Full Length Research Paper

Climate change and its influence on adoption of conservation agriculture by female smallholder farmers, Nakuru County, Kenya

Authors

[1]**Dr. Eliud Garry Michura**, *Senior Lecturer, Environmental Science Department, Kabarak University, Nakuru, Kenya. E-mail;* mican1990@yahoo.com*.*

[2]**Mr. Timothy Kamau Njuguna**, *Student, Kabarak University, Department of Environmental Science, Nakuru, Kenya. E-mail:* kamaujj51@gmail.com*.*

This paper examines the climate change and its influence on adoption of conservation by female smallholder farmers, Nakuru County, Kenya. A bout 30% of environmental problems in the world and particularly the study area is contributed by agriculture. CA is being promoted as a better practice than conventional one because it has been found to result in maximum agricultural production and protection of environment. The level of environmental degradation in the study area is high, resulting in food insecurity and biodiversity loss. Women small scale farmers' participation in agriculture is 70% of all the farmers and therefore, women are most affected by climate change, which has occurred as a result of destruction of Mau forest adjacent to the study site. The farmers have claimed that, CA adoption is low and difficult to assess which factors contribute to this. No research documentation available regarding the problems faced by women smallholder farmers in adoption of CA. The research study sampled 360 female farmers out of a target population of 120, 000 women farmers. Descriptive survey design using structured questionnaires; interview schedules and focus group discussion were used to collect data. Statistical package for social sciences (SPSS version 20) was used in the data processing and analysis. Descriptive analysis; frequency distributions, means, proportions, percentages and inferential analysis; Chi-square, ANOVA, at p < 0.05 level were employed to test the hypothesis. The findings; climate change significantly influenced women farmers' adoption of CA, adoption of CA by women farmers was very low. The following are recommendations; weather stations be established in schools, use new emerging technologies to provide information on climate variability in schools, Use of ICTs and internet services, Government lower cost of ICT services.

Key words: Conservation agriculture, adoption, climate change, women small-scale farmers.

INTRODUCTION

Climate change is the product of bad technological overtones and probably the most complex and challenging environmental problem facing the world today. The elements of climate change include weather uncertainties, persistent climatic abnormalities, rampant environmental degradation, diseases and eminent food insecurity. Increased human population and demand for more agricultural land for food production accelerate some of these complexities, which have resulted in destruction of the vegetation cover and subsequently rampant environmental degradation (Katelyn, 2016). Studies of how climate change might affect agriculture generally look only at crop yields and the amount of product harvested from a given unit of land. But climate change may also influence how much land people choose to farm and the number of crops they plant each growing season. A new study takes all of these variables into account and observes that, researchers may be underestimating the total effect of climate change on the world's food supply (Kassam et al., 2015). A new study conducted predicts that climate change will have a far-reaching effect on agricultural communities in Africa South of Sahara (SSA) that may not be redeemed in crop yields or farm income (Brown University, 2016). Immediate secondary consequences of climate change include increased vulnerability to diseases, susceptibility to nutritional disorders, deprivation of educational opportunities and ultimately, a reduction in human and

---

*Corresponding author. E-mail: mican1990@yahoo.com.

societal development potential in developing countries. Climate change therefore remains a serious challenge to all biodiversity (Katelyn, 2016). Agriculture's contribution to global greenhouse gas (GHG) emissions at 14% of total emissions (and up to 25% including related land-use changes) as well as its potential to be heavily affected by changing temperatures, water availability and extreme events make it an important focus for climate change action. Climate change attitudes and belief is only associated with intended not actual adoption (Meredith et al., 2016). Conservation agriculture (CA), causing little soil disturbance, keeping the soil covered, mixed cropping and rotating crops, has been discussed to be a potential remedy to land degradation which is very common in soil erosion prone areas. CA is recommended for climate variability adaptation in both high and low rainfall areas (Kabirigi et al., 2015). CA refers to "an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security, while preserving and enhancing the resource base and the environment (Pandey, 2016)

Many of existing studies examining farmer's perspectives and responses to climate change by a measure of likelihood to adopt a practice, support mitigation and adaptation initiatives in the future or examine the actual adoption of a practice. Very few studies have aimed to determine how intention to adopt a behavior differs from actual adoption, and whether different factors drive intended and actual behavior (Meredith et al., 2016).

It has been reported that, climate change is expected to negatively affect agricultural production in Africa (Bryan et al., 2013). Major concerns of climate variability and its adverse effect on the livelihoods of the rural poor in developing countries have been raised (Below et al., 2010). Due to heavy dependence on rain fed agriculture, the effects of climate variability are expected to be particularly prominent (Lybbert and Sumner, 2012)

In SSA small-holder farmers are the primary producers of agricultural outputs and account for 80% of all the farms. In small-scale farming, about 175 million people and about 70% of all the holders are women. The small-holder farmers in SSA cultivate small parcels of land which are often degraded and have no access to irrigation. They do not have sufficient labour, little access to financial credits and do not practice commercial market. The effect of climate change added to the challenges facing SSA small holder farmers in producing enough food for the region growing population is real (AGRA, 2014).

Climate change is actually increasing worse situation already existing with tight resources constraints facing small holders. More erratic weather patterns and extreme weather events are decreasing average yields. SSA is confronted with a range of climate risks that could have far reaching consequences for its agricultural systems in the future uncertain changes in rainfall and temperature patterns markedly threatening food production (AGRA, 2014).

Adoption of conservation agriculture

Conservation Agriculture (CA), which is sustainable, is being promoted to overcome many of the problems associated with conventional agriculture and degrading land conditions (Ngwira et al., 2014). In Africa South of Sahara, only mostly smallholder farmers are practicing a mere 0.3% of no-tillage. In addition, smallholder farmers lack agricultural assets, they continue using hand tools; have limited access to new information, and lack institutions supporting smallholder agriculture (Ngwira et al., 2014). Adoption of CA has the potential to increase smallholder farms' resilience to rainfall variability, address soil degradation, and increase food production in an efficient, productive, and profitable manner (Seline et al., 2014).

Despite the wide spread extension and investment conservation agriculture technologies, it has been less widely adopted by farmers in Swaziland. Low adoption and lack of continued use of adapted and improved agricultural production technologies amongst farmers has been identified as one of the main reasons for the low agricultural productivity in the country (Mlengo and Maseko, 2015).

In Swaziland, it was found that climate change and variability is evident as it manifests itself in many forms, including hydrological disasters, change in rainfall regime as well as extreme weather conditions. The study noted that, climate change and its anticipated large negative effects on many agricultural systems urgently calls for need for adaptation (Mlengo and Maseko, 2015). Mlengo and Maseko (2015) noted that, agriculture is the main source of Swaziland economy and is accounting as much as 17% of Gross Domestic Product, 27% of employment and 33% of foreign exchange earnings. The population of Swaziland is expanding and there is a great demand for food which is putting pressure on agricultural production. The sustainability of agricultural production in the face of increased food demand and climate change and variability, comes with many challenges that necessitates technological innovation and farmer adaptation (Mlengo and Maseko, 2015).

Women and knowledge on climate change

Studies conducted in several parts of East Africa indicate that women have the lowest access to climate information in general and yet they are the main players in agricultural production (AGRA, 2014). It is not clear to what extent the women are knowledgeable of the climate change. Farmers in other parts of the worlds in developing countries employ coping strategies to overcome effect of climate change. Climate change as a factor may not necessarily influence adoption of CA but it

may affect adoption in combination with other factors a study, which is lacking in Nakuru County (Etwire et al., 2013). Farmers' knowledge on climate change is very important and can lead to finding ways of arresting any negative condition that may work against their food production. Women in most countries are aware of such climatic variations but their deep knowledge of climate change and actions to solve food problems remain elusive (Saya, 2011). Most women small-scale farmers are knowledgeable about temperature and rainfall variability that affect their agricultural production and a study conducted in Kinangop Kenya confirms these findings. Other studies found that, climate change, results in drought, phenomena that threatens farmers farming activities (Muna et al., 2013).

Role of women in agricultural production

Kenya's economic growth and its sustainability depend heavily on agricultural production which provides employment for 80% of the population and 70% of materials for agro-based industrial production and also being the main source of livelihood (Yatich et al, 2009). 80% of farmers practice small-scale production and out of this, over 70% of small scale farmers are women (Kassam et al., 2012) holds similar views that, women play very important role in conservation agriculture although majority of women do not directly own land but at household levels, they are the producers, managers, farmers and to some extent own farmlands. Food security and environmental conservation heavily depend on women (Kassam et al., 2012). It was noted that in Kenya, women are important producers of food but their efforts are frustrated by harsh climatic conditions that affect them such as climate variability a study which needed research to establish the facts.

Rain water harvesting

80% of Kenya's population is rural and dependent on agriculture for basic livelihoods. This makes the country highly vulnerable to rainfall variability since 98% of the country's agriculture is rain-fed, hence sensitive to rainfall scarcity. Therefore adoption of agricultural water technologies and innovations may be one approach of mitigating climate change adverse effects on agriculture (Boithi et al., 2014). A report showed that, Kenya with a population of over 40 million is capable of meeting the water needs about six to seven times of its current population. Rainwater harvesting can yield numerous social and economic benefits, and therefore, contribute to poverty alleviation and sustainable development (Boithi et al., 2014).

Women farmers and conservation agriculture in Nakuru County

In Nakuru County, poverty has increased by 15% and the number of women working in the agricultural farms is reducing. The reason for this is that, many women are now working in other sectors such as flower farms, timber industries and engaged in other economic activities in order to cope with the ever changing environment, which adversely affects their lifestyles (NCR, 2016). The climate change, rapid land use changes and inaccessibility of extension services, are some of the factors affecting farming activities and biodiversity loss in the area. Conservation agriculture provides alternative ways of sustainable food production and better management of environment therefore, women farmers are now finding conservation agriculture a sure and promising method of increasing food production (NCR, 2016)

There is no in-depth analysis of the determinants of conservation agriculture adoption. It has been noted that, due to the benefits of CA which include sustainable land use, increased yields, increased incomes, timeliness of cropping practices, ease of farming and ecosystem services, the global area under CA systems is increasing (Kimani, 2015).

In Ngata division in Nakuru County, conservation agriculture was introduced to solve the problem of soil degradation caused by poor ploughing methods and too much use of industrial fertilizers. Despite its introduction in the area, adoption of these practices by smallholder farmers remains below expectations (Kimani et al., 2015). Studies conducted in Lare division and Elementaita in Nakuru County indicate that water for agricultural use has been adversary affected by climate change. Water inadequacy and un-reliability can be addressed by farmers' adoption of agricultural water technologies and innovations of water harvesting, storage and application. Adoption of these technologies is low in Lare and Elementaita (Boithi et al, 2014).

Adoption theories

Adoption of innovations has been defined as the decision to apply an innovation and to continue to use it (Rogers and Shoemaker, 1971). Different factors determine the adoption of different agricultural innovations and technologies (Akudugu et al., 2012). Agriculture extension agents and economists have long been interested in understanding the importance of the adoption of new agricultural technologies by rural smallholder farmers and several factors have been identified as influencing the adoption behaviour of farmers from qualitative and quantitative models (Oladele, 2006). Economic, social, physical and technical factors and dynamics influence the adoption of various agricultural technologies. Rao and Rao (1996) found a positive and significant association between technology adoption, age, farming experience, training received, socio economic status, cropping intensity, aspiration, economic motivation, innovativeness, source of information and agent credibility.

Table 1. Shows the sampling of respondents at the three study sites.

Njoro study site				
Churches		Self- help Groups		Total
AICNjoro	30	Kamungei	12	
SDANjoro	27	Setkobor	18	
ACK Egerton	25	Ogilgei	18	
				130
Rongai study site				
Catholic	24	Suumak	15	
AGC Ngata	31	Baraka	16	
AIC Morop	27	Kiptinend	17	
				130
Naivasha study site				
Catholic Aberdare	30	Karagita	14	
Full Gospel Gilgil	28	Gilgilia	17	
Deliverance Naivasha	26	Malewa	17	
				130

Some further findings from literature review and gaps

Comparison was made between Nyando in Nyanza region and Wote in Eastern region regarding women farmers' response to climate change and conservation agriculture. The study conducted in Nyando and Wote revealed that, there was lower awareness of CA practices in Nyando than in Wote by female farmers. Women were adapting more in Wote than in Nyando. Women were constraints in adopting CA in Nyando and Wote. In the absence of men, women were acting as decision makers. Crop failures and risks are due to increased temperature (heat) & dry spells; decreased rainfall and change in rain onset and/or cessation; Adaptation options are changes in crop and livestock-related management and collective action (group formation); Barriers to adaptation include lack of access to resources and knowledge needed for adaptation. Crop specific strategies: Maize, Sorghum, Cassava, Sweet potato, and Groundnut, cowpea, P. Pea, Sugar snaps, Baby Corn; Avocado, Irish potato. Strategies not specific to any particular crop: Crop diversification: Adoption of Drought tolerance, early maturing crops & varieties. Conservation agriculture; Agroforestry farming systems, Tied ridges Integrated pest management (Pest & disease resistance). Good agricultural/agronomic practices: Integrated Nutrient management (FAO, 2014).

Objective of the research study

The research study assessed the climate change influence on adoption of conservation agriculture by female smallholder farmers in Nakuru County Kenya.

Methodology

The population at the time of this research was approximately 1.7 million people according to estimated statistics. The population of each sub-county selected was; Njoro 195,253, Rongai 155,745 and Naivasha 269,632. The target population, women small scale farmers was estimated at 120,000. Out of the target population, a sample size of 390 women farmers was selected for interviews. To arrive at the sample size, the researcher used a modified table of population sampling (Appendix3) (Kreijecy and Morgan, 1970). The confidence level was set at 95% (alpha = 0.05). The study used purposive sampling to pick on the 3 sub counties out of 11 namely; Naivasha, Rongai and Njoro. The sub counties exhibit different ecological characteristics and highly vulnerable to land degradation particularly, soil erosion, climate change, human settlements, industrial pollution, deforestation and land use changes. Of the 390 women farmers, 130 came from each sub county by simple random selection. The 390 sample from the target farmers population of 120,000 was proportionate and would take care of the sampling errors and provide level of accuracy and confidence level of 95%. Table 1 shows the distribution of respondents in each sampling unit selected through purposive sampling. The respondents were picked from both churches and self-help groups present in the sub counties. Lists from nine churches and nine self -help groups were used to pick the small scale women farmers using simple random selection. From this a certain number of respondents from each study station were determined, forming 130 respondents from each sub county.

The Focus group discussions and interview schedule comprises of 5 agricultural extension agents, 3 Women

Table 2. Ten indicators tested and women small scale farmers' responses.

	Indicators	Non adopters	Adopters	Adopters + non adopters	Significance level
		%	%	%	
1	Temperature changes	25.5	96.3	54	.021
2	Rainfall patterns	37.7	77.8	20.9	.021
3	Frequency of droughts	35.3	77.	58.9	-.049
4	Varying planting dates	25	90.7	38	-0.061
5	Planting different crops	24	81.5	56	0.000
6	Switching from crop to livestock	37.7	66.7	20	0.021
7	Increase tree shed	30	77.8	55	-0.049
8	Intensify use of irrigation	36	87	40.3	0.000
9	Migration to different sites	48	74	55	0.000
10	Increase water conservation	75	96	20.2	0.000

self-help groups(Ogilgei in Njoro, Karagita Naivasha and , 3 NGOs (Seeds of Gold, PATFID, and Farming System of Kenya) and 3 officers from the Ministry of Agriculture at three sub counties; Njoro, Naivasha, and Rongai selected from the three Sub-counties. The self -help groups in this study consisted of only women who were small scale farmers. The questionnaire was administered by the researcher with the assistance of three trained enumerators from each sub county drawn from agricultural field officers.

Data was analyzed using SPSS version 20. In answering the questions, the respondents were rated using Likert scale from undecided, to some extent and to a great extent on their knowledge or understanding of the climate change and effects. The quantitative data collected was tabulated and analyzed according to their frequency and percentages. The data was analyzed according to the hypotheses stated in the research study. Qualitative analysis involved measure of central tendency (Cross tabulations, proportions, means and percentages). Chi- Square, ANOVA models and Bonferroni tests were used as statistical to test level of significance at alpha level $p < 0.05$. Qualitative data was analyzed by determination of patterns and trends from the open ended test items and interviews from respondents. The analyzed data were then presented in tables, graphs and charts.

Results and Discussions

The findings are presented in the Tables 1, 2 and 3 and Figure 1.

Figure 1 shows items of climate change tested and rated from the highest to the least according to the awareness of women farmers' adoption of CA. The response to women farmers of ten indicators of climate change shows that temperature variability (96.3%) and water conservation (96%) gave the highest score and were most influential on CA adoption by women. Women farmers who practiced conservation agriculture in the study area to a great extent were more aware of climate change than those who either practiced traditional conventional practice (non-adopters) and those who blended the two practices (incomplete adopters).

From personal interviews, over 90% of CA adopters acknowledged that climate change affects their farm yields greatly. When rainfall reduces, there is crop failure and too much rain also cause soil erosion and burn the crops. Table 2 shows analysis of Women Farmers Response to ten Indicators of climate change and their influence on CA adoption in Nakuru County. The results indicate percentage response of adopters, incomplete adopters and non-adopters. The adopters of CA percentage response was highest and non-adopters lowest. The level of significance shows that, climate change influence women small scale farmers' adoption of CA.

Njoro, Rongai and Naivasha study sites

Table 3 shows the results of the focus group discussions from three study sites Njoro, Rongai and Naivasha in Nakuru County.

Focus group discussions were organized into groups in each sub county. The number of farmers in each self-help groups in each site was 13 in Njoro, 11 in Rongai and 12 in Naivasha. Responses from the three groups interviewed were recorded. The responses were voted and the mean responses were determined and presented in Table 2. The mean 'Yes' response for Rongai (8.66) was higher than the other two for Njoro (8.34) and Naivasha (8.45). Women farmers in Rongai were aware
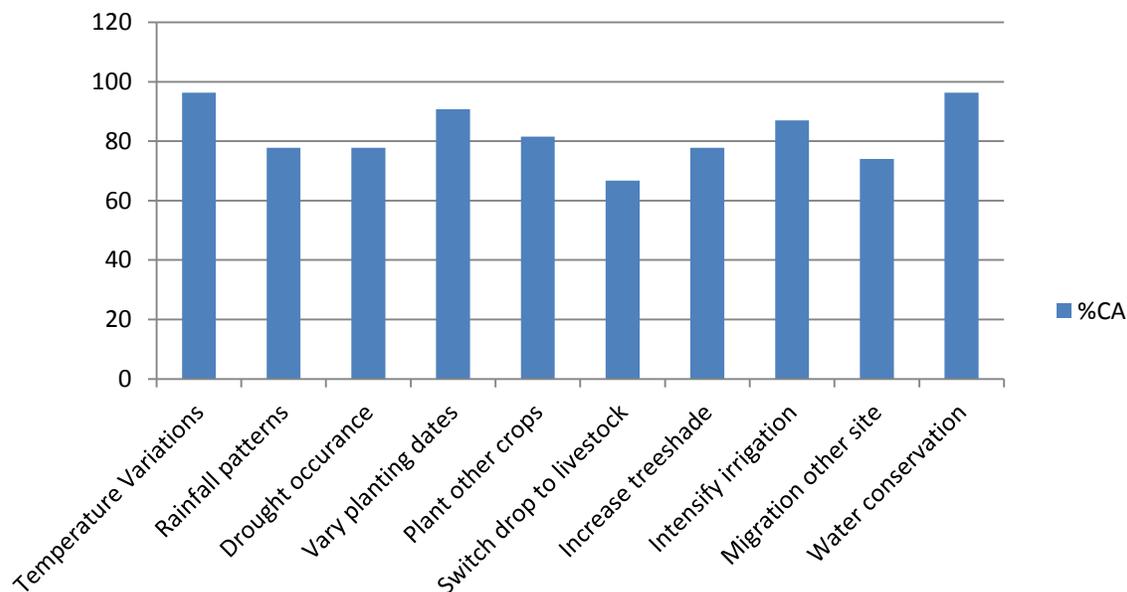
Figure 1. Showing respondents mean awareness of the indicators of climate change.

Table 3. Responses from the focus group discussions in three different study sites.

Variables	Responses	Frequency of Responses Yes and No					
		Njoro (13)		Rongai (12)		Naivasha(11)	
		Y	N	Y	N	Y	N
Climate change	Climate has changed significantly since 1970s	12	1	11	1	9	2
	Temperatures now are hotter than ever before- global warming	10	3	8	4	7	4
	Temperature variations are common (high, low at times) in this place	9	4	9	3	8	3
	Rainfall patterns have changed considerably – rainfall no longer predictable.	10	3	9	3	7	4
	Our seasons of planting have changed due to weather changes a greatly	11	2	12	0	10	1
	Droughts are too common and unpredictable unlike before	12	1	11	1	9	2
	We plant drought resistant crops due to rainfall variations	9	4	7	5	6	5
	New diseases due to changes in weather patterns warmer To	8	5	6	6	7	4
	Climate the same ever since. No change.	5	8	4	8	6	5
	Many rivers here have dried up others have reduced in volume flow	12	1	9	3	7	4
	Some animal species that used to be here in large numbers reduced or disappeared – No longer seen.	7	6	8	4	8	3
	We don't rely on weatherman because the information not accurate or we are not aware.	11	2	10	2	9	2
	Mean response of Climate change	8.34	1.64	8.66	1. 3	8.45	1.55

of climate change and were able to adopt more CA in order to cope with changes in climate and daily weather. In general, women farmers in the three different study sites were aware of climate change. Further discussions with members of the focus groups and stakeholders, also confirmed these results. The results of the discussions

are presented under each study site.

Njoro study site

In Njoro study area, there were 35, 012 households with 28,791 farm families. Female farmers are approximately 16,590 and male farmers are 12,201. The number of extension agricultural officers (Field staff) in the whole sub county was 27 from which only 4 were more of CA experts and the rest were general agriculture experts. Donors who directly deal with field staff mainly manage CA in this area. The donors do not operate through the county offices, therefore, the agricultural officers at the sub county headquarters have no direct control, although, field officers are employees of the ministry of Agriculture.

The CA uptake in Njoro is very low and it was noted that, there are reasons for its slow uptake; CA takes time to realize its benefits because the natural processes taking place that can be realized over time. CA involves decomposition of plants and animal remains to form manure. Soil fertility restoration takes time.

Farmers need to be patient and wait for over 3 years to realize the benefits. Farmers are not patient and expect quick returns. The donor funding lasts for a short duration of time and when the time is over they leave and stop the funding. When the farmers realize this, they are stuck and revert to the old practice (conventional). The farmers, who remain as adopters, are patient and benefit from yield increase. One farmer adopter had her yield increased from 10 bags to 16 bags per acre for only 3 years practice. The study found that, the other reason is that, the donors hold information and are not willing to share with the ministry or any other stakeholders. This makes CA secretive and one of the barriers affecting CA adoption.

It was found that, conservation agriculture common in the study area are; Farmers use of soil manure (animal and plant) compost, application of controlled herbicides to kill weeds reducing soil disturbances, agro forestry promotion, crop rotation and growing of cover crops such as legumes to conserve moisture.

The results also indicate that, the farmers here have to a great extent had the knowledge of climate change. It was noted that farmers' knowledge of the climate change was rated as 60%. The researcher asked if they knew the evidence of climate change and their responses noted were; changes in cropping time, variations in the amount of rainfall, temperature variations, frequent droughts, sometimes, too much rainfall as in 2010, farmers are no longer predicting weather, strange incidences of pests such as army worms, white flies, and aphids, reduced flow in streams and drying. Out of the 60% farmers having knowledge of climate change, only less than 20% acted, others were waiting for nature to take its own course and others did not have funds to act. It was observed that farmers no longer believe in weather

reports because, they don't work as accurate as is reported. A good example is the recent announcement that Elnino will come with lots of rain as from last October. So far, nothing happened. The farmers were asked how they cope with climate change. The responses were; diversification of crops moving from single cropping like conventional to mixed cropping (grains planted with legumes), growing of short season crops, water harvesting measures such as dams and water pans constructions. Dams in large scale farming and water pans in small scale, growing of drought resistant crops as practiced in Lari and Naishi areas of Njoro to cope with weather changes, increase tree cover to moderate micro climate, green house farming to increase yields.

Rongai study site

The interview results indicate that, there were 33,434 women farmers in Rongai and 50% of them practice conventional farming, 15% CA and 35% practice both CA and Conventional. Most farmers have heard about CA as one of the promising practices to overcome climate change hazards but are reluctant to embrace it fully therefore, this explains why CA uptake in Rongai is low. The reasons could be several; attitude to change to a new technology. Farmers are used to their traditional methods and are not convinced if CA works and it is beneficial; two, lack of specialized equipment. CA requires special equipment, which they do not have; three, conflicts between livestock rearing and growing of crops. Farmers would like to practice livestock and crop farming, four, decision making in the family. Most women farmers would want CA adoption but they are discouraged by their husbands who believe in conventional practice as a way of getting income. The fifth one is ownership. Most women do not own land which prevents them from practicing CA. For CA practice, land tenure is important.

It was also observed that, farmers are aware of climate change and for them to cope with it, they are now venturing into drought resistant crops such as sweet potatoes, cassava, Dolichos (black beans introduced by Seeds of Gold, Egerton University and KALRO Njoro), millet, sorghum, finger millet amongst others. It was noted that of all the farmers in Rongai, very few have adopted CA, the rest of the farmers have not fully adopted CA. In 2009 census, the total population of farmers was 142, 127 out of which 71,914 were male and 70,213 were female. The farming family was 33,707 and women farmers 18,700. Out of the women farmers, about 5% fully adopted CA, 50% partially adopted and 45% used conventional method. The farmers to some extent were aware of indicators of climate change such as Necrotic lethal virus which attacks maize and Tuta, and obsoluta which attacks tomatoes (NRC, 2015).

The farmers here have to a great extent had the

knowledge of climate change. It was noted that farmers' knowledge of the climate change was rated as 60%. The researcher asked if they know evidence of climate change and the following were the responses; changes in cropping time, variations in the amount of rainfall, temperature variations, frequent droughts, sometimes too much rainfall as in 2010, farmers no longer predict the weather, strange incidences of pests such as army worms, white flies, and aphids, reduced flow in streams and drying. Out of the 60% farmers having knowledge of climate change, only less than 20% acted, others were waiting for nature to take its own course; while others do not have funds to act.

Climate change affects women farmers and CA adopters have increased their food production and increasing biodiversity as the findings revealed. There is need to find out why some female farmers never adopted CA yet, they were to some extent aware of the climate change.

Naivasha study site

From the research study, it was found that, 65% of small-scale farmers are women, out of which 16% practice conservation agriculture. It was reported that, to a great extent, women were aware of climate change and the effects of reduction in land size and the conversion of land into other uses. The farmers experience the harsh ecological environment, which affects them greatly, and therefore, many of the farmers adopt a mixture of CA and conventional methods. The adverse climatic variations, reduced water in the area affect farming and in order to cope with dryness of the area, most farmers harvest and store water in water pans. Climate variations have caused the diversification of economic activities and abandonment of farming by other female farmers.

In promoting CA, one farmer said: "Naivasha is dry and farmers here have adopted new farming techniques that will not only guarantee them improved harvest but also transform the environment in a good way". He continued to say that in Gilgil, a group of 32 farmers are being trained on sustainable eco-agriculture practices on a 10-acre model farm established for that purpose with the support of Imarisha Naivasha and the Gilgil Environmental Protection and Advocacy Project (GEPA). The Mbegi Weru farmers group was noted as having a vision for their landscape. Their vision is to turn the dry semi-arid land into a lush verdant land with enough food for humans and animals. They mentioned that the word 'Weru' is Kikuyu for a desert, and the dry, dusty plains that the farmers inhabit have traditionally been unsuitable for any meaningful form of agriculture apart from nomadic pastoralism. It was found out that, group farming is very strong in this area in order to cope with environmental changes such as climate change and land use changes. Farmers in farming groups practice forestation to solve climate change. The forestation project has been extended to the surrounding community and each individual farmer is being encouraged to plant some trees on their farms.

The study found that, Gilgil and Ndabibi are very dry, hot and dusty. The Ndabibi Environmental Conservation Centre is a farm that trains other farmers on smart eco-friendly farming practices (CA). The farmers explained that, the area is more of a semi-desert, with scanty vegetation and is often very windy, and they therefore, intercrop horticultural crops with maize because their stalks act as wind-breakers. The farmers plant vegetables such as watermelon. Water pans are constructed to store water for use in irrigation. The farmers also keep livestock herds such as Sahiwal and Boran cattle. Within some of the farms visited, zero-grazing unit which has both Ayrshire and Friesian cows are kept by some farmers. Farmers practice Intercropping maize with crops such as cabbages and melons which would be ideal, especially in open and windy areas. Farmers who intercrop watermelons with maize, however, need to add nitrogen fertilizer to their crops as the both crops would compete for this particular nutrient thus causing a deficiency. Farmers are trained to be careful in the excessive use of pesticides and fertilizers that affect the soil and pollute water. In summary, Naivasha has been affected by harsh climate, experience climate change and land use changes that have influenced farming and especially adoption of CA. Majority of farmers are women with small and medium size farms.

Discussions

Out of 54 adopters, 52 were practicing CA and only 2 did not. This means that knowledge of climate change is important in influencing female farmers to adopt CA practices. Other factors such as culture may act negatively against women success in food production and poverty eradication as they are hit by climate change (United Nations Women Watch, 2009). Several factors such as age, level of education, ownership of farmland, extension methods could also play role in influencing farmers' adoption of CA. Many farmers employ coping strategies under climatic challenges for survival.

Climate change is a motivator and induces innovation. It was also observed by Netra et al. (2004) that climate change has a lot of challenges, which can only be mitigated by small-scale smart agriculture (Ndambiri et al., 2011). Women often have a strong body of knowledge and expertise that can be used in climate change mitigation, disaster reduction and adaptation strategies. Furthermore, women's responsibilities in households and communities, as stewards of natural and household resources, positions them well to contribute to livelihood strategies adapted to changing environmental realities. On the other hand, women are more vulnerable to the effects of climate change primarily as they

constitute the majority of the world's poor and are more dependent for their livelihood on natural resources that are threatened by climate change (Kimani, 2015).

Climate change is a motivator and induces innovation. It was also observed by (Mlengo and Maseko, 2015) that climate change has a lot of challenges, which can only be mitigated by small-scale smart agriculture (Ndambiri et al., 2011). Furthermore, they face social, economic and political barriers that limit their coping capacity. The land tenure, small farm size, agricultural policies, political influence and cultural factors may act negatively against women success in food production and poverty eradication as they are hit by climate change (United Nations Women Watch, 2009). Climate change affects women farmers and CA adopters have increased their food production and increasing biodiversity as the findings revealed (Seline et al., 2014). There is need to find out why some women farmers never adopted CA yet, they were to some extent aware of the climate change. Climate change is a motivator and induces innovation. It was also observed by Netra et al. (2004) that climate change has a lot of challenges, which can only be mitigated by small-scale smart agriculture (Ndambiri et al., 2011). Women often have a strong will of knowledge and expertise that can be used in CA adoption.

Conclusion

The research study established that, there is low uptake of adoption of CA in Nakuru County by small scale women farmers. Out of the 360 women farmers interviewed, only 54 (15%) fully adopted CA at least practicing more than three methods of CA, 204 (556.5%) did not adopt CA and the rest 28.5%) partially adopted CA. The majority of the women farmers were to some extent aware of the climate change. For non -adopters, there could be other factors that affect women farmers from adopting CA.

It was also established that there is a shift from farming to other occupation by female farmers. Due to environmental and socio economic factors facing the women farmers in the county, more women are being employed in large flower farms and other economic activities. The reason for this is that, climate change and land use changes are frustrating women efforts in food production and also to care for their families. It was noted that families with large households have further subdivided their farms into smaller units for their children and hence, farms are no longer productive in food production.

Food production in the study area has diminished as a result of climate change, land use changes and poor structuring and support of extension methods and government policy on agricultural production in the county. Conservation agriculture practices are essential to facilitate adaptation to climate change in the short and long term.

Recommendations

CA practices are not enough by themselves: They need to be delivered in association with climate-related information targeting farmers (that provides advice on when to plant, crops choice, varieties to plant; management; etc.) and Apply Gender-sensitive strategies (especially where men migrate leaving women as decision-makers). Integrate research to back-up development work.

Provide weather information to farmers that is accessible and useful to make timely farm level decisions "Bottom Up Approach".

The ministry of agriculture should develop relevant and practical policies to encourage women farmers adopt conservation agriculture, which is proving to provide higher benefits and conserving the environment for sustainable farming production.

Acknowledgements

REFERENCES

AGRA (2014). Climate Change and Smallholder Agriculture in Sub-Saharan Africa.Africa Agriculture Status Report. Issue No. 2. ISSN 2313- 5387

Akudugu MA, Guo E, Dadzie SK (2012). Adoption of Modern Agricultural Production Technologies by Farm Households in Ghana: What Factors Influence their Decisions? J. of Biol., Agric. and Healthcare, 2(3): 1-13.

Below T, Artner A, Siebert R, Sieber S (2010). Micro-level practices to adapt to climate change for African small-scale farmers. A review of Selected Literature. Environ. Prod. Technol. Division 953.

Boithi FN, Muchiri E, Birech R, Mutuku MM (2014). Factors Influencing Smallholder Farmers'Adoption of Agricultural Water Technologies and Innovations in Lare and Elementaita Divisions of Nakuru County, Kenya. No. 4 Aug. 2014, pp. 1338-1343. © 2014 Innovative Space of Scientific Research Journals.http://www.ijias.issr-journals.org/

Brown University (2016). Impact of Climate Change on Agriculture May be Underestimated. Brown University. "Science Daily.7 March 2016. www.sciencedaily.com/releases/2016/03/160307112943.htm.

Bryan EC, Okoba B, Roncoli C, Silvestri S, Herrero M (2013). Adapting agriculture to climate change in Kenya: Household strategies and determinants. J. Environ. Manag., 114: 26 - 35.

Etweri PM, Al-Hassan MR, Kuwornu KMJ, Owusu OY (2013). Smallholder farmers' adoption of technologies for adaptation to climate change in Northern Ghana. J. of Agric. Extension and Rural Dev., 5(6): 121-129, July 2013. DOI: 10.5897/JAERD13.0481. ISSN 2141-2170 ©2013.

Academic Journals. http://www.academicjournals.org/JAERD.

Kabirigi M, Musana B, Ngetich F, Mugwe J, Mukuralinda A, Nabahungu NL, (2015). Applicability of conservation agriculture for climate change adaptation in

Rwanda's situation.Journal of Soil Science and Environmental Management.Vol. 6(9): 241-248, September, 2015 DOI10.5897/JSSEM15.0508 Articles Number: 0E26F4154882 ISSN 2141-2391.

Kassam A, Fredrich T, Derpsch R, Kienzle J (2015). Overview of the Worldwide Spread of Conservation Agric. J. of Field Actions Science Reports. Volume 8: 2015.

Kassam A, Friedrich T, Shaxson F, Pretty J (2009). The spread of Conservation Agriculture: justification, sustainability and uptake. International Journal of Agric. Sustain., 7(4), 292-320. http://dx.doi.org/10.3763/ijas.2009.0477.

Kassam AH, Friedrich T, Derpsch R (2012). Reconciling Poverty Eradication and Protection of the Environment. Overview of the Global Spread of ConservationAgriculture.The Journal of Field Action.Special Issue 6/ 2012.

Katelyn R (2016). Climate change impact on agriculture expected to have multi sector effect. 50 CMMYT 1966 to 2016.

Kimani   D   (2015).   Ministry   of   Agriculture. http://www.nakuru.go.ke/2015/07/03/ministry-

of-agriculture-to-work-closely-with-Nakuru-county-cs-Adan/

Lybbert TJ, Sumner DA (2012). Agricultural technologies for climate change in developing countries: Policy options for innovation and technology diffusion.

Food Policy 37 (1): 114-123.Meredith TN, Margaret B, Robyn D (2016). Farmer's   intended   and   actual adoption of climate change mitigation and adaptation strategies. March 2016, 135(2): 277–295.

http://link.springer.com/article/10.1007/s10584-015-1558-0

Mlengo DH, Maseko S (2015). Factors Influencing Adoption of Conservation. Agriculture: A Case for Increasing Resilience to Climate Change and Variability in Swaziland. Journal of Environment and Earth Science www.iiste.org ISSN: 2224-3216 (Paper) ISSN 2225-0948 (Online) Vol.5, No.22, 2015

Mugo BJ (2012). Factors affecting adoption of conservation Agriculture among small holder farmers in Ngata Division, Nakuru County.M.A,Thesis. University of Nairobi Jomo Kenyatta Memorial Library.

Muna MW, Njenga WN, Muriuki JN (2013). Perceived Impacts of Climate Invariability and Change on Small Scale Farmers in North Kinangop. Location.

The International Journal of Climate Change: Impact and Responses. Volume 5, 2013, on-climate.com, ISSN: 1835- 7156.

NCR (2014). Nakuru County Integrated Development Plan 2013-2017.

NCR (2015).Nakuru County Development Plan 2013- 2017.

Ndambiri HK, Ritho HK, Mbogoh SG (2011). An Evaluation of Farmers perceptions of and Adaptation to the Effects of Climate change in Kenya.

International Journal of Food and Agricultural Economics. ISSN 2147-8988. 1(1): 75-96.

Netra BC, Shrestha S (2004). The Prospects of Agricultural Adaptation to Climate Change: Climate-Technology Interaction in Rice-Wheat Cropping System in Nepal. Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Denver, Colorado.

Ngwira A, Johnsen FH, Aune B, Mekuria M, Thierfelder C (2014). Adoption and Extent of conservation agriculture practices among smallholder farmers in Malawi.Soil and Water Conservation Society. J. of Soil and Water conservation.www.swcs.org 69(2):107-119.

Oladele OI (2006). A Tobit Analysis of Propensity to Discontinue adoption of Agricultural Technology among Farmers in South Western Nigeria. J. of Central European Agric., 6(3): 249-254.

Pandey D (2016). Conservation Agriculture: Why is Adoption not increasing as Expected? AGRILINK.https// www.agrilink.org. FAO, (2014). Sharing Evidence and Experience on Climate-Smart Agriculture in Smallholder Integrated Farming Systems. Kenya CSA Workshop 8-9 Oct 2014.

Rao PP, Rao VGK (1996). Adoption of rice production technology by the tribal farmers. Journal of research and ANGRAU 24 (1-2): 21 – 25.

Rogers EM, Shoemaker (1971). Communication of innovations: A cross culture approach. The Free Press, Collier Macmillan publishing Inc. NY.pp 11-28.

Saya S (2011). Climate change and Women Farmers in Burkina Faso. Impact and Adaptation Policies and Practices. Oxfam Research report July 2011.

Yatich W, Shah P, Joseph M, Joseph T, David K, Mwangi G, Wanja K, John W, Ikonye N (2009). Challenging conventional mind sets and disconnects in conservation: The emerging role of Eco agriculture in Kenya's Landscape Mosaics.

Brown University (2016). Impact of Climate Change on Agriculture May be Underestimated. Brown University. "Science Daily.7 March 2016.

www.sciencedaily.com/releases/2016/03/160307112943.htm.