International Journal of Multidisciplinary Research Updates

Journal homepage: https://orionjournals.com/ijmru/

ISSN: 2783-0179 (Online)

(Research Article)

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Adoption intensity of climate smart agricultural practices in arabica coffee production in Bududa District

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International Journal of Multidisciplinary Research Updates, 2021, 01(01), 016–025

Publication history: Received on 02 March 2021; revised on 13 April 2021; accepted on 15 April 2021

Article DOI: https://doi.org/10.53430/ijmru.2021.1.1.0037

Abstract

Uganda is one of the largest producing and exporting countries of coffee in the world and second in Africa, but it continues to experience significant impacts of climate change, including erratic rainfall variability and environmental degradation. This research investigated the determinants of adoption intensity of Climate Smart Agricultural (CSA) practices in Arabica coffee production in Bududa district. A cross-sectional survey design was adopted to collect data from 117 respondents, where face to face questionnaire were used to collect the quantitative data of the study. Descriptive statistics such as frequency count and percentages were used to characterize coffee farmers. Tobit regression model was used to assess determinants of adoption intensity of CSA practices. Results showed that majority of the farmers (67.3%) hardly obtained any credit and majority of them (64.5%) never had access to extension services. Majority of the respondents highly adopted the use of shades (71.7%), CBI (76%), mulching (61.5), organic fertilizer (89%), contour trenches (58.9), cover crops (84.6), and stumping (55.5). Tobit regression analysis revealed that farmer's level of education, access to extension services and marital status showed a positive and significant ($P \leq 0.01$), ($P \leq 0.01$), and ($P \leq 0.05$) influence on adoption intensity of CSA practices, respectively. Years of farming, access to credit, farm size, and farmer's age showed a negative relationship with adoption intensity of CSA practices. In conclusion, the government of Uganda should intensify extension of adoption of CSA practices among coffee farmers.

Keywords: Climate Smart Agriculture; Coffee production; Climate change; Adoption intensity

1. Introduction

Coffee is one of the most important cash crops in the agricultural sector of Uganda and plays a vital role in poverty reduction, economic development, and income generation [14,45,17]. It is second to crude oil as the most important internationally traded commodity in monetary value [20,2]. In spite of high export earnings from coffee globally, coffee production in most African countries is still low as a result of climate change, among other production consequents [27,22]. Climate change which includes changing weather patterns, drop in water levels, decrease in rainfall, combined with significant wetter seasons, and increased frequency of extreme weather events like floods, as well as drought, whose social economic impacts make communities very vulnerable, have significantly contributed to the current trend [52]. Only 7% of the coffee farmers in Uganda are involved in Arabica coffee cultivation [55,38]. This is attributed to the fact that Arabica coffee is very sensitive to climate variability and change and thus strongly influenced by natural climatic oscillations [8,13,25,10]. Notre Dame Global Adaptation Initiative index ranks Uganda as the 9th most

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vulnerable and 27th least ready country to adapt to climate change globally [24]. In order to improve and maintain sustainable coffee production, attention should be paid to improving the quality of coffee by engaging in sustainable, environmentally friendly climate smart agricultural practices like use of organic fertilizer, stumping, shade trees, mulching, contour trenches and cover crops [51,1,43]. Agricultural coffee production systems in Uganda are currently less resilient to climatic changing conditions [7]. There has been a significant decline in Arabica coffee production in Bududa District in the past two decades [51]. This has been attributed to climate change, land degradation and poor crop management [29,38]. Adoption of climate smart agricultural practices such as terrace farming, contour trenches, mulching, planting shade trees and covers crops, among others, have been suggested by a number of scholars to accelerates Arabica coffee production [38,1,55,43,51]. However, very few studies have been conducted to assess the adoption intensity of climate smart agricultural practices of Arabica coffee production among coffee farmers in Uganda. Therefore, the present study sought to understand the determinants of adoption intensity of climate smart agricultural practices in Arabica coffee production in Bududa district. This was done through characterizing coffee farmers and assessing determinant factors influencing the adoption intensity of Climate Smart Agricultural practices in Arabica coffee production.

2. Material and methods

2.1. Research Design

A cross sectional survey design was used where data was collected at one time. In-depth, face-to-face interviews were carried out while using a pre-tested and structured questionnaire as a survey instrument to collect quantitative data.

2.2. Study Area

The study was conducted in Bumayoka sub county of Bududa district, which is located in mountain Elgon region of eastern Uganda. It borders the republic of Kenya in the East, the districts of Sironko in the North, Mbale in the West, Bukwo in the North-East and Manafwa in the South. It lies between the longitudes of 34° 16’ 18” and 34° 32’ 6.69” East, and latitudes 00° 58’ 45.63” to 1° 7’ 22.07” North.

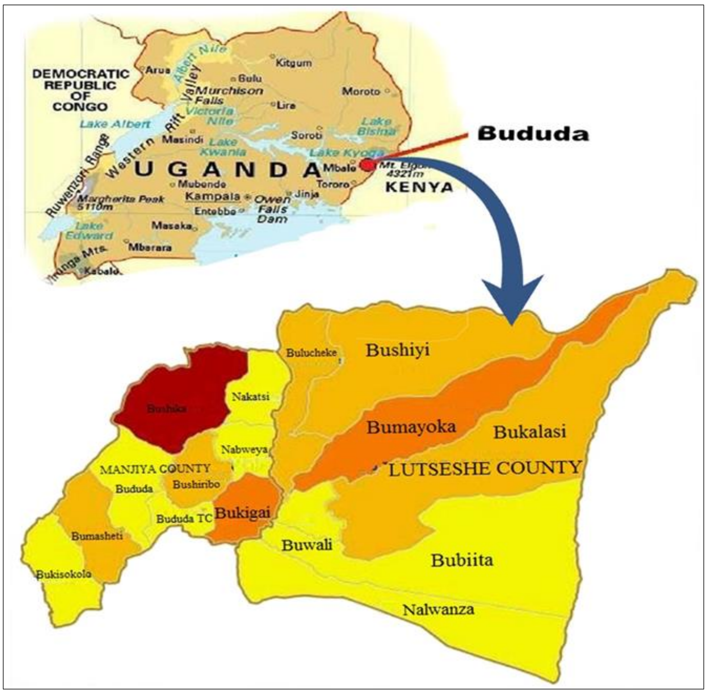

Figure 1 Map of Uganda showing the location of Bududa district in Mount Elgon region

2.3. Sampling Technique and sample size determination

A multi-stage sampling technique was employed, and this involved purposive selection of Bududa district due to its status of coffee production. This was followed by purposive selection of Bumayoka sub county which was intensively involved in Arabica coffee production from which Arabica coffee farmers who were registered in Bumayoka co-operative were selected.

117 participants were randomly selected while following procedures provided by [60]. Data was collected on socio-Economic variables (age, sex, marital status, education level, among others) Climate Smart Agricultural Practices (use of shades, CBI, mulching, organic fertilizer, contour trenches, cover crops, stumping, among others) and adoption of Climate Smart Agricultural Practices.

2.4. Data Analysis

Socio-Economic data was subjected to descriptive statistics such as frequencies, percentages, means, and standard deviation by employing Stata 13. These would be further subjected to t-test and chi- square test. In order to measure intensity of adoption of CSA practices, adoption Index of individual farmer was calculated following procedures of Tadasse [61]. This was measured by an adoption quotient (number of CSA practices used by i^{th} farmer over the Total number of CSA practices in the package). It was then categorized into low, medium, and high level of adoption.

$$Adoption\ Intensity\ (AI)\ = \frac{\text{Number of CSA practices used by } i\text{th farmer}}{\text{Total number of CSA practices in the package}}$$

Tobit model regression was used to assess factors influencing adoption intensity of CSA practices as presented below;

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 \ldots\ldots\ldots\ldots \beta_nX_n + \varepsilon i$$

Where Y: Dependent variable (adoption intensity of CSA practices), β_0: Intercept, β_1-n: coefficient of the explanatory variables, X_1-n: Explanatory variables (social, economic and institutional variables).Variables considered included: X_1 = Age, X_2 = Marital status, X_3 = Years of farming, X_4 = Gender, X_5 = Farm size, X_6 = credit, X_7 = Extension services, X_8= Education, and εi=error or disturbance term with zero mean and constant variance.

3. Results and discussion

3.1. Socio-economic and institutional characteristics of the coffee farmers

Results showed that most (34.9%) of the coffee farmers were within the age range of 43 to 54 years (Table 1). This indicated that farmers in the active age dominate Arabica coffee production in the area. The assumption was that younger people are likely to adopt improved practices than old people. Present findings are in line with those of Kadafur and Oyakhilomen [62] who reported that the active farmers were within the same age and referred to them as young and energetic. These are agile and active to withstand the rigors of technology [63]. 67.52% of the farmers were males while females were only 32.48%. This shows that coffee production in Bududa district was dominated by males. This is consistent with the findings of Chekene and Chancellor [64] and Dontsop-Nguezet et al. [65] whose results indicated that rice farming was dominated by males.

Furthermore 91.9% of the farmers were married. Similar results were also observed by Chandio and Yuansheng, [66] in their study on determinants of adoption of improved rice varieties in Northern Sindh, Pakistan. Marriage aids in creating family labour since both women and children can participate in crop production and use of technologies [67] Additionally, 79% of the respondents were ranging between 1-15 years of farming. This indicates that as experience exceeds 15 years, farmers' involvement in coffee production tends to diminish. An average of 10 years' experience in coffee farming was advantageous since it encourages prompt adoption of improved coffee production practices. Results revealed that primary level was the highest level of education (61%) attained by most farmers followed by secondary (25%). This implies that most of the farmers had attained formal education which puts them in a better position to understand and adopt climate smart agriculture practices. Further findings showed that the mean farm size was 1.56ha which indicates that the study area consisted of generally small-scale farmers. This agrees in what Mugagga [35] reported in a rural area like Kaato of mount Elgon region eastern Uganda, small scale farmers were dominant in the coffee production of the area. Only 35.5% of respondents had access to extension officers, whereas 67.3% had not. Extension services help in revealing opportunities of adopting agricultural technologies to farmers. However, limited extension contacts by farmers hinders their access to information on adoption decision. Furthermore, 32.7% of the respondents could access agricultural credit, meaning majority of respondents (67.3%) could hardly obtain any credit for Arabica coffee production. This in line in what Muggaga [35] reported in Kaato sub county of Manafwa District, Eastern Uganda. Access to agricultural credit is very crucial for acquisition of the most essential agricultural inputs for example inorganic fertilizer and farm implements since they help in agricultural productivity.

Table 1 Socio-economic and institutional characteristics of the coffee farmers

Variable	Frequency	Percentage		Variable	Frequency	Percentage
Education level				**Age**		
Primary level	67	57.26		18-30	14	11.97
Secondary level	24	20.51		31-42	26	22.22
Tertiary education	6	5.13		43-54	40	34.19
No formal education	20	17.09		55 and above	37	31.62
Gender				**Access to extension**		
Male	79	67.52		Yes	38	35.5
Female	38	32.48		No	79	64.5
Farm size (Acres)				**Access to credit**		
less than 2	72	61.54		Yes	38	32.7
2.5 - 4.5	27	23.08		No	79	67.3
4.6 – 7.4	15	12.82		**Years of farming**		
7.5 - 9.5	3	2.56		0-15	93	79.00
Marital status				16-30	19	17.00
Married	107	91.90		31-45	5	4.00
Single	4	3.20				
Divorced	2	1.60				
Widowed	4	3.20				

Source: Survey, 2020

3.2. Usage of climate smart agriculture practices by coffee farmers

Results in figure 2 revealed that majority of the respondents highly adopted the use of shade trees (71.7%), coffee banana intercropping (76%), mulching (61.5), organic fertilizer (89%), contour trenches (58.9), cover crops (84.6), and stumping (55.5). This could be attributed to access to information and market. Present results relate with the findings of Zakaria et al., (2020) and sambeek (2015) which pointed out that smallholder farmers had adopted to more 5 CSA practices. On contrary, grass strips (46.1%) and terrace (41.8%) were the least adopted CSA practices by coffee farmers. This could be attributed to the high cost and inadequate knowledge on the practices. Andersson [68] had similar findings.

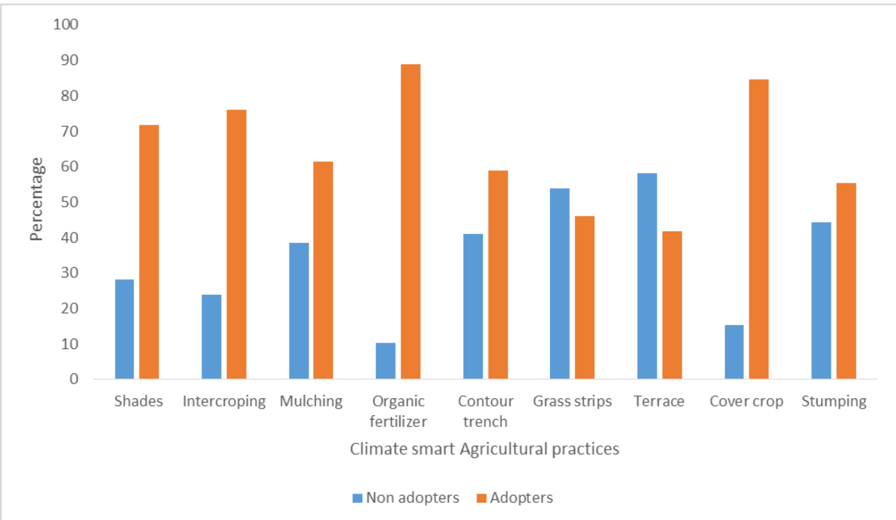

Figure 2 Usage of CSA practices by coffee farmers; Source: Survey, 2020

3.3. Adoption intensity for climate smart agriculture practices

Analysis of variance for adoption intensity for climate smart agriculture practices indicated that there was a significant difference ($p \leq 0.001$) among the adoption indices of the three adoption categories. High adopters had a mean adoption index (AI) score of 0.93, whereas medium and low adopters had 0.65 and 0.02, respectively (Table 2).

Table 2 Adoption intensity of climate smart agricultural practices

Adoption categories	DF	MS	P-value
Low	1	12.362	0.077*
Medium	1	20.447	0.007***
High	1	34.587	0.000***

***, **, * indicates significance at 1%, 5% and 10% respectively;
DF-Degrees of freedom, MS- Mean sums of square; Source: Survey, 2020

3.4. Adoption categories for climate smart agriculture practices

Figure 3 shows adoption categories for climate smart agriculture practices. Farmers were allocated to three adoption categories: Low (4.27%), medium (37.61%) and high (58.12%) adopters with adoption indices ranging from 0.1-0.33, 0.34-0.66 and 0.67-1.00, respectively.

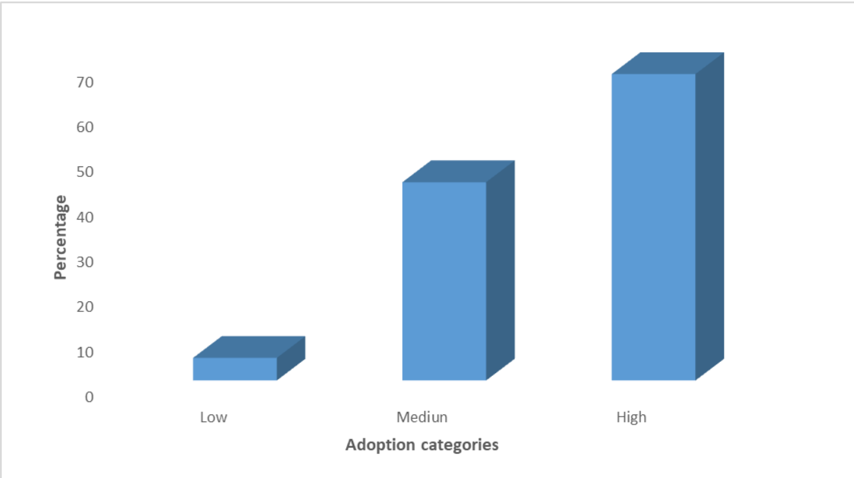

Figure 3 Adoption categories of climate smart agriculture practices; Source: Survey, 2020

3.5. Factors That Influence Adoption Intensity of CSA Practices

Results for Tobit estimate of factors influencing adoption intensity of smart agriculture practices were presented in table 4. Farming experience was anticipated to have a positive effect on intensity of adoption of climate smart agriculture practices since experienced farmers were thought to have accumulated technical know-how over time and therefore were in a better position to adopt the technologies. However, results in the current study indicated that farming experience had a negative relationship with adoption intensity of the production technologies. This inverse relationship with intensity of adoption, was in contrary with Zakaria et al., [56] and Mudzonga [36]. Present results highlighted the point that several experienced farmers feel more comfortable and secure with the conventional technologies which they have been practicing over time. Extension contact positively and significantly ($p \leq 0.01$) influenced the extent of adoption of climate agriculture practices in the study area. This implied that, frequency of extension visits for dissemination of information and advisory services would give the farmers more confidence to sustain the use of climate smart agriculture practices. This is in line with Mugagga [35] and Mudzonga [36] who reported that extension contacts have a positive and significant impact on intensity of adoption. Zakaria etal [56] in a study carried out in northern Ghana, reported a positive effect of extension contacts on intensity of adoption of climate smart agricultural technologies among rice farmers. Danso-Abbeam *et al.* [69] also reported a significant and positive effect of extension contacts on the adoption of improved maize variety in northern Ghana.

Table 3 Tobit estimate for factors influencing adoption intensity of CSA practices

AI	Coefficient	Std. Err.	P>t
Credit	-8.41E-08	6.06E-08	0.109*
Extension services	0.007594	0.011419	0.007***
Marital status	0.040675	0.019067	0.035**
Years of farming	-0.00096	0.00175	0.586
Age	-0.00014	0.00181	0.938
Education	0.00014	2.41E-05	0.000***
Gender	0.02552	0.030694	0.408
Farm size	-0.01712	0.019438	0.380
Constant	0.579924	0.098821	0.000***

***, **, * indicates significance at 1%, 5% and 10% respectively; Number of observation = 117; F (9, 108) = 8.17; Prob > F = 0.0000; Log pseudo likelihood = 59.706905; Pseudo R2 = -0.6739; Obs. summary: 14 left-censored observations; 97 uncensored observations; 6 right-censored observations; Source: Survey, 2020

Education level showed a positive and significant (P≤0.01) influence on adoption intensity of climate smart agricultural practices. Possible explanation is that educated farmers tend to be better access to research output reports and generally to update information about the risks associated with improved production technologies and hence tend to spend more time and money on that. The result was consistency with the findings of Abegunde [6] and Wamalwa [57]. Alene et al. [4] similarly found in their study in the central highlands of Ethiopia that adoption and intensity use of improved maize varieties was determined and significantly influenced by the education level of the farmers. Literate farmers often serve as contact farmers for extension agents in disseminating information about agricultural technologies from government agencies [3]. However, Kolady et al. [28] made a diverging finding where education had an insignificant determining in precious agricultural technologies adoption in their study of determinants of adoption and adoption intensity of precious agriculture technologies in south Dakota, USA. Results showed a negative effect of credit on intensity of adoption of climate smart agriculture practices. This denotes that as farmers' access to credit increases, their desire to venture into other non-farm profit making enterprises also increases, and this eventually limits their investment in coffee production. This could also be attributed to the unpredicted rainfall and temperature patterns of the area which puts farm enterprises at a risk. This observation was consistent with Zakaria et al. [56] who reported diversion of farm credit to non-farm activities by farmers in the Indo-Gangetic Plains of India and Northern Ghana respectively. The negative effect of credit was in contrary with a study by Mugagga [35] and Mudzonga [36] who reported a significant and positive impact of credit on perceptions and response actions of smallholder coffee farmers to climate variability in montane ecosystems and farmers' adaptation to climate change in Uganda and Zimbabwe respectively. Results further showed a negative influence of farm size on adoption of climate smart agriculture practices. This implies that as land size increases, use of climate smart agriculture practices decreases. However, this is in contrary to the findings of Abegunde [6], Wamalwa [57] and Tesfay [46] who reported that farm size is also a statistically significant to adoption intensity of climate smart agricultural practices. They indicated that there was positive and significant relationship between farm size and agricultural innovation utilization. Similar result was reported by Mugagga [35] in a rural area of Kaato of mount Elgon region of eastern Uganda. Furthermore, the study findings revealed that age had negative relationship with adoption intensity of CSA practices in Bududa district. The finding of the study goes in line with Wamalwa [57] and Kolady et al [28] who reported that age was insignificance in the adoption of improved practices. Adeola et al (2019) had similar findings in their study of investigating the determinants of adoption intensity of improved sweet potatoes varieties among farmers in Nigeria. However, findings in this study showed that adoption intensity of climate smart agricultural practices was irrespective of gender. This was consistency with the study of Alene et al. [3] who reported that parameter of age of the farmer was statistically insignificant. Davis et al. [13] similarly showed that gender played no significant role in the adoption decision of the household. This was quite a contrast from many other gender studies that have consistently found that men generally have greater control over household resources than women do, and as such, adoption gaps exist between men and women. Farmers' marital status had a positive and significant (P≤0.05) relationship with adoption intensity of climate smart agriculture practices. Marriage aids in creating family labour since both women and children can participate in crop production and use of technologies. The family determines how much family labour will be used on the farm [45].

4. Conclusion

Majority of the respondents highly adopted the use of CSA practices. Farmers' level of education, access to extension services and marital status positively and significantly influenced adoption intensity of CSA practices, whereas, years of farming, access to credit, farm size, and farmers' age negatively related with adoption intensity of CSA practices. Government should intensify extension of adoption of CSA practices among coffee farmers for increased production and productivity.

Compliance with ethical standards

Acknowledgments

Faculty of Environment and Agricultural Science, Ndejje University and Cereals Research Program, National Crop Resources Research Institute for technical support provided throughout this study.

Disclosure of conflict of interest

The authors, Abdullahi Faisal, Simon Zziwa, David Talengera, Lydia Nabatanzi, and Olivia Makumbi , declare that no conflict of interest exists with them in whatsoever.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

References

[1] Abraham Alemu, EbisaDufera. Climate Smart Coffee (coffea arabica) Production. American Journal of Data Mining and Knowledge Discovery. 2017; 2(2): 62-68.

[2] Amsalu, Solomon, Mansingh Poul J. Operational Performance of Assella Malt Factory Within the Value Chain: ASELLA, Ethiopia. Available on researhgate.ne. 2019.

[3] Adeola RG, Ogunleye KY, Adewole WA. Adoption intensity determinants for improved sweet potato varieties among farmers in Nigeria. International Journal of Agricultural Management and Development. 2019; 9(3): 203-211.

[4] Alene AD, Poonyth D, Hassan RM. Determinants of Adoption and Intensity of Use of Improved Maize Varieties in The Central Highlands of Ethiopia: A Tobit Analysis. Agrekon. 2000; 39(4).

[5] Arslan, Aslihan, Leslie Lpper, Nancy McCarthy, Solomon Asfaw. Adoption and intensity of adoption of conservation farming practices in Zambia. 2014.

[6] Abegunde Victor O, Sibanda Melus, Obi Ajuruchukwu. Determinants of the Adoption of Climate-Smart Agricultural Practices by Small-Scale Farming Households in King Cetshwayo District Municipality, South Africa. Sustainability. 2020; 12: 195.

[7] Bunn C, Lundy M, Läderach P, Fernández P, Castro-Llanos F. Climate-smart Coffee in Uganda. International Center for Tropical Agriculture (CIAT), Cali, Colombia. 2019.

[8] Camargo MBP. The impact of climate variability and climate change on Arabica coffee crop in Brazil. Bragantia vol.69 no.1 Campinas 2010. ISSN 0006-8705.

[9] Chukwuji OC, Ogisi OD. Tobit analysis of fertilizer adoption by smallholder cassava farmers in Delta State. Nigeria Agricultural Journal. 2006; 1(4): 240-248.

[10] Craparo ACW, Van Asten PJA, Laderach P, Jassogne LTP, SW Grab. Coffee Arabica yields decline in Tanzania due to climate change: Global implications. Agricultural and Forest Meteorology. 2015; 207: 1-10.

[11] Creswell J. Research: Qualitative, quantitative and mixed methods approaches. Sage: London, UK. 2003.

[12] Corey Watts. The climate institute; A Brewing Storm: The climate change risks to coffee. 2006.

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

[14] Diao, Xinshen, Peter Hazell, James Thurlow. The role of agriculture in African development. Available on ResearchGate. 2010.

[15] DaMatta Fabio M, Claudio P Ronchi, Moacyr Maestri, Raimundo S Barros. Ecophysiology of coffee growth and production. Brazilian Journal of Plant Physiology. 2007.

[16] DaMatta Fábio M, Ramalho José D Cochicho. Impacts of drought and temperature stress on coffee physiology and production. Braz. J. Plant Physiol. 2006; 18(1): 55-81.

[17] Economic Policy Research Centre. Uganda 2013 fin scope III Report: Unlocking Barriers to Financial Inclusion in Uganda. Available on eprcug.org. 2013.

[18] Food and Agriculture Organization. Climate Smart Agriculture; sourcebook., E-ISBN 978-92-5-107721-4 (PDF). 2013; 41-124.

[19] Food and Agriculture Organization. Agriculture and climate change – Challenges and opportunities at the global and local Level – Collaboration on Climate-Smart Agriculture. Rome. Licence: CC BY-NC-SA 3.0 IGO. 2019; 52.

[20] Food and Agriculture Organization. The state of Food Insecurity in the World. Monitoring progress towards the World Food Summit and Millennium Development Goals. Available on fao.org. 2004.

[21] Food and Agriculture Organization. Handbook on climate information for farming communities – What farmers need and what is available. Rome. Licence: CC BY-NC-SA 3.0 IGO. 2019; 184.

[22] Hepworth N, Goulden M. Climate Change in Uganda: Understanding the implications and appraising the response, LTS International, Edinburgh. 2008.

[23] Goosse H, PY Barriat W Lefebvre, MF Loutre, V Zunz. Introduction to climate dynamics and climate modeling. Chapter 1. Description of the climate system and its components. 2010.

[24] Irish Aid. Uganda climate action report. Resilience and economic inclusion team. 2017.

[25] Jassogne L, Laderach P, Van Asten P. The Impact of Climate Change on Coffee in Uganda: Lessons from a case study in the Rwenzori Mountains. Oxfam research report. 2013.

[26] Joas Tugizimana. Effects of soil and water conservation techniques on soil productivity and bean grain yield in nyamasheke district, Rwanda. A master thesis submitted in the school agriculture and enterprise development, Kenyatta University. 2015.

[27] Keely Dinse. Climate Variability and Climate Change. Michigan Sea Grant. 2010.

[28] Kolady DE, Sluis EVD, Uddin M, Deutz AP. Determinants of adoption and adoption intensity of precious agriculture technologies: evidence from south Dakota. 2020.

[29] Kimani Martin, Tony Little, Janny GM Vos. Introduction to coffee management through discovery learning. CAB international. African Regional Centre, Nairobi, Kenya. 2002.

[30] Krishnan Sarada.. Sustainable coffee production. 2017.

[31] Masiga, Moses, Ruhweza, Alice. Commodity Revenue Management: Coffee and Cotton in Uganda. International Institute for Sustainable Development. 2012.

[32] Muratori, Lodovico. Price Gap along the Ugandan Coffee Value Chain. Working paper 1/16, Sapienza University of Roma, DISS. 2016.

[33] Menale K, Mahmud Y, John P, Gunnar K, Randy B, Elias Mulugeta. Impact of soil conservation on crop production in northern Ethiopian Highlands. International Food Policy Research Institute (IFPRI). 2007.

[34] Mugagga F, V Kakembo, M Buyinza. Land use changes on the slopes of Mount Elgon and the implications for the occurrence of landslides. 2012.

[35] Muggaga Frank. Perceptions and Response Actions of Smallholder Coffee Farmers to Climate Variability in Montane Ecosystems. Environment and Ecology Research. 2017; 5(5): 357-366.

[36] Mudzonga Evengelista. Farmers' Adaptation to Climate Change in Chivi District of Zimbabwe. TRADE AND DEVELOPMENT STUDIES CENTRE3 Downie Avenue Belgravia , Harare Zimbabwe. 2011.

[37] Mukiibi Joseph. Agriculture in Uganda volume II Crops. Kampala, Uganda: Fountain publishers ltd. ISBN 9970-02-234-2. 2001.

[38] Ministry of Water and Environment. Economic assessment of the impacts of climate change in Uganda. Arabica coffee production in the Mount Elgon region. 2005.

[39] Lungu, Harad Chuma. Determinants of climate smart agricultural technology adoption in the Northern Province of Zambia. Published master thesis. University of Pretoria. 2019.

[40] Okeyo AI, M Mucherui-Muna, J Mugwe, KF Ngetich, DN Mugendi, J Diels, CA Shisanya. Effects of selected soil and water conservation technologies on nutrient losses and maize yields in the central highlands of Kenya. Agricultural Water Management. 2014; 137: 52-58.

[41] Rice R. Culture, agriculture, and nature: Shade coffee farms and biodiversity. InR. W. Thurston, J. Morris, & S. Steiman (Eds.), Coffee: A comprehensive guide to the bean,the beverage, and the industry. Lanham, MD: Rowman& Littlefield. 2013; 41–51.

[42] Saha MK, Biswas AA, Faisal J Meandad, FM Sakib. Factors Affecting to Adoption of Climate-smart Agriculture Practices by Coastal Farmers' in Bangladesh. American Journal of Environment and Sustainable Development. 2019; 4(4): 113-121.

[43] Santaram, Akundi. Sustaining Coffee Production: Present and Future. 2018.

[44] Sambeek Lisa Van. Gender analysis on Climate-Smart Agriculture, National Environmental Policies, and Climate Change Adaptation in Rakai District, Uganda. Published master thesis. 2015.

[45] Salami OA, Abdul Kamara, Zuzana Brixiova. Smallholders Agriculture in East Africa: Trends, Constraints and Opportunities. Available on ResearchGate.net 2010.

[46] Tesfay, Kide Gebru. Smallholder farmers' adaptation strategies to climate change in Ethiopia (the case of Adwa Woreda, Tigray region). Master thesis. Mekelle university. 2014.

[47] Teddlie, Charles, Tashakkori Abass. Foundations of Mixed Methods Research: Integrating Quantitative and Qualitative Approaches in the Social and Behavior Sciences. SAGE publications. 2009.

[48] UN-Water. Climate change adaptation: the pivotal role of water. UN-Water policy brief. 2010.

[49] Uganda Coffee Development Authority. Monthly report, available on ucda.ug. 2018.

[50] Uganda Coffee Development Authority. Annual report v. 25, available ucda.ug. 2016.

[51] Uganda Coffee Development Authority. Robust Coffee Handbook. Available on www.ugandacoffee.go.ug. 2019.

[52] UNDP. Ecosystem Based Adaptation in Mount Elgon Ecosystem. Project Document. 2010.

[53] Uganda Bureau of Statistics. The National Population and Housing Census 2014 – Area Specific Profile Series, Kampala, Uganda. 2017.

[54] Uganda Bureau of Statistics. Bududa District Local Government Statistical Abstract. Kampala: UBOS. 2012.

[55] Van Asten P, Ochola D, Wairegi L, Nibasumba A, Jassogne L, Mukasa D. Coffee-Banana Intercropping: Implementation guidance for policymakers and investors. 2015.

[56] Zakaria A, Alhassan SA, Kuwornu JKM, Azumah B.sS Derkyi MAA. Factors influencing of climate smart agricultural technologies among rice farmers in northern Ghana. Earth system and Environment. 2020; 4: 257-271.

[57] Wamalwa, Isaac Wafula. Adoption of Climate Smart Agricultural Practices Among Small Scale Farmers of Kitutu and Nyaribari Chache in Kisii County, Kenya. Published PhD thesis. Kenyatta university. 2017.

[58] Whelsan Tensie, Newsom Deanna. Sustainable coffee farming: Improving income and social conditions, protecting water, soil and forests. Rainforest Alliance. 2014.

[59] Wintgens JN. Coffee: Growing, Processing, Sustainable production: A Guidebook for Growers, Processors, Traders and Researchers. 2nd edition, Wiley-VCH. 2009.

[60] Yamane, Taro: Statistics, An Introductory. Analysis, 2nd Ed., New York: Harper and Row. 1967.

[61] Tadasse B. Fayissa B., Nsiah C. Impact of Tourism on Economic Growth and Development in Africa. Tourism Economics, 14, 807-818. 2008.

[62] Kadafur MI, and Oyakhilomen O. Understanding the Drivers of Adoption Intensity of Improved Maize Varieties in Northern Guinea Savannah of Borno State, Nigeria. Available on https://www.researchgate.net/publication/318044144. 2017.

[63] Okunlola O. Oludare O. Akinwalere B. Adoption of new technologies by fish farmers in Akure, Ondo state, Nigeria Journal of Agricultural Technology 7(6):1539-1548. 2011.

[64] Chekene MB. Chancellor TSB. Factors Affecting the Adoption of Improved Rice Varieties in Borno State, Nigeria. Vol. 19 No. 2. 2015.

[65] Dontsop P.M. Nguezeta VO. Okoruwa AI. Adenegan KO. Productivity Impact Differential ofImproved Rice Technology AdoptionAmong Rice Farming Households inNigeria. Journal of Crop Improvement 26(1):1-21.2012.

[66] ChandioJiang Y. Abbas A. Determinants of Adoption of Improved Rice Varieties in Northern Sindh, Pakistan. Volume 25 (2): Pages 103-110. 2018.

[67] Ogunlade I. Ilesanmi O. Proximate, mineral composition, antioxidant activity, and total phenolic content of some pepper varieties (Capsicum species). International Journal of Biological and Chemical Sciences 6(5). 2012.

[68] Andersson JA. Shereen DS. From adoption claims to understanding farmers and contexts: A literature review of Conservation Agriculture (CA) adoption among smallholder farmers in southern Africa. Agriculture Ecosystems & Environment 187:1-94. 2014.

[69] Danso AG. Edinam DS. Gershon I. Gershon KAI. Modelling Farmers Investment in Agrochemicals: The Experience of Smallholder Cocoa Farmers in Ghana. Research in Applied Economics. Vol. 6, No. 4. 2014.