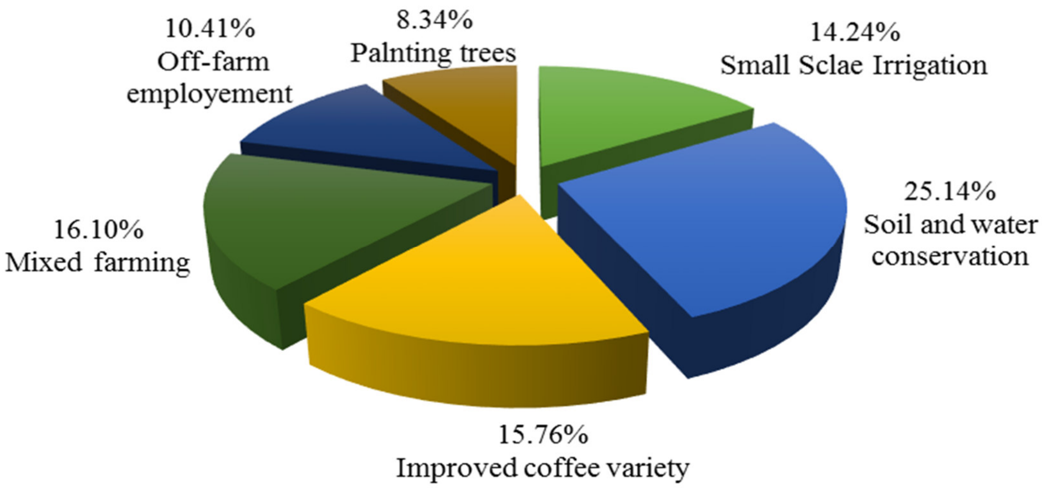

Figure 9: Climate variability adaptation strategies used by the farmers at Dara woreda

3.7. Barriers to climate change adaptation in Dara Woreda

The response of the farmers for not taking any adaptation measure which could help them to with stand effects of climate variability was associated with various reasons (Fig. 10).

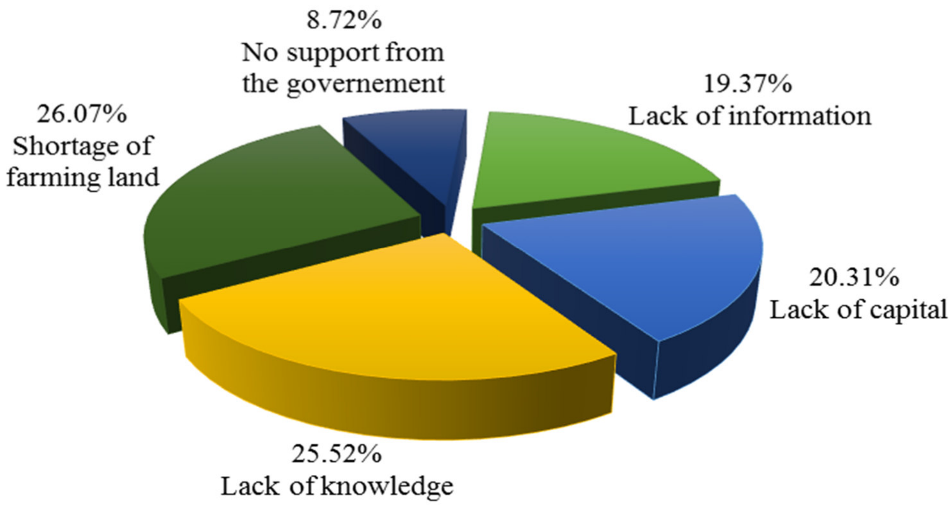

Figure 10: Barriers to climate variability adaptation at Dara woreda

The result shows that, the main constraint to take adaptation measures for most of the respondents (26.07%) was shortage of farm land, since land is among the main inputs required in the farming community. For instance, the farmer who has large farm size can have a chance to produce multiple cropping which in turn has a crucial role for risk diversification against climate related problem.

Lack of knowledge was also considered by 25.52% of the respondents to be among main barriers for taking adaptation measures. Similarly, lack of capital including, human capital, physical capital as well as financial capital were among the barriers confirmed by 20.31% to take adaptation measures (Fig. 10). Hence adaptation to climate variability needs money to purchase improved coffee variety and introduce new technology. Lack of information on climate related problems and limited support from the government are also among barriers to climate variability adaptation in the study area.

3.8. Determinants of household participation in adaptation strategies

In this section, the result of econometric analysis on the determinants of household's participation in adaptation strategies to climate change and variability is presented. Prior to running the logit model the presence of multicolliniarity was checked using Variance Inflation Factor (VIF) for testing association among the continuous explanatory variables and Contingency Coefficients (CC) for the dummy variables. According to Gujarati (2004) if the value of VIF is 2 and above, the variables are said to be collinear. Computed through SPSS program version 20, the values of the VIF for the continuous variables were found to be small (i.e. VIF value < 2) indicating that the data have no serious problem of multicollinearity. Hence, all the four continuous explanatory variables were retained and entered into the binary logistics analysis.

Similarly, contingency coefficients were computed for dummy variables from chi-square ($\chi 2$) value to detect multicollinearity problem (the degree of association between dummy variables). According to (Paulos, 2002), if the value of contingency coefficient greater than 0.75, the variables said to be collinear. The result of the Contingency Coefficient, (Appendix 1), reveals absence of strong association among independent variables. The likelihood ratio chi-square of 95.79 with a p-value of 0.0001 tells that the model as a whole fits significantly.

Hence, out of the eight variables analyzed, the coefficients of five variables, namely perception, education level, farm size, access to credit service and total family size were significantly affected households' decision to take climate variability adaptation strategies in the study area. The remaining three explanatory variables age, sex, training and extension services were not significant (Table 4).

Table 3: Parameter Estimates of the Logit of Adaptation Strategies

ADPTNM	Coef.	Std. Err.	Z	P>t	(dy/dx)
AGE	.004735	.0474587	0.10	0.921	.0006218
SEX	.3865953	.6947589	0.56	0.578	.0300737
PRCPN	1.585963	.8151694	1.95**	0.052	.1349924
EDUCLEV	1.004169	.3842866	2.61***	0.009	.092915
FMSIZE	.9942625	.228648	4.35***	0.000	.1207361
ACSCRDT	1.256709	.75192	1.67*	0.095	.0858874
TEXNS	.3017049	.6683782	0.45	0.652	.0309052
TFASIZE	.3003393	.1726158	1.74*	0.082	.0184682
_cons	-11.69996	2.885872	-4.05	0.000	

***, Significant at <1% level, **Significant at < 5% level, * Significant at <10% level
LR chi^2 (8) = 95.79 Prob > chi^2 = 0.0000
Number of obs = 145 Pseudo R^2 = 0.5816
Log likelihood = -34.459507

Education level of house hold (EDUCLEV); this variable was found to be highly significant at (P<0.01) and positively related with decision of taking adaptation measures. An increase in the level of education by one year for the mean educational level increases the likelihood for adaptation by 9.3% keeping other things at their respective mean. This result is in support of the findings of (Deressa T., 2009) who found a positive relationship between education and adaptation to climate variability in Ethiopia.

Farm Size (FMSIZE); is also highly statistically significant (P<0.001) explanatory variable. The positive sign of its coefficient indicates the presence of positive relationship between farm size and farmers decision for taking climate variability adaptation measure in Dara woreda. For instance, one hectare increases in the farm size from its mean increase the likelihood for adaptation by 12% holding other things at their respective mean. The result of this study is in line with the hypothesized direction of effects of this variable. For instance, the bigger the size of the farm, the greater the proportion of land allocated for modern crop varieties the adaptation strategies that the farmer is likely to adopt (Aschalew, 2014).

Access to Credit Service (ACSCRDT); is also significant variable at less than 10% level (P<0.095). The coefficient of this variable is positive which show the positive influence of this variable in adapting to climate variability in Dara. As compared to the farmer who has no access to credit, the likelihood for adapting to climate variability increases by 8.5% for the farmer who has credit access holding other things at their respective mean.

Climate variability adaptation needs money to purchase improved inputs such as fertilizer, improved seeds, improved livestock variety and others like different seedlings. Therefore, access to credit is very important to finance the purchase of necessary inputs for adapting to climate variability. That is why here found positive effect on adaptation decision. This result is similar to the findings of (Deressa T., 2009) as well as (Di Falco S, 2011) which were conducted in Nile Basin of Ethiopia.

Total Family Size (TFASIZE); total family size also has significant and positive effect on decision to take adaptation strategies to climate variability at less than 10% level (P<0.082). A one unit increase in the family size, the probability of farmers use adaptation methods increase by 1.8% keeping other variables constant. Because household size can influence adaptation, due to the fact that its association with labor endowment. It is argued that a larger household size enables the adoption of technologies by availing the necessary labour force in one hand and enabling the generation of additional income from extra labor invested in off farm activities (Yirga, 2007).

Perception (PRCPN); this variable is significantly (P<0.05) and positively related with household decision to take adaptation measure. The possible justification for the positive relationship could be associated with farmers' level of perception and awareness is prerequisite to make decision to take adaptation strategies to climate variability.

When framers clearly perceive the existence of climate variability and understand the effects; they engage in the adaptation of climatic problems. Many studies have shown that clearly perceiving climate change and problems is crucial in the selection and implementation of agricultural technology and improved agricultural inputs and it is a key precondition for their choice to adopt (Christopher, 2015).

4. CONCLUSION AND RECOMMENDATION

Based on the findings of this study, the following conclusions could be drawn regarding the effects of climate change and variability on coffee production and determinants of adaptation mechanisms. The study area has experienced a decrease in rainfall, increase in temperature and a decline trend in coffee yield during the past twenty years. The correlation between minimum temperature and yield was negative and also the correlation between rainfall and yield was positive. The minimum temperature in was increasing significantly and affected coffee production.The farmers in the target area are well aware about the changes in rainfall and temperature, consequently practicing adaptation strategies; however adaptation strategies such as off-farm employment and planting trees have been exercised only by limited farmers. Some farmers are still reluctant to take adaptation measures due to lack of knowledge, shortage of farming land, lack of capital and lack of information, inadequate support from the government. The perception about climate variability, educational level of the household head, farm size owned by the household, access to credit service, and total family size of the household are among the factors which are contributing to the farmers' decision to take climate change and variability adaptation strategies. Therefore, concerned institutions and individuals should use drought and disease resistant coffee varieties and increase farmers' level of perception and awareness.

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