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Factors Affecting the Adoption of Climate Smart Agricultural Practices among Smallholder Farmers in Bungoma County, Kenya

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Abstract:
While a better understanding of factors influencing adoption of Climate Smart Agricultural (CSA) practices is important in promoting successful climate change adaptation strategies, there is little information on the various practices adopted by smallholders. Accordingly, this study analyses the factors influencing adoption of CSA practices in Bungoma, County. The study adopted a descriptive research design. Theory of planned behaviour and technology acceptance theory guided this study. Multistage sampling, purposive sampling, systematic random sampling procedures were employed to select a sample size of 228 respondents was interviewed using structured questionnaire. Data collected was analysed using combination of descriptive statistics. The findings indicated that social factors (age and sex) were found to significantly relate to adoption of climate smart agriculture. Land size and income facilitate the adoption of CSA practices. Land ownership increases the likelihood of farmers adopting strategies that capture the returns from their investment. Most of the training that they have received has been mainly through workshops, field day and group training. The study recommends that more integration between extension partners should be considered. There is need for better land security to enable farmers adopt CSA. Policies and strategies should strengthen the existing agricultural extension service, supporting proven technologies such as soil fertility management, improved crop and livestock breed, agro forestry and water harvesting and management. Capacity enhancement is needed for climate smart agricultural practices including access to weather information adapted to farmers' needs.

Keywords: *Factors, climate smart agriculture, adoption*

1. Background of the Study

Globally, agricultural activities account for 14% of global greenhouse gas (GHG) emissions. Between 1886 and 2012, global average temperatures have risen by 0.85°C and predictions are 1.5°C by 2050. If nothing is done today, global temperature levels will exceed 2^0 C, which will be catastrophic and irreversible. Predictions are that the next 50 to100 years will see widespread declines productivity of cropland particularly in sub-Saharan Africa and southern Europe (IPCC, 2007). Give that African economies are highly dependent on agriculture which constitutes approximately 30% of GDP and heavily rely on rain fed agriculture; multidimensional challenges of ensuring food and nutrition security, preservation of ecosystems and slow economic growth are bound to develop (FAO, 2011).

In Kenya, the agriculture sector has experienced the impacts of climate change which are manifested in extreme weather events that causes drought, flooding, strong winds, landslides; seasonal weather variations; gradual change in precipitation patterns and increased temperatures. Farmers are unlikely to invest in various CSA practices such as conservation agriculture, which uses permanent soil cover, minimally disturbs the soil and crop rotations due to insecure land tenure. This is because to practice conservation agriculture, it requires investment in expensive equipment which requires higher maintenance costs compared to traditional agriculture and further it requires more time to reap the benefits (FAO, 2011).

The need for climate smart agriculture has been necessitated by deleterious farmers' practices within the continent. Boykoff (2011) points out that;

There is wide scientific consensus that the global climate is attributed in part to human activities. Current data demonstrates that the climate is changing globally at an unprecedented rate and that unparalleled levels of human induced greenhouse gas (GHG) emissions, especially carbon dioxide, are causing an increase in global temperatures that creates changes in the earth's weather. Atmospheric concentrations of carbon dioxide have increased from a pre-industrial value of 278 parts per million (ppm) to 379 ppm in 2005. It is now generally accepted that this climate change is the result of increasing concentrations of carbon dioxide, methane, nitrous oxide and other GHGs in the atmosphere (Boykoff, 2011).

This susceptibility is likely to jeopardize attainment of the sector contribution to the national economy. It is critical that innovative and transformative measures are put in place to assist stakeholders in the sector across the agricultural value chains to cope with effects of current and projected change in climate patterns Lipper, Thornton, Campbell, Baedeker, Braimoh, Bwalya, & Hottle, 2014). Climate smart agriculture (CSA) has been identified as a viable approach/adoption to provide solutions towards increased agriculture sector productivity while addressing impacts of changing climate. Climate smart agriculture is a revolutionary term that aims at integrating climate change in agriculture and make agriculture adapts to climate change and to reduce emissions (or mitigation) that causes climate change. According to FAO (2010) climate smart agriculture is the agriculture that i) sustainably increase productivity, ii) reduce climate change vulnerability (enhance adaptation), iii) reduce emissions that cause climate change (mitigation), while iv) protecting the environment against degradation and v) enhancing food security and improved livelihood of a given society.

In Bungoma County, agricultural production have attracted several institutions and/or organizations, all with the main objective of improving agricultural efficiency and conditions through various intervention such as capacity building of the farmers, provision of improved inputs, on-farm demonstrations plots of new agricultural technologies, remedial or mitigation measures of degrade soils advocacy among other functions. Such Institutions include: One Acre Fund, Conservation Agriculture for sustainable agriculture for rural development (CA SARD), Sygenta, Kick Start, among others.

1.1. Statement of the Problem

Kenya's agriculture is highly vulnerable to the impacts of climate change and from Kenya Meteorological Department (KMD) data; it indicates that a temperature rises of 2°C would lead to large areas currently suited under certain crops becoming unsuitable. More intense rainfall and frequent floods lead to loss of crops and life, destruction of homes and displacement of households as well as increased incidences of new crop diseases Maize Lethal Necrosis Disease (MLND) in Maize, fall armyworm. More so, economic costs of climate change impacts in Kenya are estimated at 3% of GDP per year by 2030 and 5% by 2050 (IPCC 2007). Therefore, these changes are likely to jeopardize agricultural production and food security and the country's ability to grow and develop. It is against this backdrop that smallholder farmers who lack knowledge about existing and new potential options for adapting their agricultural systems ought to integrate CSA practices (FAO 2011). Most of the proposed CSA practices have assisted farmers to cope up with the effects of climate change impacts and not necessarily to adapt to the impacts. Several studies conducted in the area of climate smart agriculture by Amin, Mubeen, Hammad, & Jatoi (2015) focused on CSA for sustainable food security. McCarthy, Lipper and Branca (2011) focused on the role of institutions for CSA improvement. Crouch, Lapidus, Beach, Birur, Moussavi and Turner (2017) focused on the role of economic modelling as a policy to strengthen CSA**.** From the on-going little in-depth study has been conducted on the adoption of climate smart agriculture among small holders' farmers. It was therefore important to examine factors for adoption of CSA among the small holders' farmers.

1.2. Specific Objectives

The specific objectives of the study are:

- To assess the social economic characteristics of smallholder farmers in Bungoma County, Kenya.
- To evaluate the adoption of climate smart agricultural practices among smallholder farmers in Bungoma County, Kenya.

1.3. Literature Review

The study adopted the Theory of Planned Behavior (TPB), which states that attribute alone is not enough to predict behavior, but also social pressures and the perceived difficulty in carrying out the action are also important. It was developed from the expectancy value model and the theory of reasoned action (Conner & Armitage, 1998). TPB regards beliefs as the fundamental blocks of behavior intention. They represent the information an individual has about a specific behavior and attribute of his/ her behavior. The key component to this model is behavioral intent; behavioral intentions are influenced by the attitude about the likelihood that the behavior will have the expected outcome and the subjective evaluation of the risks and benefits of that outcome. The TPB has been used successfully in predicting and explaining a wide range of health behaviors and intentions. The TPB states that behavioral achievement depends on both motivation (intention) and ability (behavioral control) (Carsrud & Brännback, 2011).

1.4. Research Approach

The study covered Bungoma County located between longitude 34° 21.4′ and 35° 04′ East and latitude 0°25.3 and 0° 53.2′ North. Descriptive and an explanatory research designs were used to underpin the study. Purposive sampling was used to select 3 sub-counties in the county with different livelihoods and agro ecological zones. Then systematic random sampling procedure was employed to select 333 farmers. This approach was chosen because it ensures an equal probability of inclusion of each unit in the population than simple random sampling (Nassiuma & Mwangi, 2004). Quantitative and qualitative data analysis methods were used.

2. Findings

2.1. Social and Demographic Characteristics

The first objective of the study sought to find out the social and demographic characteristics of the sampled small holders' farmers in Bungoma County. A number of variables were investigated. These included the demographic characteristics of respondents that included sex, age, and length of residence in community in years, number of persons in household, number of dependents and the education of the respondents. Table 1 presents the findings.

Social/Demographic Characteristics		Frequency	Percent (%)
Sex	Male	105	46.1
	Female	123	53.9
	Total	228	100
Age range of respondent:	18-25	22	9.6
	26-33	44	19.3
	34-41	77	33.8
	42-49	10	4.4
	Above 50	75	32.9
	Total	228	100
Length of residence in Community in years	Less than 1 year	3	1.3
	1-5yrs	6	2.6
	6-10yrs	21	9.2
	11-15yrs	11	4.8
	16-20yrs	187	82
	Total	228	100
No. of persons in household:	1-3 persons	128	56.1
	4-6 persons	20	8.8
	7-10 persons	80	35.1
	Total	228	100
No. of dependants:	1-3 persons	129	56.6
	4-6 persons	51	22.4
	Above 6	48	21.1
	Total	228	100
Education of respondent	Primary	100	43.9
	Secondary	45	19.7
	Technical/vocational	10	4.4
	Tertiary	73	32
	Total	228	100

Table 1: Social and Demographic Characteristics of the Sampled Smallholder Farmers in Bungoma County

Findings in Table 1 indicate that 53.9% (123) of the respondents are female while 46.1% (105) are male. This is an indication that there was almost equal representation of male and female smallholder farmers. Age is said to be a primary latent characteristic in adoption decisions. In regard to the age of the respondents, 33.8% (77) of the respondents are between 34 to 41 years of age, 19.3% (44) of them are between 26 to 33 years, 9.6% (22) are between 18 to 25 years, 4.4% (10) of the respondents are between 42 to 49 years and 32.9% (75) are above 50 years of age. Most of the respondents are between 34 to 41 years of age implying that they are in their productive age bracket. However, there is a contention on the direction of the effect of age on adoption. In terms of length of residence in the community, 82% (187) of the respondents have lived in the community for 16 to 20 years, 9.2% (21) for 6 to 10 years, 4.8% (11) for 11 to 15 years, and 2.6% (6) of them for 1 to 5 years and 1.3% (3) of the respondents have lived in the community for less than a year. Overall, most of the respondents (82%) had lived in the community for more than 16 years and this provided responses based on a wider knowledge base. The number of persons in household was also established. From the findings, 56.1% (128) of the respondents noted that there are between 1 to 3 persons,35.1% (80) 7 to 10 persons while 8.8% (20) of the respondents affirmed that there are between 4 to 6 persons in the household. The large number of persons in the household may provide for family labour required in agricultural production. In terms of the number of dependents, 56.6% (129) of the respondents established that there are between 1 to 3 dependents, 22.4% (51) of the respondents stated that there are between 4 to 6 dependents while on the other hand 21.1% of the respondents stated that there are over 6 dependents. The high numbers of dependents in most cases is translated into increased family pressure on the limited resources. In regard to the education of the respondents,43.9% (100) of the respondents have primary as their highest education level,32% (73) tertiary level of education,19.7% (45) secondary level of education and 4.4% (10) technical/vocational. This shows that on average, farmers attained the minimum required education level that is adequate for understanding agricultural instructions provided by the extension workers. They also have higher allocative abilities and can adjust faster to farm and technologies adoption conditions.

2.2. Economic Factors Influencing Adoption of CSA

The study sought to find out the economic factors that influence adoption of climate smart agricultural practices among the sampled small holder farmers in Bungoma County. The economic factors include land ownership, land size and use and total income earned by the farmers.

2.2.1. Land Ownership

Land as a factor of production and storage of wealth is the most important asset influencing adoption (Shively, 1999). Land ownership and size are associated to the ability to uptake climate change adaption strategy. Small scale farmers and those who lease land to farm for a short period of time are unlikely to adopt major climate change and adaptation strategies. This prompted the researcher to establish land ownership. Figure 1 highlights the results on land ownership.

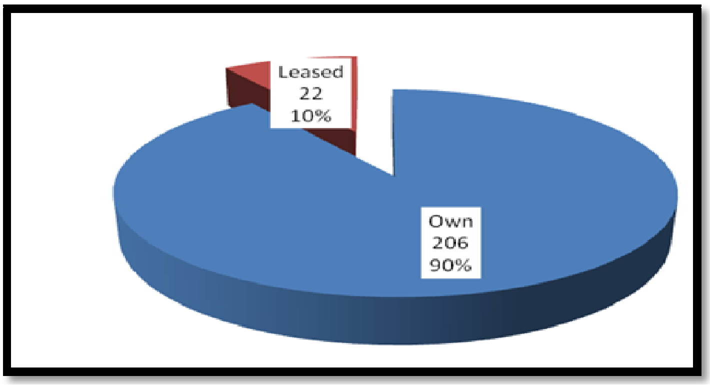

Figure 1: Type of Land Ownership among the Smallholder Farmers

Finding in Figure 1 indicated that 90% (206) of the respondents own the land while 10% (22) of them have leased the land. This implies that adoption of the CSA may not be a problem to the majority small holder farmers.

2.2.2. Land Size (Acres) and Use

The researcher deemed it important to establish the number of acres owned by the respondents. This information is presented in Table 2.

Land Size (acres)	Frequency	Percent %
Below 1 acre	33	14.5
1-2	92	40.4
3-4	61	26.8
5 and above	42	18.4
Total	228	100

Table 2: Category of Land Size in Acres Owned by SHFs

As presented in Table 2, 4.2, 40.4% (92) of the respondents 1-2 acres of land, 26.8% (61) 3-4 acres of land, 18.4% (42) of them own four acres of land while 14.5% (33) of the respondents do not own land. Therefore, majority of the farmers in Bungoma County are small scale farmers with less 2 acres. This result is in concurrence with a study done by Waithaka (2010) in Western Kenya which points out that land size is getting smaller and exacting pressure on the agricultural activities.

The researcher deemed it important to establish land use. Table 3 highlights the results.

Land Use Type	N	Minimum	Maximum	Mean	Std. Deviation
Livestock-size in acres	228	0	1	0.1	0.296
Livestock - year in same use	228	0	25	8.18	12.247
Livestock – rank	154	0	2	0.51	0.873
Crops-size in acres	217	0	0	0	0
Crops- year in same use	217	0	30	13.14	8.013
Crops- rank	154	0	5	0.89	1.595
Homestead -size in acres	228	0	3	1.53	1
Homestead - year in same use	228	0	40	13.43	12.093
Homestead – rank	154	0	1	0.4	0.491
Forest-size in acres	217	0	2	0.29	0.625
Forest - year in same use	194	0	15	7.18	8.649
Forest – rank	126	0	3	0.24	0.814

Table 3: Land Use among Small Holders Farmers in Bungoma County

Finding in Table 3 indicated that most part of the land was used for crops (mean = 0.89, 1.595) followed by livestock (mean = 0.51, SD = 0.873) then homestead (mean = 0.4, SD = 0.491) and finally agro forest (mean = 0.24, SD = 0.814). The homestead and crops were used for an average of 13 years, forest for 7 years and livestock 8. These findings give credence to the study by Waithaka (2010) in Western Kenya, in which findings showed that western farmers were practicing conservation agriculture and crop intensification as a buffer to climate change as compared to other activities.

2.3. Institutional Factors Influencing Adoption of CSA

The study sought to find out the institutional factors that influence adoption of climate smart agricultural practices among the sampled small holder farmers in Bungoma County. This included knowledge of Climate smart Agricultural practices, access to extension service and noticed of climate change among the sampled farmers in Bungoma County.

<u>2.3.1. Knowledge and Awareness on Climate Smart Agricultural Practices</u>

Efficient and effective capacity development and knowledge management in adapting to climate change is an important role that National Climate Change Action Plan (NCCAP) acknowledges. The researcher assessed the respondents' knowledge and awareness on CSA practices. The respondents were asked if they are aware of any CSA practices to help them adapt to climate change. Information gathered is presented in Figure 2

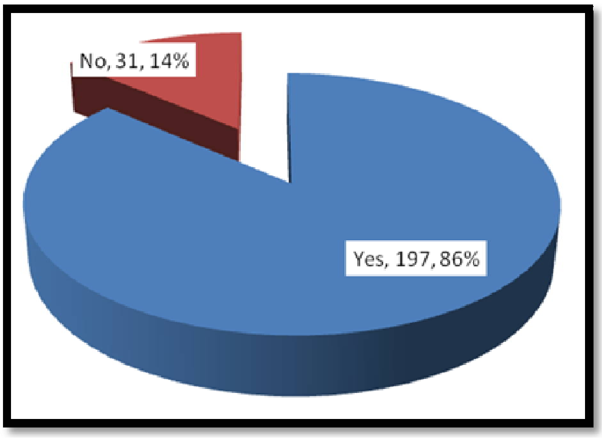

Figure 2: Proportion of the Sampled Awareness on Climate Smart Agricultural

Finding in Figure 2 shows that 86% (197) of the respondents are aware and have some basic knowledge on CSA practices. However, 14% (31) of the respondents noted that they lack awareness and no knowledge on climate smart agricultural practices. This implies that adoption of Climate Smart Agriculture may be a challenge thus the need to institutionalise structures that will be enable information reaching as many farmers as possible.

Further information was sought from the respondents on the climate smart practices they were aware of. The CSA practices investigated in the study were grouped into 4. Findings are indicated in Table 4;

CSA Practices	Frequency	Percent (%)
Soil Fertility Management	127	55.7
Improved Crop and livestock breeds	174	76.3
Agro forestry	32	14
Water harvesting and management	133	58.3

Table 4: Type of CSA Practices Sampled Farmers are aware of

Findings in Table 4 shows that 55.7% (127) of the respondents are aware of soil fertility management, 76.3% (174) respondents were aware of improved crop and livestock breed, 14% (32) agro forestry and 58.3% (133) water harvesting and management practices. Findings indicate that majority of the farmers talked of change to high-yielding and maturing varieties especially for maize and most included indigenous crop types and varieties. More so, some of the farmers pointed out to have changed to early planting.

On the contrary few farmers were aware of agro forestry as represented by 14%. The farmers that had trees on their farm were not deliberate in the combination of trees with agricultural crops and/or animals on the same land management unit in some form of spatial arrangement or temporal sequence.

Water harvesting practices that they are aware off was roof catchment. Therefore, majority did not mention any other practice of water harvesting such as zai pits, retention ditches and water pans.

<u>2.3.2. Access to Extension Service</u>

Extension services play a critical role in agricultural development through dissemination of technologies, innovations and knowledge. When well-coordinated and collaborative, it produces synergies and delivers sustainable results. Therefore, the study determined the various forms of extension service that farmers in Bungoma received and the providers of the service.

The researcher sought to establish whether the farmers' sought extension services from the Ministry of Agriculture extension workers. The findings are indicated in Figure 3.

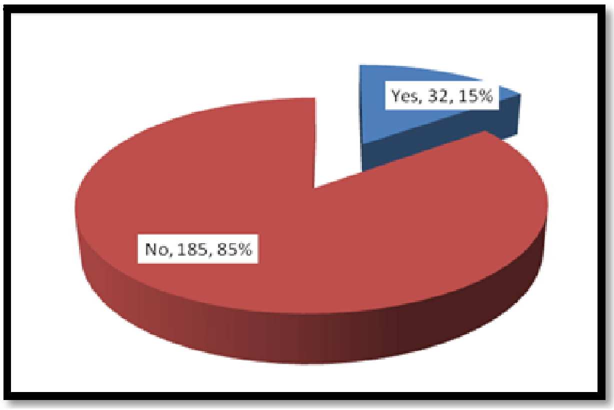

Figure 3: Proportion of Farmers Who Accessed Extension Service on Climate Change

Figure 3 shows that majority (85%) of the respondents did not seek advice on climate change from the extension workers. It is only 15% of the respondents that sought advice on climate change. Majority of farmers who did not seek extension service could be attributed to the adopted mechanism by the Ministry of Agriculture of demand driven approach, where farmers go and visit the Ministry of Agriculture staff in their offices.

However, when asked whether they had received extension from other service providers, 64% of the respondents noted that they had been offered information on climate smart agricultural practices.

2.3.3. Notice of Unpredictable Climate Change

The researcher put into account whether there is climate change. Table 5 highlights the results.

Type of Climate Change Noticed	Mean	Std. Deviation
Human activities in the area are causing the environment to change	1	0
Climate is changing over time	1.09	0.284
Temperature is increasingly rising	1	0
Rainfall amount is decreasing every year	1.36	0.887
Rainfall received is variable	1.09	0.284
The weather is becoming drier every year.	1.09	0.284
The yearly rains are not supporting crop production as before	2.04	0.717
Crop diseases and pest infestation because of Climate change	1.44	0.829
Climate change has affected food production	1	0
Climate change has led to increased cost of food	1	0
Decreased vegetation due climate change.	1	0
Fuel wood scarcity is being experience	1	0
Rural-urban migration because of Climate change	2.17	0.784
Decline of forest cover and resources	1	0
Change of livelihood system because of climate change	1.09	0.284
During the raining season, there have been increased incidences of floods	1	0
During the dry season, there have been increased incidences of droughts	1.46	0.986
There is serious campaigns and awareness on climate Change	4.68	0.466

Table 5: Type of Climate Change Noticed

Eighteen in Table 5 items were measured on a 5-point Likert scale and respondents agreed to the following statements; that human activities in the area are causing the environment to change (mean = 1),the climate is changing over time (mean = 1.09,SD = 0.284), temperature is increasingly rising (mean = 1), rainfall amount is decreasing every year (mean = 1.36, SD = 0.887), rainfall received is variable (mean = 1.09, SD = 0.284),the weather is becoming drier every year (mean = 1.09,SD = 0.284), crop diseases and pest infestation because of Climate change (mean = 1.44, SD = 0.829), climate change has affected food production (mean = 1), climate change has led to increased cost of food (mean = 1), decreased vegetation due climate change. (mean =1),there is now fuel wood scarcity (mean = 1), decline of forest cover and resources (mean = 1), change of livelihood system because of climate change (mean = 1.09, SD = 0.284), during the raining season, there have been increased incidences of floods (mean = 1) and during the dry season, there have been increased incidences of droughts (mean = 1.46,SD = 0.986).Additionally, the respondents somewhat agreed that the yearly rains are not supporting crop production as before (mean = 2.04, SD = 0.717) and climate change has led to rural-urban migration (mean = 2.17, SD= 0.784).However, the respondents agreed that there is serious campaigns and awareness on climate change (mean = 4.68, SD = 0.466).

2.4. Strategies

The researcher deemed it important to establish the strategies employed by the respondents to deal with the challenge of adapting climate smart agricultural practices. Findings are indicated in Table 5.

Strategies	Freq	Percent (%)
Planting drought resistant crops and/or early yielding varieties	83	36.4
Fencing	39	17.1
Use of locally available materials	44	19.3
Knowledge and skills enhancement	228	100
Help farmers financially	22	9.6

Table 6: Strategies of Dealing with Challenges of Adopting CSA Practices

As shown in Table 6, 36.4% (83) of the respondents have planted drought resistant crops and/or early yielding varieties, 17.1% (39) of them have engaged in fencing and 19.3% (44) of them have enhanced the use of locally available materials.

3. Conclusion

From the results, social factors (age and sex) were found to significantly relate to adoption of climate smart agriculture. Specifically, most of the farmers are in the productive age bracket (34 to 41 years) with the minimum required educational level to adopt CSA. Besides, the ratio of male to female farmers is 5:4 meaning that both male and female farmers have decision-making power pertaining the adoption of CSA at the household level. Economic factors are of essence in the adoption of CSA. Farm land size has been found to be significant and affects adoption of CSA. It has been revealed that increase in land size decreases the ability of the farmer to adopt soil fertility management whereas increase in income facilitates the adoption of CSA. Land ownership increases the likelihood that farmers adopt strategies that will capture the returns from their investment in the long run. More so, the small land sizes make the farmers to enhance farm intensification by using improved varieties. For small scale farmers, income is a limiting factor to adopt some of the CSA practices. However, with an increase in income the farmer increases the probability of adopting CSA practice of soil fertility Management. From the foregoing, economic factors play a role in the adoption of CSA.

On institutional factors, both access to extension service and noticing of unpredictable temperature change is significant in influencing adoption of CSA practices. It is evident that majority of the farmers have received and are aware of at least one of the CSA practices. This is through various extension service providers but majorly from NGOs. Most of the training that they have received has been mainly through workshops, field day and group trainings. For sustainability and synergies well-coordinated and collaborative approach is required by extension providers.

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