FACTORS INFLUENCING ADOPTION OF CLIMATE-SMART AGRICULTURE AS A CLIMATE CHANGE ADAPTATION IN TIGANIA WEST, MERU COUNTY, KENYA

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ABSTRACT

The purpose of this study is to investigate factors influencing adoption of climate-smart agriculture as a climate change adaptation in Tigania West-Meru County Kenya. The study was guided by four specific objectives, which were: To assess how land ownership system influences adoption of Climate-Smart Agriculture in Tigania west Sub County; To determine how information access influences adoption of Climate-Smart Agriculture in Tigania west Sub County; To determine how agricultural financial services access influences adoption of Climate-Smart Agriculture in Tigania west Sub County and lastly, to determine how agricultural inputs market access influences adoption of Climate-Smart Agriculture in Tigania West Sub County. The study was guided by the Sustainable development theory. The research design used a descriptive cross-sectional survey design with a sample size of 382 farmers that was sampled from a target population of 60,040 farmers using the Fisher's model sample size determination. Stratified random sampling technique was used to select respondents from the five wards. The data collection tool was a structured questionnaire, focus group discussion and key informant interviews. Descriptive statistics (frequencies, percentages) and inferential statistical analysis (correlation and multiple regression) were done, using Statistical Package for Social Sciences. Qualitative data that was obtained from the focus group discussions and the key informants was used to complement the quantitative data and be presented in narrative format. The research was relevant to Agricultural extension officers and other like-minded agencies in environmental conservation that got relevant insights that informed them to review their strategies and approaches in their quest to combat climate change. The study found that the farmer's main sources of CSA information were through other farmers. The study found that most of the farmers did not own their land and had between 1 - 5 acres of farming land. The study also found that all the farmers had access to credit to finance their farming business and accessed the credit through table banking/group savings & loaning. The study found that the farmers mostly got information of the inputs to buy from other farmers. The study concluded that land ownership system had the greatest influence on adoption of climate-smart agriculture in Tigania West in Kenya followed by agricultural inputs market access, then information access while agricultural financial services access had the least influence on the adoption of climate-smart agriculture in Tigania West in Kenya. The study recommended that that National and County governments to revamp extension initiatives bearing in mind the current technologies, make CSA implements accessible and provide a conducive environment for inputs and outputs market to operate efficiently. Further, there is a need for farmers to embrace collective action to mobilize resources through table banking, cost-sharing, collective input purchasing and collective output marketing.

Key Words: *adoption, climate-smart agriculture, climate change adaptation, Tigania West, Meru County, Kenya*

INTRODUCTON

Climate Smart Agriculture involves various approaches that farmers and other players in the agricultural sector can use not necessarily as a whole but to maximize the synergies among them. This include; diversification of improved crop varieties that can survive diverse climatic conditions; soil and water conservation which involves the use of conservation agriculture; soil fertility improvement via agroforestry, application of optimum quantities of recommended fertilizer and use of well-decomposed organic manure; irrigation and rain water harvesting involving storage and supplying water to the form; mitigation of the negative impacts of climate viariability. FAO (2016) Various climate change adaptation strategies available for farmers include but not limited to the following: - Changes in crop husbandry practices (site selection, timely planting, plant densities/population among others); Changes in livestock husbandry practices (feeding, animal health and movement among others); Soil and land use management, SLM (afforestation, soil erosion control, irrigation, water harvesting, tillage, soil fertility management, ground water recharging mechanisms among others); Livelihood management (Mixed farming opportunities, non-farming activities, migration among others) (Bryan et al 2011) Growing alternative crops, intercropping of alternative crop varieties, planting of drought-tolerant crop varieties, installing irrigation and water-harvesting techniques, insuring crops, instituting early warning and monitoring system, changing cropping patterns, diversifying on-farm and off-farm investment among other approaches are some of the measures that can be employed to reduce the adverse effects of climate change (Ochieng et al 2016).

Sub-Saharan Africa's limited capacity to adapt, has made her particularly vulnerable to climate change impacts. (FAOSTAT 2010) places poverty rate in Kenya at 52% while 75% of the labour force depends on agricultural production for their livelihoods, poor farmers are most likely to experience a myriad of challenges as a result of climate change. IFPRI-KARI 2010 lists the following climatic change shocks that are most likely to be experienced by farmers; drought, floods, erratic rainfall patterns, hail-storms among others. The report goes further to list the likely effects of the above climate change shocks to the farmer; loss of assets, loss of income, decline in crop yields, death of livestock, food insecurity, increased food prices among others.

According to Kenya Bureau of Statistics, KNBS, Agriculture has continued to be the back bone of Kenya's economy contributing up to 25.9% of the Gross Domestic Product. Various researchers have associated climate change to increase in temperature between 3o C and 4o C in Africa by the end of 21st Century. Due to this increase in Temperature, East Africa's rainfall means are likely to increase, but this won't result to increased agricultural productivity simply because of factors like poor rainfall distribution, timing among others. Kenya is likely to experience countrywide losses in production of staples such as maize (Herrero et al, 2010).

Tigania West Sub County covers an area of 567.3 KM2, with a population of 135,980 people which is projected to increase to 178,009 by the year 2022 covering her five wards namely; Mbeu, Nkomo, Kianjai, Akithi and Athwana (KNBS 2009). The Sub County has been listed as

having the highest level of firewood use in Meru County which stands at 94% as compared to the Meru County average of 81.9%. (Kenya Population & Housing Census Volume 1A 2009) Geographically, Tigania west is considered largely semi-arid especially in the western side bordering Isiolo County. It has a high dependency rate and an absolute poverty of 52% (NCAPD, 2005). This is way higher than national poverty index estimated to be 45.2% (KNBS 2009). These statistics exposes Tigania West dwellers to unbearable consequences of climate change and variation since according to (FAO 2016), poor nations are the ones likely to be heat hard by climate change effects since they have low coping mechanisms.

Climate adaptation can greatly reduce vulnerability to climate change effects by moderating potential damages, helping the rural communities cope with adverse consequences of climate change (IPCC, 2001). Adaptation to climate change would require concerted efforts involving various stakeholders who may include; policymakers, extension agents, Non-Governmental Organizations, researchers, communities and farmers. Climate smart Agriculture is an approach for transforming and re-orienting agricultural systems to support food security under the new realities of climate change (Lipper, 2014).

STATEMENT OF THE PROBLEM

Global Challenges Foundation's 2018 report listed climate change as one of the biggest threats to humanity. Climate change may have devastating and irreversible consequences if appropriate measures are not taken currently. Climate change is estimated to have already reduced global yields of maize and wheat by 3.8% and 5.5% respectively, and several researchers warn of drastic declines in crop productivity if temperatures exceed critical physiological thresholds. Continued climate variability aggravates production quagmires and posing a challenge to farmers' coping ability (Lipper, 2014). Climate change poses a threat to food security for both rural and urban dwellers by lowering agricultural production and incomes, increasing risks and disrupting markets. The disruption of food production and markets, also pose population-wide risks to food supply. Global projections indicate that global agricultural food production will need to increase by 60 per cent by the year 2050 in order to meet increased demand – most of this will need come from increased productivity. Lipper et al (2014). Agriculture was listed as the leading contributor to greenhouse emissions in Kenya according to World Resource Institute Climate Analysis tool (WRI CAIT). WRI CAIT estimates that in the year 2013, Agriculture was responsible for 62.8% of total greenhouse emissions followed at a distant by energy (31.2%), industrial processes (4.6%) and waste (1.4%). One of the biggest challenges facing the Kenyan government is to intensify food crop production so that farm output can keep up with the rapid population growth without necessarily increasing the size of the land devoted to food crops, especially milk and maize. Kabubo et al (2007). There was a call to change the approach to planning and investment for agricultural growth and development in order to avert the risk of misallocating resources in generating agricultural systems that are incapable of supporting food security and instead exacerbating climate change Lipper et al (2014). It is for this case that

there's need for climate-smart Agriculture – integrating climate change into the planning and implementation of sustainable agricultural strategies hence mitigating the adverse effects of climate change while ensuring food security. Lipper (2014). Climate change research identified several scenarios that are likely to affect agriculture. They include (1) rising temperatures around the world (2) rising levels of sea, (3) increased snow melt and change in the volume and timing of water use for irrigation, and (4) increased probability of extreme events (Stern, 2006). Crop failure and associated risks are caused by increased temperature, more often heat waves incidences and dry-spells, decreased rainfall and change in rain on-set and/or cessation. This calls for adoption options which include changes in crop and livestock related management and collective action. However, it is believed that farmers lack access to resources and knowledge needed for adoption. Furthermore, farmers perception of climate change risks is often not consistent with measure risks hence the need to adjust CSA agricultural practices to be sensitive to issues like gender, local societal norms and cultural beliefs (FAO, 2016). AU Malabo Declaration (2014) on "accelerated Agricultural growth and transformation for the shared prosperity and improved livelihood" – commitment six requires that countries to commit towards enhancing resilience to climate change and variability. In her 2017 scorecard, Kenya scored poorly on the implementation of the commitment six of the Malabo Declaration at 3.40 out of a possible 10 points hence declared 'not on track' in terms of ensuring resilience to climate related risks and investment in resilience building. In recent years, various Climate-Smart Agricultural practices like Conservation Agriculture (CA) has been emphasized in Kenya as an alternative farming system especially for small-scale farmers to try and avert declining land productivity and climate change and variations. But even if there is a 'perfect fit', the farmer still has his or her own reasons to choose whether to switch to CA or not. The question that has been lingering in the minds of development agencies is "if approaches that are climate smart like CA yield immense benefits both to the farmer, ensures the farmers' resilience against Climate change while mitigating against global warming, then why is it that its uptake still too low in spite of years of its advocacy? According to Ministry of Agriculture, Various organizations have promoted the CSA climate Smart agriculture techniques in the country; including but not limited to the following: FAO, ACTN, PAFID, TIST, NCCK, CCK, Catholic Diocese of Kenya (Caritas), KENDAT among others. But according to FAO, less than 10% of farming can be considered as Climate Smart Agriculture. Very little research has been done to show the mentioned objectives are affecting the adoption of this whose rewards have been documented to be immense. Therefore, the research is aimed at finding out the mentioned variables have contributed to slow uptake of this important technic. NDMA Meru County Drought Early Warning Bullet for March 2019 lists Tignaia West as having the lowest Food consumption score behind sub counties like Igembe North, Igembe Central and Tigania East. 96.7% of those interviewed by NDMA were on borderline while less than 10% of interviewees had acceptable food consumption score which was determined using the frequency of meals comprising of Cereals, Pulses and vegetables. NDMA report further notes that there has been dwindling vegetative coverage especially along the Meru-Isiolo Border which has occasionally sparked

conflicts between communities who are mainly Agro-Pastoralists. The dwindling vegetation coverage is further worsened by the overreliance on firewood as a source of energy which NDMA puts at 94% being the highest in Meru County. The Sub County has been listed as having the highest level of firewood use in Meru County which stands at 94% as compared to the Meru County average of 81.9%. (Kenya Population & Housing Census Volume 1A 2009) Geographically, Tigania west is considered largely semi-arid especially in the western side bordering Isiolo County. It has a high dependency rate and an absolute poverty of 52% (NCAPD, 2005). This is way higher than national poverty index estimated to be 45.2% (KNBS 2009). These statistics exposes Tigania West dwellers to unbearable consequences of climate change and variation since according to (FAO 2016), poor nations are the ones likely to be heat hard by climate change effects since they have low coping mechanisms.

PURPOSE OF THE STUDY

The purpose of this study will be to investigate factors influencing adoption of climate-smart agriculture as a climate change adaptation in Tigania West Meru County – Kenya.

RESEARCH OBJECTIVES

1. To assess how land ownership system influences adoption of Climate-Smart Agriculture in Tigania west Sub County.
2. To determine how information access influences adoption of Climate-Smart Agriculture in Tigania west Sub County.
3. To determine how agricultural financial services access influences adoption of Climate-Smart Agriculture in Tigania west Sub County.
4. To determine how agricultural inputs market access influences adoption of Climate-Smart Agriculture in Tigania West Sub County.

LITERATURE REVIEW

Climate-Smart Agriculture Adoption

Human adoption of any economic activity is dependent on the cost benefit rationale. Rationale is however a product of existing knowledge. People often find it easier and beneficial to engage in activities that they understand and are skilled in. Climate-Smart Agriculture has the potential to improve the lives of small-scale farmers and enhance their resilience to climate change and variations, but since it initiation back in 2010 by FAO, less than 10% of farmers adopted the way of farmers FAO (2016). Lipper 2018 traces climate change policy change using Gupta 2010 framework which starts with the 1979 World Climate Conference and establishment of International Panel on Climate Change (IPCC) in 1988. Thereafter, the Rio Convention (1992)

led to the creation of UN Framework Convention on Climate Change (UNFCCC) in 1994; later, in 2001, the Kyoto Protocol was established.

The concept of Climate-smart Agriculture was first launched by Food and Agriculture Organization in 2010 in a paper prepared for the Hague conference on Agriculture, Food Security and climate change. The paper elaborated three main objectives; i) Sustainably increase food security by increasing Agricultural productivity and incomes in order to support equitable food security and develpment; ii) Build resilience and adapt to climate change; iii) Reduce and/or remove greenhouse gas emissions where possible (FAO 2010).

Climate-Smart Agriculture refers to an approach that aims to universally guide Agriculture management in light of Climate change. In light of this, various policy conferences have been held in follow to the Hague Conference on Agriculture, food security and climate change. They included; CSA policy conference in Hanoi Vietnam in 2012 and in Johannesburg South Africa, Global CSA science conference at Wageningen in 2011, followed by another at the University of California at Davis in 2013 and CIRAD Montpelier in 2015. These conferences culminated in creation of GACSA, Global Alliance on Climate-Smart Agriculture in 2014 which aimed to bridge the gap between science and policy aspects with emphasis on three key areas; 1) building relevant evidence-based criteria for assessing trade-offs and synergies amongst the three main objectives of CSA, 2) developing conducive policy environment that is required in coordinating climate change and agricultural policies, 3) investments and linkages to climate finance FAO (2018).

FAO highlights various specific strategies that plays a big role in CSA approach; Crop diversification with a bias to drought-tolerance variety and/or early maturing varieties; Conservation Agriculture (which include incorporation of Agroforestry, Minimum Tillage, Soil cover – which can either be a cover crop and/or crop residue retention, crop rotation/association), Integrated pest management (IPM) – which involves breeding for pest and disease resistant varieties, good agricultural practices (GAP) – which include integrated nutrient management and lastly, financial services ; which include risk transfer strategies like taking crop or livestock insurance, sources of capital for investment and sources of agricultural credit.

Land Tenure Regime and Adoption of Climate-Smart Agriculture

Land ownership in Kenya can be categorized into five main regimes: i) Communal ownership ii) Individual ownership iii) Lease ownership iv) Group ownership (society) and v) state-owned land. Each system gives the user of the land varied rights regarding what can or cannot be done on the land. Individual ownership (Individual Tenure system) refers to where land is owned by an individual who either operates or leaves it to another person under some sort of agreement Harbeson, (2012).

Under Individual owner-operator, the farmer owns and operates the land. It offers a lot of freedom for the farmer to choose appropriate production plans, the owner may organize the land

resource for profit maximization provides greatest incentive in farming, conservation and improvement of the land, the owner has incentive for long term investment in the land. Where the farmer has a title deed to the land, he can use it as a collateral/security to obtaining agricultural credit/loan. This system of land ownership is common in many parts of Kenya where land consolidation and registration has been done. However, lack of title deed has hampered some individuals from reaping the above-mentioned benefits. On the flipside, the system has been blamed for the increase in government cost for extension service, the system may encourage inequality in land ownership and resulting to poor land resource distribution, encourages land fragmentation which lowers land productivity and hampering agricultural mechanization (Rigon, 2016).

The landlordism and Tenancy land use arrangement refers to a scenario where the landlord transfers the right to use the land to a tenant at a payment. The landlord makes a formal or informal agreement where the tenant pays a certain rate as rent. By payment, the tenant gets the right to use the land. Where agreement is formal, both landlord and tenant know their obligations and the tenant has a legal backing hence some security of tenure. Landlordism/Tenancy system has can be said to have benefits like: landlords who cannot use land for any reason, get income after renting land to tenant; land is not left idle, hence contribute to agricultural production hence increasing production; the landless can rent land from landlords to earn livelihood and lastly, it ensures equitable distribution of land as natural resource. However, this arrangement has is fair share of downside which include but not limited to the following; in most cases, there is no incentive to improve the land; where the lease period is short, tenants may have no incentives to invest in expensive long term investment even if there is likelihood to increase the productivity of land; In the Kenya, land rates are not fixed by the government; this may lead to landlords overcharging the tenants and hence lose motivation in the investment in productive ventures of the land and lastly, In case of a short lease period, the tenant may just be concerned with profit while ignoring soil conservation (Rigon, 2016).

Information Access and Adoption of Climate-Smart Agriculture

Nyasimi 2014 notes that limited knowledge regarding promising initiatives often lead to poor uptake of CSA interventions. Siting an example of Malawi farmers who have exhibited slow uptake of conservation agriculture – an approach of CSA, partly because of a poor understanding of the concept among extension workers and farmers as well. The inconsistent and conflicting advice about CSA confuses the farmers even farther. This situation is farther worsened by the fact that, most capacity building programmes are project-based and donor-funded, which in most cases ceases once the project funding comes to an end. The over-reliance on donor-funded initiatives creates the hand-outs dependency syndrome hence the need for a local and reliable solution and investment as per the African Union (AU) Maputo Declaration on Agriculture and Food Security in Africa of 2003; “commitment to the allocation of at least 10 percent of national

budgetary resources to agriculture and rural development policy implementation within five years".

The history of research for development indicates that only a small fraction of the outputs of agricultural research has been adopted by next users (Extension officers, NGOs, institutions etc.) and end-users (beneficiaries, farmers, etc.) (Westermann et al 2015). Climate change escalates a significant urgency to the already wanting situation, and there is no good 'new' news on the climate change front: Hansen et al. (2015) Time is running out, and particularly for the poverty-stricken and malnourished of the developing countries. Therefore, the agricultural research for development players need to find new ways of ensuring that their research products contribute to development outcomes much faster than has fared in the past. Implementing Climate-Smart Agriculture practices requires a shift in the behavior and strategy of the several farmers. Rural Advisory Services can play an important role in transitioning to CSA and help build resilient food security systems if an enabling environment for their effective functioning is provided.

Enhancing the capacity of farmers to manage risk and adopt effective climate change adaptation and mitigation strategies requires special attention. The implementation of Climate Smart Agriculture innovations calls for the design of appropriate solutions adapted to the technical, institutional and policy related needs of the stakeholders involved. (FAO 2018). Agricultural extension can be referred as an educational service for advising, training, and informing the farmer regarding scientific and practical matters relating to the farmers farm business, and influencing him/her to use improved techniques in his/her farming operations, for which this purpose, includes livestock and crop production, farm management, conservation and marketing. Bunyatta et al. (2006). Through his research, Bunyatta et al. 2006 found out that there's a strong link between Farmer Field Schools (FFS) and adoption of Agricultural innovation as compared to non-FFS farmers.

Financial Services Market Access and Adoption of Climate-Smart Agriculture

Agricultural financial services include risk transfer strategies that a farmer can access which like insurance, contract farming and sources of agricultural capital. The AU Maputo Declaration on Agriculture and Food Security in Africa of 2003 which required each country to commit 10% of her national budgetary resources to agriculture and rural development policy implementation within five years"- is targeting 6% growth in GDP. In her financial year 2017/2018, Kenya allocated 2.3 percent of her annual budget to Agriculture, urban and rural development totaling Kes 38 billion. Bearing in mind, The Malabo Declaration 2014 which was of re-commitment to the Comprehensive Africa Agriculture Development Programme (CAADP) implementation, the Kenyan Government committee 11.3% of her annual public expenditure to Agriculture, urban and rural development in the 2018/19 budget totaling to KSh. 190 billion. (Institute of Economic Affairs 2018). The allocation to agriculture in Meru County currently stands at 6.6% of public expenditure budget of 2018/2019.

Agricultural Inputs Market Access and Climate-Smart Agriculture

Agricultural inputs; certified seeds, fertilizers and organic manures agrochemicals and services, have an enormous potential to leverage the efforts of rural small-scale farmers. If used appropriately, they can significantly improve farm productivity, food security and increased profits. Nyasimi et al. (2014) assessed the impact of Agrodealers strengthening program which aimed at increasing farmers' access to inputs by reducing the distance travelled by farmers to reach an agrodealer from 40KM to 7KM resulting to 30% increase in fertilizer use and seeds which significantly increased productivity. The authors further recommend that responsive national regional markets should be encouraged to provide access to credit and financial schemes to enable farmers adopt new and emerging climate-smart technologies.

THEORETICAL FRAMEWORK

Theoretical framework can be referred to as a collection of interrelated concepts that guide the scope of a study. The framework introduces, describes and explains why the research problem under research exists. It aids in forecasting and understanding a phenomenon and presents a platform to contest and extrapolate existing knowledge within the realms of critical assumptions.

This research alludes to the sustainable development theory which is defined as "that development that meets the needs of the present generation without compromising the potential of the future generations to cater for their own needs". The theory was first postulated by economists Reverend Thomas Malthus in 18th century through his book; "An article on the Principles of population", Malthus was concerned about the ever increasing and dynamic human needs that could easily outstrip the existing natural resources (Malthus, 1888). He foresaw a state of perpetual hunger, disease and struggle unless God intervened and curbed population explosion. Inspired by Malthus Charles Darwin another 18th century economist through a research concluded that the struggle between more and less fitness to survive was dependent on a natural selection process that filters and leaves the most appropriate and resilient specie to survive (Malthus, 1888).

Inherent in the definition of sustainable development are concepts of environmental stewardship and inter- and intergenerational equity. Efforts to define and address sustainability were born from the recognition that existing development patterns cannot proceed without jeopardizing the environmental systems necessary to sustain life and economies, and that significant disparity within and between generations is neither sustainable, ethical, nor in tune with development goals Hammer and Pivo (2017). Hammer & Pivo (2017) notes that practically, sustainable development calls for the "integration of economic, environmental, and social objectives across sectors, territories, and generations." hence, sustainable development demands the elimination of fragmentation among the environmental, social, and economic concerns which must be integrated throughout decision making processes in order to move towards development that is truly sustainable. They farther correlate the concept of SD to the Triple Bottom Line (TBL)

which refers to economic environment and social value of an investment. The term TBL (which is sometimes referred to as the 3Ps; People, Planet and Profit) was first coined by John Elkington in the 1990s with the aim of more accurately value assets and leverage resources, so that capital is employed as efficiently and effectively as possible. Darwin's "survival for the fittest" theory cast doubt on the survival of subsequent generations thanks to the ever-increasing population that has fewer choices, they either put their act together or the nature takes its course (Baker, 2012). The repercussions of climate change have left the human race scampering for survival - frequent droughts, more incidences of heat waves, and increased flooding incidences - have been a real threat to humanity in the recent years. There are fatal conflicts and uprising incidences in many African nations sparked and fueled by perception of limitation - which is regrettable. A little innovation coupled with deliberate efforts can unearth and or increase resources to sustainably support human survival.

The concept of sustainable development is anchored on the balance of different and often competing needs against an awareness of the underlying environmental, social, and economic limitations. It goes beyond taking care of the available resources to ensuring a strong, healthy and just society by meeting people's diverse needs, promoting well-being, social cohesion, inclusion, and creating equal opportunity among communities (Dasgupta, 2007). Sustainable development is therefore a deliberate effort by all individuals to make good decisions, plan, and pursue viable alternatives that place resources in the best use to serve current and future human needs (Baker, 2012).

Adoption of Climate-Smart Agriculture is a deliberate sustainable development effort since Agriculture is said to the back-bone of Kenya's economy, contributing up to a quarter the country's GDP while offering above three-quarters of employment opportunities both directly and/or indirectly KNBS (2009). However, Agriculture has been listed as the biggest contributor to GHGs – stresses the point adopting CSA in order sustainably feed the human race. Maize is undoubted one of the staple foods of Kenya (Fleming et al. 2016). However, maize production in Kenya been fluctuating due the high dependence on rain-fed agricultural production. FAO-KE maize statistics shows volatile variation in maize output over the years, for instance, in 2010 the country produced 3,464,541 tons of maize translating to 7.8 bags (90kg) per acre of maize while in 2017 the country 3,186,000 tons of maize translating to 3.1 bags (90kg) per acre. The huge drop in maize production can be attributed to bad weather experienced in 2017 which prompted the government to order maize from abroad. Nyoro et al. (2004) estimated Kenya's per capita consumption to range

RESEARCH METHODOLOGY

Research Design

Kothari (2003) defines research design as the structure of conditions for collection and analysis of data in manner that aims to combine relevance to the research purpose and stipulates the road-

map for collection, measurement and analysis of data. In this study, descriptive field research design was employed simply because, descriptive research design describes the situation it is at present considering in this case where the researcher has no control over the variables, one can only document what is occurring or what has occurred. A descriptive research approach tries to expressly describe attitudes towards a particular situation (Bryman, 2015). It relied on the premise that if a statistically significant nexus exists between two variables, then it is possible to construe one variable using the information gathered on another variable (Kothari, 2011). In addition, descriptive research design presents an opportunity to collect an array of data that give explanation to research questions and logically configure the inquiry into the problem of study, Marsh (1982). Qualitative information was also collected from respondents' group discussions (FGDs) and key informants (KIIs) during the study.

Target Population

Target population refers to all items in the specified field of inquiry which can also be referred to as the universe (Kothari 2011). According to Cooper & Schindler, (2014), a study population refers to individuals, households, or organizations with more or less similar attributes about which a researcher wants to draw inferences. By 2009, Tigania West had 29,810 households, 44.8% of the population in Tigania West are engaged in farming which translates to 60,919 farmers (KNBS, 2009). Therefore, the target population for this study was 60,919 farmers.

Sample Size and Sampling Procedures

Sample refers to a subset of a population identified for observation, measurement, or question, to provide statistical information regarding the population Bryman (2015). To ensure a good representation among Tigania West farmers, stratification of the target population was done with the assistance of the Tigania West Administrative Wards using probability proportional to size. The study made use of the probability proportion sampling size, a process entails dividing the size of the final unit and giving bigger Wards a bigger chance of selection and smaller one's lower chances (Abdulla et al., 2014). This was relevant whenever the sampling units differ in size to ensure that those in bigger wards have similar likelihoods of getting into the sample like those in smaller wards. The stratified random sampling is whereby respondents are identified in a manner that the existing sub-groups in the population will be more or less reproduced in the sample (Mugenda and Mugenda, 2012). This technique was relevant where most population are segregated into several mutually exclusive sub-populations or strata (Bryman, 2015; Cooper & Schindler, 2014). In descriptive research design, 30% of the accessible population is sufficient (Mugenda and Mugenda 2008). Given a population of 60,040 farmers, 30% would require 18,012 respondents. However, (Krejcie & Morgan, 1970) suggested the formula below in the determination of sample size:

$$s = X^2NP(1-P) \div d^2(N-1) + X^2P(1-P).$$

Where*: s* = required sample size; X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841); *N* = the population size; *P* = the population proportion (assumed to be .50 since this would provide the maximum sample size; *d* = the degree of accuracy expressed as a proportion (.05).

Using the table generated by the above formula, target population of 60,040 farmers required a sample simple of 382 farmers. This sample was representative of the population in giving the desired characteristics because it was spread across all the area of study. The five wards namely; Mbeu, Nkomo, Kianjai, Akithi and Athwana. in the Tigania West Sub-County was used as stratums for sampling. Stratified random sampling was used as it accorded each sampling element an equal chance of selection while guarding against clustering of selected elements in one point. This was necessary since each ward had its own uniqueness in terms of ecological zones and agricultural potential. This was calculated as the population of individual category of farmers divided by the total population of all categories (target population) multiplied by the sample size of 382 farmers. Stratified random sampling gave all the individuals in the defined sample an equal chance of being picked as a respondent for the study, (Orodho 2014). Every stratum applied simple random sampling technique to choose participants. Determination of the sample size followed proportionate to size sampling methodology as specified by Anderson et al. (2016). A representative sample was selected according to the five Wards as shown in

Data Collection Instrument

Mugenda and Mugenda (2012) and Cooper and Schindler (2011) defined data collection instruments as the tools and procedures used in the measurement of variables in research. A questionnaire containing closed and open-ended questions was used to collect data from farmers since this one of the most commonly used data collection tools (Creswell, 2011). A questionnaire refers to a technique of data collection by which each respondent is requested to respond to the same set of questions in a certain order (Cooper & Schindler, 2011; Burns & Burns, 2012). Questionnaires were used as they have an advantage of collecting data from several respondents within a reasonable time, minimize costs and can accord respondents some time to think through their responses and are relatively easy to administer and score (Kothari, 2011). In addition, focus group discussion using an FGD guide was used. Discussions and consultations with key informants were done using a questionnaire. The questionnaire was formulated in a way to make sure that all factors essential to the study were considered.

Data Collection Procedures

Introduction letter from the University of Nairobi and a research permit from the National Commission for Science, Technology and Innovation (NACOSTI) were sort through online application via NACOSTI website where relevant documents and payments were submitted. The researcher and research assistants thereafter systematically issued introduction letters and

administered the questionnaires to the identified farmers and stakeholders. The farmers and stakeholders were randomly selected from the Ward agricultural office data base. Farmers who were able to fill the questionnaire by themselves were allowed to do so while those who had difficulties to read and write were assisted by the research assistants

Data Analysis Techniques

Kerlinger (1973) defined data analysis refers to categorizing, summarizing and manipulating information gathered in order to answer the research questions. A careful analysis of the filled questionnaires was conducted in order to ensure that collected data was consistent with other information. The questionnaires were then coded in order to eliminate unusable data and outliers, interpretation of ambiguous answers and contradictory information from closely related questions. A coding scheme was developed for the responses to each question in order to facilitate the development of an appropriate data structure to enable its entry into the computer. The study used data entry and storage by the aid of Statistical Package for the Social Sciences (SPSS) then data was analyzed using descriptive statistics. The data was tabulated into tables and others figures while frequencies and percentages were used in the discussion of the findings.

RESEARCH RESULTS

The study aimed to determine how information access influences adoption of Climate-Smart Agriculture in Tigania west Sub County. The study found that the farmers' main sources of CSA information were through barazas, other farmers, internet/social media/mobile phones, print media (Newspapers etc), Radio/TV stations and extension workers . Further, the study found that most of the farmers had frequent access to CSA information and that CSA messages were reliable/actionable.

The study sought to assess how land ownership system influences adoption of Climate-Smart Agriculture in Tigania west Sub County. The study found that most of the farmers did not own their land and had between 1 - 5 acres of farming land. The study also found that the farmers acquired land by leasing/hiring, communal land, squatting and through freehold. The study found that most of the people with full rights to use the main land of farming were parents. The study found that most of agreement if farming was done on land owned by someone else was for 1 – 2 years and also the farmers would most likely practice CSA on their own land and were likely to practice it on land owned by someone else.

On agricultural financial services access, the study found that the major source of capital for investing in farming was off- farm income, credit and on-farm income. The study also found that all the farmers had access to credit to finance their farming business and accessed the credit through table banking/group savings/loaning, Agro-Dealer input loan, mobile telephony and Financial Institutions (Bank, MFIs). Further the study found that farmers acquired credit to buy/hire farm machinery, to lease more farming land, to buy farm inputs and to pay farming

labour. The study also found that all the farmers were aware of Agricultural Insurance and most of them had taken crop micro insurance and livestock micro insurance.

The study also sought to determine how agricultural inputs market access influences adoption of Climate-Smart Agriculture in Tigania West Sub County. The study found that the farmers mostly got information of the inputs to buy from Internet/Social media/mobile phones, other famers, Barazas, agro-dealer sales reps, Radio/TV stations, 8 Print media (Newspapers etc) and extension workers. Further, the study found that farmers sourced their farm input from agro-vet shops, Itinerant Agro-Inputs vendor, ordered online and directly from Agro-input Company. The study found that majority of the farmers were less than 1KM away from the nearest Agro-Dealer shop. Also, a majority of the farmers always got all the recommended farm inputs they required whenever they wanted them. The study also found that the farmers got inputs mostly of good quality (perform as expected). The study also found that most of the respondents were not satisfied with the prices of inputs they typically used.

The study found that all the farmers were aware of Climate-Smart Agriculture (CSA) and majority of them practiced CSA on their farms. The study found that the farmers practiced conservation Agriculture (Minimum Tillage, Soil cover, Crop rotation), appropriate crop selection (early maturing, drought tolerant varieties), soil fertility management (Application of optimum quantities of recommended fertilizers and manures), 7 diversification of household income streams (Both on-farm and Off-farm), SLM (Sustainable Land Use Management; Terraces, reclamation etc), installed irrigation and water harvesting techniques, IPM (Integrated Pest Management), permaculture, agroforestry/afforestation, Agricultural Insurance and good livestock husbandry practices.

INFERENTIAL STATISTICS

Regression analysis was conducted to determine the relationship between factors influencing adoption of climate-smart agriculture in Tigania West Meru County – Kenya.

Table 1: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.851	0.725	0.721	0.496

From the Table 1, the adjusted R square for the adoption of climate-smart agriculture in Tigania West was 0.721; this meant that independent variables were statistically significant. This implied that 72.1% variations in adoption of climate-smart agriculture in Tigania West are explained by land ownership system, information access, agricultural financial services access and agricultural inputs market access. The remaining 27.9% was explained by other institutional factors influencing adoption of climate-smart agriculture in Tigania West that were not covered in this study.

Table 2: ANOVA Test

	Sum of Squares	df	Mean Square	F	Sig.
Regression	179.121	4	44.780	179.735	.000
Residual	68.017	273	0.249		
Total	247.138	277			

The findings from Table 2 show that the p-value was 0.000 and was less than 0.05. The F-calculated was 179.735 and was greater than F-critical (2.4047). This reveals that the model could predict the outcome of the relationship between the independent variables (land ownership system, information access, agricultural financial services access and agricultural inputs market access) and adoption of climate-smart agriculture in Tigania West.

Table 3: Coefficients of Determination

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	1.267	0.182		6.962	.000
Land ownership system	0.812	0.196	0.714	4.143	.000
Information access	0.712	0.208	0.611	3.423	.001
Agricultural financial services access	0.568	0.208	0.462	2.731	.007
Agricultural inputs market access	0.771	0.312	0.672	2.471	.015

The established model for the study was:

$$Y= 1.267 + 0.812X_1 + 0.712X_2 + 0.568X_3 + 0.771X_4$$

Where: Y= Adoption of climate-smart agriculture in Tigania West; X_1= Land ownership system; X_2= Information access; X_3= Agricultural financial services access; X_4= Agricultural inputs market access

The study found that if all independent variables(land ownership system, information access, agricultural financial services access and agricultural inputs market access) were held constant at zero, then the adoption of climate-smart agriculture in Tigania West will be 1.267 which is significant since p= 0.000 < 0.05. The findings obtained also show that Land ownership system is 0.812 which is significant since p=0.000 is less than 0.05, meaning that when a unit change in land ownership system leads to 0.812 units change in adoption of climate-smart agriculture in Tigania West.

The study further found that a unit change in information access changes would lead to a 0.712 units change in adoption of climate-smart agriculture in Tigania West. The variable was significant since p=0.01<0.05. Further, the findings show that a unit change in agricultural financial services access changes would lead to 0.568 units change in adoption of climate-smart

agriculture in Tigania West in Kenya. The variable was significant since p-value=0.007 is less than 0.05. The study also found that a unit change in agricultural inputs market access changes would lead to 0.771 units change in adoption of climate-smart agriculture as a climate change adaptation in Tigania West in Kenya. The variable was significant since p-value= 0.015 is less than 0.05.

Overall, land ownership system had the greatest influence on adoption of climate-smart agriculture in Tigania West in Kenya followed by agricultural inputs market access, then information access while agricultural financial services access had the least influence on the adoption of climate-smart agriculture in Tigania West in Kenya. All the variables were significant since their p-values were less than 0.05.

CONCLUSIONS

The study concludes that information access has a positive and significant influence on the adoption of CSA in Tigania West. The study concluded that more CSA training for farmers, government extension staff working at the local level, and use of communication tools to share and promote knowledge on CSA use to combat the global challenge of climate change are essential. Further, the study deduced that understanding barriers and enabling conditions to CSA adoption helps in designing and formulating extension messages and agricultural policies that can accelerate CSA dissemination and help safeguard agricultural production and food security. The CSA messages need to be packaged in a manner that is reliable, actionable, devoid of conflicting messages that may lead to CSA dis-adoption or lowly implemented.

The study concluded that land tenure system has a positive and significant influence on the adoption of CSA in Tigania West. The study also concluded that not all CSA practices require the same level of tenure security in order to encourage productivity- enhancing investment by farmers and herders. As compared with some conventional agricultural practices, many CSA investments require greater assurance and longer duration of rights. More emphasis should be channeled towards small-scale farmers and interventions that are suitable to these categories of farmers bearing in mind the continuous land fragmentation.

The study also concluded that agricultural inputs market access positively influences adoption of Climate-Smart Agriculture in Tigania West Sub County. The study concluded that when the inputs are made accessible, in satisfactory qualities and competitive prices to the farmers then more will be produced without having to increase land under agriculture hence being climate-smart.

RECOMMENDATIONS

However, to ensure that many farmers are empowered to benefit more from the improved agricultural practices, this study recommends that National and County governments to revamp extension initiatives bearing in mind the current technologies. This could be achieved by

increasing and motivating farmer trainers to train more farmers, promoting farmer-to-farmer learning, and harmonizing CSA messages, establishing demonstration plots in their farms and organizing for additional field days and learning tours for farmer groups to build their capacity on CSA practices.

To overcome some of the financial constraints to adoption of CSA practices at the local level, as suggested by farmers themselves, there is a need for them to embrace collective action to mobilize resources through table banking, merry-go-rounds, cost-sharing and group credit access. Farmers also felt that strengthening capital bases on the existing farmer groups would provide the required group collaterals to access credit facilities. Deliberate arrangements are required to support farmer-to-farmer dissemination of promising improved practices. A reward mechanism requiring that non-participating farmers be periodically allowed to visit model farms maintained by participating farmers, will ensure that those farmers who are not necessarily in groups are also adopting climate-smart agricultural practices. This way the adoption of CSA practices will get entrenched and more economic and environmental benefits realized by many farmers. Sensitization of community members about the effects of climate change should be made participatory with farmers taking center stage in championing for the mitigation measures through lobbying and advocacy. Farmer-Centered civil society organisations should be encouraged to take the leading role in combating the effects of climate change and demand changes in policies governing farming.

Access to markets, credit and extension services and other information sources are found to play a crucial role in increasing CSA uptake. Therefore, it is important to focus on policies and plans that improve market access and enhance agricultural credit facilities and the quality of extension services. Dissemination of CSA knowledge and its role in climate risk mitigation is critical to promote it.

The study also deduced that agricultural financial services access influences adoption of Climate-Smart Agriculture in Tigania west positively and significantly. The study concluded that access to credit and other income sources provides resources for long-term investments in CSA and are two proxies for market orientation. Access to capital – credit facilities and off-farm income – has positive impact towards enabling farmers to access CSA equipment and farm inputs with ease. This will definitely boost food production without necessarily increasing the acreage under agriculture. By so doing, the farmers will be able to meet the needs of current generation without compromising the potential of future generation to meet their needs.

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