Implications of Adaptation Strategies to Climate Variability on Small-Scale Coffee Production in Kirinyaga County, Kenya.

Abstract: Coffee farming constitutes a substantial source of income to a significant fraction of ménages across the globe, Kenya being one. The impact of climate variability on coffee farming is negative. Small-scale coffee farmers in Mukure ward, Kirinyaga have not adequately assumed appropriate adaptation strategies to enhance resilience against this challenge. The purpose of the research was to evaluate climate variability, how it relates with coffee farming and to determine the effects of adaptation strategies for resilience against climate variability by small-scale coffee farmers in Mukure ward. The study area was Mukure ward within Kirinyaga County with a total population of 30,534. Primary data was collected using questionnaires, conducting interviews among selected respondents and field observations. Data on temperature and precipitation trends was accessed from the local Kenya Meteorological Department offices while data on coffee farming was provided by Kirinyaga County Government. The raw data from the field was analyzed using Statistical Package for Social Science (SPSS) and spreadsheets that then generated tables, comparative graphs and frequencies. The findings from this study indicated that small-scale coffee farmers in Mukure Ward experienced climate variability in the period 1987-2017. The study concluded that small-scale coffee farmers in Mukure ward were facing climate variability, and had devised different adaptation mechanisms which were on the other hand faced by myriad of challenges. Going by the findings of the study, with the fluctuations in temperature and rainfall patterns, there is an absolute need to create awareness among small scale-coffee farmers on climate variability, weather forecast and appropriate adaptation strategies.

Key words: Climate Variability; Adaptation Strategies; Vulnerability

Introduction: Climate variability has in a large way altered crop growth cycle. Although there is a better interpretation world-over, of the complexities underlying climate variability,

acculturation of these conceptions at the local level remains grim. The position is spiraled by the fact that the degree and extent of effects of climate variability are dissimilar and not foreseeable. In some circumstances, meteorological data from accredited climatological stations isn't there, and appreciation of the weather patterns is almost impractical.

For decades, small-scale farmers in Kirinyaga have observed unpredictable weather patterns. They can't predict the appropriate seasons when they should apply certain types of fertilizers or spray supplements for optimal yields. This has culminated in sundry consequences on their financial well-being. They now juggle between strengthening adaptation strategies and venturing into other enterprises as a whole. The ever-rising ambiguity obscures the capability of involved stakeholders to offer satisfactory direction on how best resources can be spread to curtail vulnerability. There is an pressing urge to commence investigations for purposes of unearthing the adaptation strategies to climate variability best suited for small-scale coffee farmers in Kirinyaga County.

Literature Review

2.1 Climate Variability, Arable Land and Agricultural Productivity

Across the globe, the precipitation patterns have been shifting, and it is expected that the trends will intensify in the future. It will mean that many parts of the world will experience more intense seasons of heavy rainfall that alternate with extended dry spells (Kane and Shogren, 2000). Areas historically identified as agricultural belts have been experiencing floods with the frequency rising in the recent past. In Midwest, in the United States of America for example, floods are blamed for crop destruction in immeasurable scales while at the same time damaging supportive infrastructure, polluting waters and accelerating soil erosion on farms (Nazari *et al.*, 2017).

Extended dry seasons have been recorded in many parts of the world (Baker and Haggar, 2007). Frequent droughts have caused crop failure, led to livestock deaths and resulted in overall stress among farmers. These scenes have become common in Sub Saharan Africa, especially the arid zones (Ncube *et al.*, 2013). Continued trends in temperature rise are expected to worsen drought situations, deplete water supplies, and in formerly forested areas trigger wildfires likely to wipe away green cover (Killeen and Harper, 2016).

2.2 Coffee Production in East Africa

Cash crop growing in the Sub-Saharan Africa (SSA) area is typically done at a small-scale scope single households. Usually, a large segment of the populace livelihood is pegged on tea and coffee and tea (Iscaro, 2014). The most popular varieties in Africa have remained Arabica and Robusta, with aSrabica dominating most farms in East Africa (Kasterine, 2010). Kenya, just as its neighbor Ethiopia majorly produces arabica with Uganda specializing in robusta option.

The coffee industry in East Africa supports more than 5 million individuals, directly and indirectly (Kasterine, 2010). Ethiopia and Kenya are well-known as exporters of world's best quality processed coffee, and originators of some of the coffee varieties since the early 1990s

(Mwenda, 2012). Coffee farming in Rwanda, Uganda, Ethiopia and Kenya is mostly done by small-scale farmers on small farm sizes (Gbetibou, 2009). Compared to other regions of the world, the East African coffee industry faces challenges such as weak infrastructure, small land sizes and threats from climate variation (Holvoet, 2016).

2.3 Research Gap

There are different studies that have been undertaken on the implications of climate variability on coffee production across the globe. However, these studies have been restricted to specific zones within those countries with each of the study areas having their unique temperatures, humidity levels, precipitation and soil characteristics. At the broader global aspect, a study was done by William *et al.,* (2020) on climate variability and the impacts it has on small-scale coffee production in Western Ghana while Philpot *et al.,* (2008) conducted investigations on the implications of microclimatic dynamics on small-scale coffee production in selected estates within Latin America. Morton (2007) conducted a study on the vulnerability of small-scale coffee production in Northern America. Baker (2007) sought to establish the impact of global warming on global coffee. These findings cannot be taken to represent the actual situation of other parts of the world that weren't individually captured owing to their unique soil characteristics, precipitation patterns, humidity records, temperatures and types of coffee grown.

In Kenya, GIZ (2010) carried out studies on climate variation adaptation and mitigation within the Kenyan coffee segment in general while DaMatta (2006) sought to find out the ecophysiological constrictions on the growth of shaded and unshaded bushes of coffee. These studies analyzed the effects of climate variability over a period of less than fifteen years. This study examines climate variability for a span of thirty year.

Methodology:

Study Area

The research was conducted in Mukure Ward, Kirinyaga County which is found at the foot of Mt. Kenya. It is located between 0°31’40.1’’S and 37°13’38.1’’E in Kirinyaga County, Kenya. Mukure Ward has an altitude that ranges between 1158 M and 5380 M above sea level (GoK, 2019). It is about 110Km from Kenya’s capital, Nairobi.

Physical and Topographic Features

The terrain is generally gently sloping along the borders with Mt. Kenya, while the lower ends are basically flat. The area bordering the mountain is forested, and is defined by steep slopes with rivers cutting along them (GOK, 2019).

There are several rivers and streams emanating from the forest. Thiba river, Nyamindi, Rupingazi, Ragati, River Sagana as well as Rwamuthambi River define the main sources of water in the expansive county (GOK, 2009). They all drain to Tana River. These rivers are mostly used in small-scale and commercial farming. The main types of soils are the volcanic soils on the Mt. Kenya slopes and red soils where the terrain is gently sloping (Mwenda & Kibutu, 2012).

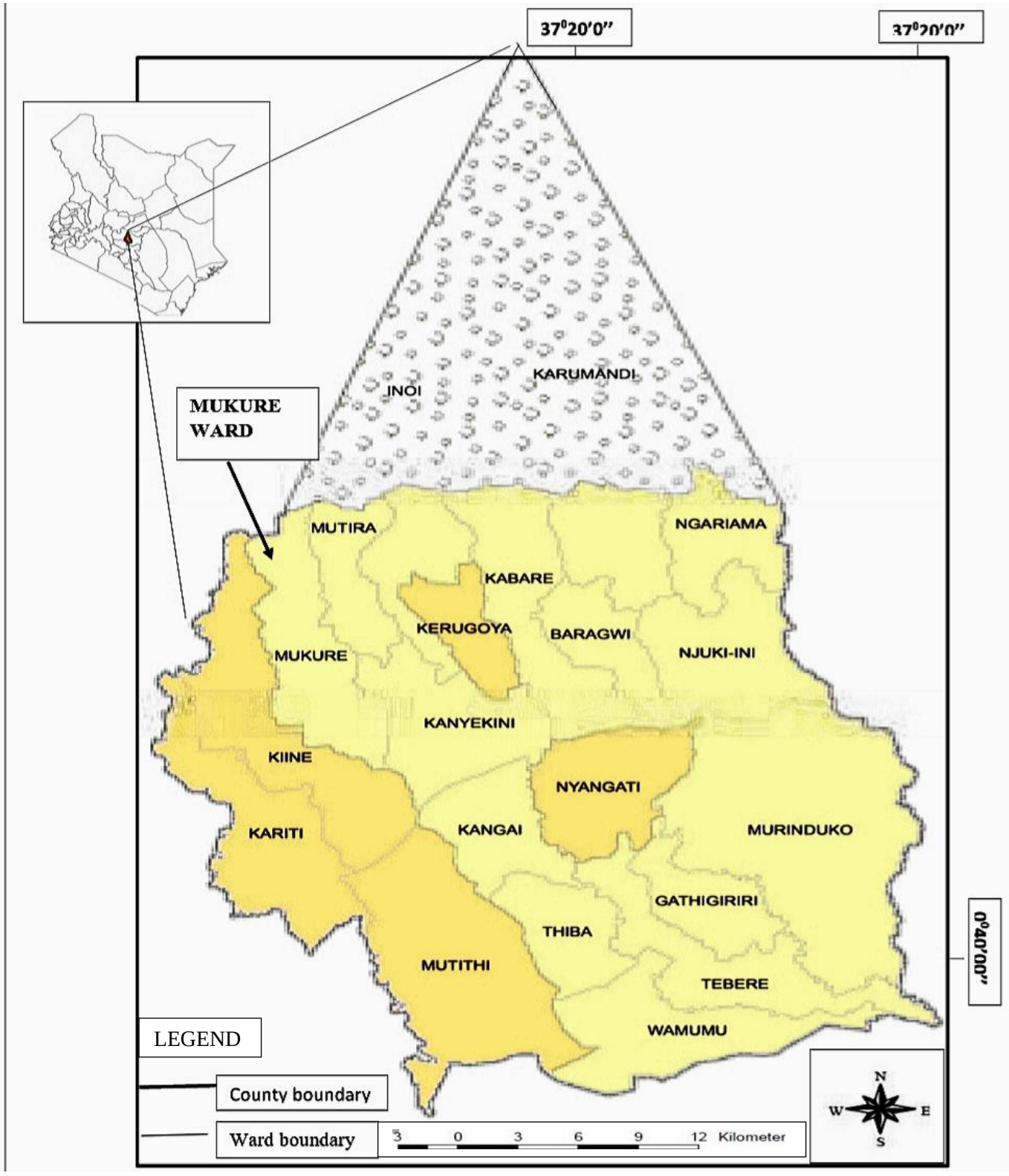

Figure 1: Map of Study Area

(Source: GoK 2019)

Climatic Conditions

Mukure Ward is positioned on a high elevation with equitably calm climate. It has a tropical climate with two main rainy seasons within a year. Temperature ranges from a low of 12^0C to a high of 30^0C (GOK, 2009). The rains are mostly influenced by the proximity of the ward to the equator, and its windward location from Mt Kenya. Long rains are experienced between March and May while the short rains season falls between October and December. Mukure Ward has an annual precipitation of 1200mm with an equatorial rainfall pattern (Mwenda & Kibutu, 2012).

Vegetation

The apex of Mukure Ward falls within Mt. Kenya Forest. There are indigenous and exotic tree species within the forest and a few spread across the ward. The areas of the mountain slopes considered very wet have thick trees blended with bamboo. The belt that follows has montane forests although a fraction of it has been cleared by locals to pave way for tea farming. For a long time, residents of Mukure Ward have planted cash crops such as tea and coffee, majorly on small scale basis while those residing in the low lands plant cereal crops. It is also common to find maize, beans and banana farming across Mukure Ward.

Research Design

The study utilized descriptive research model in collection of raw data by way of interrogating and administering questionnaires to a sample of individuals. Data collected was both qualitative and quantitative. Descriptive research entails observation as well as reporting of the behavior of specific subject without interfering with it at that time (Mugenda and Mugenda, 1999).

Target Population

Kirinyaga County population based on the 2019 Kenya Population and Housing Census had 610,411 persons with an annual growth rate of 1.5%. Going by the figures, it is projected that the

population will hit 625,157 by 2030 (KBS, 2010). The study focused on Mukure Ward whose population was 30,534 (GoK, 2019).

Sample Size and Sampling Procedure

The sample size was determined using Yamane's (1973) formula since it maintains a very high confidence interval, and therefore high exactness.

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

Where n = sample size, N= size of the entire population and e=is the acceptable sampling error. Usually, 95% confidence level with P=0.5 are assumed when using Yamane's formula. Applying the formula, the resultant sample size was 395, but the study took advantage of a larger sample and made it 400;

n= 30,534/ [1+30,534*$(0.05)^2$]

n= 30,534/ [1+76.335]

n= 394.83

The research applied multi-stage sampling technique that ensured clusters (in this case, villages), systematic as well as purposive sampling. Cluster sampling was necessary because it capitalized on natural groupings of households that depict resembling characteristics. Some villages within Mukure with high coffee yields from small-scale coffee farmers were purposely selected with the guidance of key informants from the agriculture department and opinion leaders in the study area. Key institutions involved in coffee production, agriculture in general and coffee marketing within the county were identified and chosen through purposive sampling. Purposive sampling was also used in seeking expert opinions among members of staff in the selected institutions.

Data Collection Methods and Instruments

Questionnaires (both structured and semi-structured) were applied for purposes of collecting data in this study. Data from Embu meteorological center (under which meteorological data of Mukure Ward is held) within the study area was also sought. Interviews were administered to key informants. Photography was also applied as a means of documenting evidence. In addition to this, Participatory Rural Appraisal (PRA) was used to collect information on farmers' awareness of climate variability, vulnerability prompted by climate variability and their adaptation mechanisms. Historic reference to life forms were collected from reliable people within Mukure Ward. The main intention of this approach was to establish occasions and processes of climate variability in the interviewee's life trajectories and expound further on them.

Life experiences were gathered from respondents within the age bracket of sixty-five and eighty-five years who had resided in the area of study for a substantive period of time. When selecting the respondents, household heads were engaged to bring forth their experiences, knowledge and opinions.

Data Analysis

Data was analyzed using the statistical package for social sciences (SPSS) version 21 using descriptive and inferential statistics such as ranges, percentages, charts and bar charts as well as Chi-square and Pearson Correlation when testing significance and relationships between variables (non-parametric statistic instruments). SPSS and Excel spreadsheets were as such used to analyze data collected using the structured questionnaires. Data was then organized, structured and processed and presented using pie charts, graph comparisons and percentages after getting a broad overview of the variables that can be tested quantitatively (Ganti, 2020).

Qualitative data was scrutinized using content analysis. Observations from the field, interactions with respondents, and other forms of data captured on site were categorized, summarized and structured in tables and spreadsheets.

For purposes of establishing the impact of independent variables of precipitation amounts and temperature levels on coffee production (dependent variable), regression analysis was used. Linear correlation coefficient (*R)* was used to quantify the level of association between variables (coffee yields and climate variability) as outlined by Sharon (2009).

Results and Discussion:

This study targeted of 400 samples and all questionnaires were filled. The study established that 56% of people interviewed were 45 years and above. The respondents who were in the age bracket 45-65 years comprised 39.8% while those above 65 years represented 16.2% of the sample size (Table 1). In Mukure Ward, there are more young people engaged in farming, particularly coffee farming. This could be ascribed to the ever-increasing rates of unemployment in the country, which, going by a report by Krishnamurthy & Dejan, (2009) was put at 40% in the year 2009. The findings have a slight variation with the 2019 KNBS census which indicated that persons above 65 years in Mukure Ward comprised 6% of the population while those aged between 15 and 64 years comprised 61% whereas 33% were in the 15 to 34 years bracket (GoK, 2019). It therefore means that many of the small-scale coffee farmers are above the youthful age, and have experience in coffee farming.

Table 1: Percentage of Respondents by Age

Age Bracket	**Frequency**	**Percentage (%)**
29 and below	69	17.2
30-44	107	26.8
45-65	159	39.8
Above 65	65	16.2
Total	**400**	**100**

Effects of Adaptation Strategies to Climate Variability on Coffee Production

Majority (92%) of small-scale coffee farmers in Mukure Ward indicated that application of adaptation strategies to climate variability had a noticeable positive implication on coffee production. On the other hand, 8% of the respondents had not applied any adaptation strategy, and had as such not realized change in coffee production. The farmers indicated that there was noticeable change in coffee production with every adaptation strategy applied. For instance, use of new and improved coffee varieties resulted in improved quality and quantity of coffee among all small-scale coffee farmers in Mukure. One farmer said: "*You only need to be patient with new varieties like Ruiru 11. Upon planting, it takes 2 years before a farmer can harvest some cherry, and 4 years before the bushes achieve full potential. This of course requires one to take good care of the crop".*

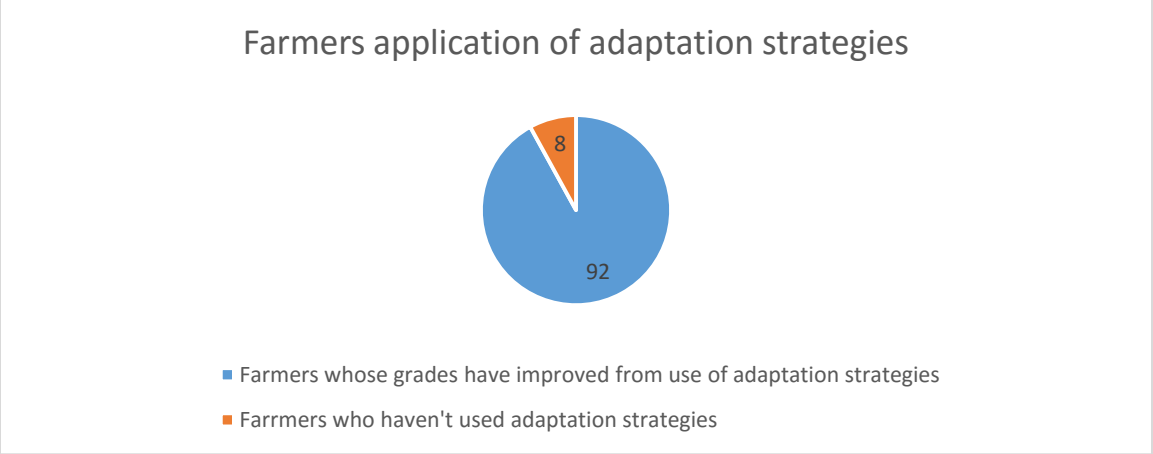

Figure 2: Farmers' benefits from application of adaptation strategies

4.7.1 Correlation Analysis for Adaptation Strategies to Climate Variability and Coffee Production

This research applied Pearson correlation coefficient to find out if there is relationship between dependent variable (small-scale coffee production) and independent variables (adaptation strategies to climate variability). The outcomes show existence of a significant association

between adaptation strategies to climate variability and small-scale coffee production (r=0.653, p= 0.000) (Table 2).

Adaptation strategies to climate variability play an important role in influencing small-scale coffee production in Mukure Ward with all other factors are considered to be constant. The other factors are soil type, farm inputs, prevalent pests and diseases in the area, humidity conditions, temperatures and humidity.

Table 2: Correlations Coefficients

		Yields Kg/ Acre	**Adaptation Strategies to Climate Variability**
Yields Kgs/ Acre	Pearson Correlation	1	
	Sig. (2-tailed)		
Adaptation Strategies to Climate Variability	Pearson Correlation	.653**	1
	Sig. (2-tailed)	.000	

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

4.7.2: Adaptation Strategies to Climate Variability and Small-Scale Coffee Production

Regarding the efficiency of the adaptation strategies to climate variability on small-scale coffee production in Mukure Ward, the findings, as depicted in table 3 below are that there exists a relationship between the two variables.

Table 3: Model Summary for Adaptation Strategies and Small-scale Coffee Production

Model	R	R^2	Adjusted R^2	Std Error of Estimate
1	.899[a]	.808	.789	198.71948

a. Predictors: (Constant), Adaptation Strategies to climate variability

The R-squared for the relation between adaptation strategies for climate variability and coffee production in Mukure Ward was .808. It therefore means that adaptation strategies for climate variability account for 80.8 per cent of coffee production in Mukure Ward. In addition, F-calculated (42.140) was much greater than F- critical (4.84) and p-value (0.000) was way below the significance level (0.05) (Table 4). It therefore means that the model was fit for application in forecasting the effect that adaptation strategies to climate variability have on small-scale coffee production in Mukure Ward, Kirinyaga County.

Table 4: ANOVA for Climate Variability Adaptation Strategies and Small-Scale Coffee Production

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1664070.692	1	1664070.692	42.140	.000[b]
	Residual	394894.308	10	39489.431		
	Total	**2058965.000**	**11**			

a. Dependent Variable: Yield Kgs/ Acre

b. Predictors: (Constant), Climate variability adaptation strategies

These findings clearly show that adaptation strategies to climate variability have a noteworthy influence on small-scale coffee production in Mukure Ward as depicted by a regression coefficient of 1282.402 (Table 5). It therefore shows that a unit rise in the application of

adaptation strategies to climate variability would result in a 1282.402 rise in coffee yields in Mukure Ward, Kirinyaga County.

Table 5: Coefficient for Adaptation Strategies to Climate Variability and Coffee Production

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	**Std.Error**	**Beta**		
1	(Constant)	-1075.246	716.118		-1.501	.164
	Adaptation strategies to climate variability	1282.402	197.551	.899	6.492	.000

a. Dependent Variable: Yields/ acre

Findings from the study showed that adaptation strategies to climate variability have a significant positive relationship with small-scale coffee production in Mukure Ward. According to Davis (2013), in the current times, adjusting to climatic variation is not a permanent or even inferior alternative. It is extremely critical that societies that are faced with challenges associated with climate variability to urgently devise solutions and implement them with urgency. Enomoto (2011), notes that there will be an urgent need to alter the air and soil temperatures and moisture through tailor-made farming mechanisms, and providing buffers against unfavorable growing conditions and extreme weather events if coffee farming in Ethiopia is to be sustained. He adds that interventions like irrigation, shade management and application of mulch on farm, as well as proper pruning will be essential. In many regions of the world, on-farm adaptation and

improvements in small-scale coffee production has the potential to boost resilience among a number of farmers (Enomoto, 2011).

Summary And Conclusion

The study found out that adaptation strategies to climate variability have a positive and significant influence on small-scale coffee production in Mukure Ward. The research established that farmers in Mukure Ward were using new and improved coffee varieties, traditional coffee shades, diversification in farming, strengthening local farmers groups and adjusting their farm management practices. The study also established that small-scale coffee farmers also had household safeguard strategies, all of which had a positive impact on coffee production.

The study concluded that adaptation strategies to climate variability have a positive and significant influence on small-scale coffee production in Mukure Ward, Kirinyaga County.

Consent

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

Acknowledgement

The contributions and support of Dr. Benson K. Mburu and other staff and students, Department of Environmental Studies, Kenyatta University.

REFERENCES

Adzawla, W. & Baumuller, H. (2001). Effects of Livelihood Diversification on Gendered Climate Vulnerability in Northern Ghana. Environment, Development and Sustainability

Agbogidi, O.M, (2011). Global Climate Change: A Threat to Food Security and Environmental Conservation. British Journal of Environment & Climate Change, 1(3), 74-89

Al-Balushi, S. M., Al-Musawi, A. S., Ambusaidi, A. K., & Al-Hajri, F. H. (2017). The effectiveness of interacting with scientific animations in chemistry using mobile devices on grade 12 students' spatial ability and scientific reasoning skills. *Journal of Science Education and Technology*, *26*(1), 70-81.

Alim, N., Linda, W., Gunawan, F., & Saad, M. S. M. (2019). The effectiveness of Google classroom as an instructional media: A case of state islamic institute of Kendari, Indonesia. *Humanities & Social Sciences Reviews*, *7*(2), 240-246.

Asghar, M. Z., Rahman, F., Kundi, F. M., & Ahmad, S. (2019). Development of stock market trend prediction system using multiple regression. *Computational and mathematical organization theory*, *25*(3), 271-301.

Baker, P.S. and Haggar, J. (2007). Global Warming: The Impact of Global Coffee. *Specialty Coffee Association of America Conference Handout,* Long Beach, 14 pp

Brown, M. E., and Funk, C.C (2008). Food Security under Climate Change. Science 319:580–581.

DaMatta FM (2006). Ecophysiological Constraints on the Production of Shaded and Unshaded Coffee: A Review. Field Crop Res 86:99–114.

Damatta FM, Ronchi CP, Maestri M, Barros RS (2008). Ecophysiology of Coffee Growth and Production. Braz. J. Plant Physiol.19:485–510.

Daoud, J. I. (2017, December). Multicollinearity and Regression Analysis. In *Journal of Physics*: Conference Series (Vol. 949, No. 1, p. 012009). IOP Publishing.

Davis AP, Gole TW, Baena S, Moat J (2012). The Impact of Climate Change on Indigenous Arabica Coffee (Coffea arabica): Predicting Future Trends and Identifying Priorities. PLoS One 7(11):e47981.

Dutta, R. (2014). Climate Change and its Impact on Tea in Northeast India. *Journal of Water and Climate Change, 5*(4), 625-632

Eakin, H. and Wehbe, M.B. (2005). Linking Local Vulnerability to System Sustainability in a Resilient Framework: Two Cases from Latin America. La Jolla, C A. pp 19

Enomoto R (2011). Climate-friendly and Productive farming Guide for Coffee smallholders in Africa.

FAO. (2012). "Towards the future we want, end hunger and make the transition to sustainable Agricultural and food systems". Rome.

FAO. (2011e). "FAO's Framework Programme on Climate Change Adaptation". Rome

FEWS-NET, 2010. Food Security in East Africa. *Retrieved June 2020.*

Ganti, A. (2020). Correlation coefficient. Corp. Finance. Account, 9, 145-152.

Gbetibou, G. A. (2009). Understanding farmers' perceptions and adaptations to climate change and variability: The Case of the Limpopo Basin, South Africa (IFPRI Discussion Paper). Washington DC: International Food Policy Research Institute.

Gelman, A., Goodrich, B., Gabry, J., & Vehtari, A. (2019). R-squared for Bayesian Regression Models. The American Statistician.

GIZ. (2010). Climate change adaptation and mitigation in the Kenyan coffee sector. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Eschborn, Germany.

Government of Kenya. (2009). Statistical Analysis of TourismTrends Globally and Locally, Ministry of Tourism and Wildlife, Republic of Kenya. accessible http://www.tourism.go.ke/ministry.nsf/doc/Tourism_Trends_OCT2006_Revised.pdf/$file/ Tourism_Trends_OCT2006.

Hartmann, D. L., A. M. G. Klein Tank, M. Rusticucci, L. V. Alexander, S. Bronnimann, Y. Charabi, et al. (2013). Observations: atmosphere and surface. Pp. 159–254

Holvoet, N. (2016). Intersections of Gender and Marital Status in Accessing Climate Change Adaptation: Evidence from Rural Tanzania. MacMillan Publishers, Nairobi

Iscaro, J (2014). The Impact of climate change on coffee production in Colombia and Ethiopia. Global Majority E-Journal, 5(1):33-43

Jaramillo, J., E. Muchugu, F. E. Vega, A. Davis, C. Borgemeister, and A. Chabi-Olaye. (2011). Some Like it Hot: The Influence and Implications of Climate Change on Coffee Berry Borer (*Hypothenemus hampei*) and Coffee Production in East Africa.

Jayne, T.S., Yamano, T., Weber, M., Tschirley, D., Benfica, R., Chapoto, A., and B. Zulu (2003). Smallholder income and land distribution in Africa. Implications for poverty reduction strategies. *Food Policy* 28 (3) pp253-275

Kallio, H., Pietilä, A. M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: developing a framework for a qualitative semi- structured interview guide. Journal of advanced nursing, 72(12), 2954-2965.

Kane, S.M. and J.F. Shogren, (2000). Linking Adaptation and Mitigation in Climate Change Policy. *Climate Change,* 45 (1), 75-102

Kasterine A, Scholer M, Hilten JH (2010). Climate Change and the Coffee Industry. Abstract for trade information services. International Trade Centre, Palais des Nations, 1211 Geneva 10, Switzerland.

Kenya Bureau of Statistics, 2010. 2009Kenya Population and Housing Census, Nairobi

Killeen JT, Harper G (2016). Coffee in the 21st century. Will Climate Change and Increased Demand Lead to New Deforestation?

Kraus, L., Wechsung, I., & Möller, S. (2017). Psychological needs as motivators for security and privacy actions on smartphones. Journal of Information Security and Applications, 34, 34-45.

Krishnamurthy, S. and Dejan, V. (2009). *The Global Public Relations Handbook Revised Edition,* 329. (Taylor & Francis: 2009). Routledge Publishers. New York. ISBN 13:978-203-88937-4(ebk).

Kristine, A. (2019). How Climate Change Impacts Women Farmers- And What We're Doing about It. Oxford University Press, New York

Lin, B. B., Perfecto, I., and Vandermeer, J. (2008). Synergies Between Agricultural Intensification and Climate Change could Create Surprising Vulnerabilities for Crops. *Bioscience* 58: 847-855

Marginson, S. (2016). High participation systems of higher education. The Journal of Higher Education, 87(2), 243-271.

Martin, R. & Sunley, P. (2006). Path Dependence and Regional Economic Evolution. *Journal of Economic Geography* 6 (4), 395-437

Momanyi, S., Mutai, N. & Bii, J. (2012). Attracting Young People to Farming. Agfax. Reporting Science in Africa.

Morton JF (2007). The Impact of Climate Change on Smallholders and Subsistence Agriculture. National Academy of Sciences, Washington, DC

Mugenda, O. M., and Mugenda, A. G. (1999). Research Methods: Quantitative and Qualitative. Nairobi: ACTS Press.

Murphy,D. and Chirchir, D. (2017). Kenya County Integrated Development Plans (CIDPs) 2013-2017: Review of Climate Change Mainstreaming. StARCK+ Technical Assistance to Government of Kenya

Mwenda, A. and Kibutu, T. (2012). Implications of the New Constitution on Environmental Management in Kenya. Law, Environment and Development Journal, 1(1)

Nazari, S. Pezeshki, H., Sedighi, H. & Azadi, H. (2017). Vulnerability of Wheat Farmers: Towards A Conceptual Framework. PP. 517-532

Ncube, M., Madubula, N., Ngwenya, H., Zinyengere, N., Zhou, L., Francis, J. & Madzivhandila, T. (2013). Climate Change, Household Vulnerability and Smart Agriculture: The Case of two South African Provinces. *Disaster Risk Studies,* pp. 6-8

Ngigi, S.N. (2009). Climate Change Adaptation Strategies: Water Resources Management Options for Smallholder Farming Systems in Sub-Saharan Africa. *The MDG Centre, East and South Saharan Africa.* The Earth Institute at Columbia University

Nzeadibe, T.C., Egbule, C. L., Chukwuone, N. A & Agu, V. C. (2011). Farmers' Pereption of Climate Change Governance and Adaptation Constraints in Niger Delta Region of Nigeria. Published by the African Technology Policy Studies Network Nairobi, Kenya

Onang'o, O. T., & Orodho, J. A. (2016). Effects of level of adequacy of higher education loans on participation rates of students in distance degree programmes at Kenyatta University, Kenya. Research on Humanities and Social Sciences, 6(8), 66-73.

Philpot, S. M., Arendt W. J, Armbrecht, I.,Bichier, P., Dietsch, T. V., Gordon, C., Greenberg, R. (2008). Biodiversity Loss in Latin American Coffee Landscapes: Review of the Evidence on Ants, Birds and Trees. *Conservation Biology.* 22: 1093-1105.

Poerbonegoro, G. A., & Setiawan, M. (2017). The Phenomena of Organizational Structure Change as Change Factor of Financial Consultant's Motivation.

Sappleton, N., & Lourenço, F. (2016). Email subject lines and response rates to invitations to participate in a web survey and a face-to-face interview: the sound of silence. International Journal of Social Research Methodology, 19(5), 611-622.

Sharon L. Lohr (2009). Sampling: Design and Analysis. Second Edition. Arizona State University. USA

UNDP, 2012. *Factoring Weather and climate information and products into disaster management policy: A contribution to strategies for disaster reduction in Kenya,* Nairobi, Kenya.

URT. (2003). Initial national communication under the United Nations Framework Convention on Climate Change (UNFCCC). United Republic of Tanzania, Vice President's Office, Dar es Salaam, Tanzania.

William, A., Azumah, B., Anani, P., Donkoh, S. (2020). Analysis of Farm Households' Percieved Climate Change Impacts, Vulnerability and Resilience in Ghana. *Scientific African Journal*

Wintgens JN (ed) (2009) Coffee: Growing, Processing, Sustainable Production - A Guidebook for Growers, Processors, Traders, and Researchers, 2nd edn. Wiley-VCH, Weinheim