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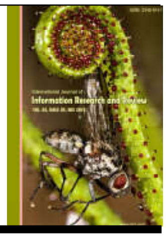

Research Article

PERCEPTION OF CLIMATE CHANGE EFFECTS AND ITS INFLUENCE ON UPTAKE OF CLIMATE SMART PRACTICES AMONG SMALL SCALE FARMERS OF KISII COUNTY, KENYA

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ABSTRACT

The study examined perception of climate change effects on farming and its influence on adoption of climate smart practices among small scale farmers of Kisii County. Asurvey research design was used and data collected through focus group discussions, questionnaires, key informant interviews, observations and desk reviews. Simple random and purposive sampling methods were used, where 420 small scale farmers and 30 key informants from Kitutu and Nyaribari Chache participated. The study revealed farmers growing recognition of climate change problem (63.1%) characterized by temperature rise (48.1%), changing rainfall patterns (24.3%), and new strains of pests and diseases (40.7%). Consequently, most farmers (89%) had difficulties in planning their farming activities with resultant crop failure and decline in crop yield (47%). This perception was in congruence with the observed changes by weather experts and resonated well with crop production statistics. There were efforts towards adoption of climate smart practices based on chi square test results (P=0.05). In conclusion, farmers from high potential rainfall areas are equally affected and aware of climate change; however, adoption of climate smart practices is hampered by limited understanding of the practices. The study recommends enhanced knowledge of climate change and climate smart practices for their improved adoption.

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INTRODUCTION

Though, there were concerns many decades back over the possibility of global warming, certainty of global warming in relation to greenhouse gases was established by scientists under Intergovernmental Panel on Climate Change. Their findings unequivocally affirmed the warming of the climate system, with global average temperature increase of 0.74% (IPCC, 2007). In tandem with global warming, Africa has been warming at the rate of 0.05% per decade for the last 100 years (Hulme *et al.,* 2001). This rate is projected to rise further based on model projections. The climate model simulation for Africa, indicate the median temperature increase of between 3°C and 4°C, roughly 1.5 times, the global mean response under a range of possible emissions scenarios (Christensen *et al.,* 2007). It's projected that drier subtropical regions may become warmer than the moister tropics with much of Mediterranean Africa, northern Sahara and southern Africa expected to register decline in rainfall (Collier *et al.,* 2008). Whilst all models concur that it will become warmer, the extent of warming is quite unpredictable (Hulme *et al.,* 2001).

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Rainfall on the other hand has been shown to be highly inconsistent spatially and temporally (IPCC, 2007).Great uncertainty exists, in terms of regional-scale rainfall changes simulated by GCMs. The difficulty involves determining the character of the climate change effect on African rainfall against a backdrop of huge natural unpredictability compounded by the use of imperfect climate models (Sivakumar *et al.,* 2005). East Africa is experiencing increasing mean rainfall and there are a small number of places where rainfall means are likely to decrease (Thornton *et al.,* 2009). There is still some doubt about this development, however, others argue that climate models to date have most likely underestimated warming impacts of the Indian Ocean and thus may well be overestimating rainfall in East Africa (Funk *et al.,* 2008). Hulme *et al.,* (2001) indicated why there is much less confidence about the ambiguous representation of climate variability in the tropics in most GCMs via mechanisms such as ENSO, and dynamic land cover–atmosphere interactions. Such interactions has been suggested to be important in determining African climate Variability (Hulme *et al.,* 2001). Kenya exhibits wide-ranging climatic conditions due to maritime and terrestrial influence. While mean temperature varies with altitude, the more significant climatic variation is with respect to rainfall. Kenya experiences bimodal seasonal pattern, with long rainfall occurring between March to June, and short rains taking place from September to November/December. Rainfall is correlated to topography with highest elevation regions receiving rainfall amount of 3200mm per year and low areas receiving 320mm, over two thirds of the country receive below 500mm of rainfall per year particularly in the northern parts of the country (Osbahr & Viner, 2006). Rainfall has been shown to have become highly variable in arid and semi-arid areas, and unreliable in high rainfall areas due to climate change (Osbahr & Viner, 2006).Kenya also experiences a cycle of droughts and floods in every decade based on long term historical climate data, with floods contributing 60% of all disasters in Kenya. Floods occur mainly in Lake Victoria basin, lower Tana river basin, coastal areas and semi-arid and arid regions despite low rainfall (WRI, 2007). The trend of the floods and droughts shows an apparent increase in frequency, magnitude and subsequent impacts as a result of climate change (UNEP/GoK, 2000). Current impacts on development and livelihoods from weather events in Kenya may be extrapolated into even more extreme scenarios with the future impacts of human-induced climate change. As a result of the aforementioned changes, agricultural production in developing countries and particularly among small scale farmers relying mainly on rainfall has become unstable and declined resulting into enhanced food insecurity and poverty (Mendelsohn *et al.,* 2000a; Boko *et al.,* 2007; Mburu *et al.,* 2014). With erratic and unpredictable weather patterns, and frequency and intensity of extreme climatic events set to increase as a result of climate change (IPCC, 2012), further decline in crop yields will occur in most tropical and sub-tropical regions (IPCC, 2007). This will compound the already existing food insecurity and the prevalence of hunger in developing countries, and reinforce the existing vulnerabilities of small scale farmers (Osbahr & Viner, 2006). Results from various studies on impacts of climate change on agriculture in Africa, based on various climate models and SRES emissions scenarios indicate that, by 2100, parts of the Sahara are likely to emerge as the most vulnerable, with expected decline of 2 and 7% of GDP, while western and central Africa, Northern and southern Africa may experience a decline in agricultural production by 2 to 4% and 0.4 to 1.3% respectively (Mendelsohn *et al.,* 2000b).

Reports also indicate that climate change will cause a wide-ranging decline in most of the crops such as sorghum, maize, millet and groundnuts in several countries such as Sudan, Ethiopia, Eritrea, Zambia, Ghana, Sudan and Gambia. Yields from rain-fed crops could drop by 50% by 2020 and dwindle net revenues from crops by 90% by 2100 in some countries, worsening food insecurity and putting millions of people at risk of hunger, with Africa expected to account for the majority by 2080s particularly small scale farmers (Fischer *et al.,* 2005; Boko *et al.,* 2007). In Kenya, high spatial and temporal variability of climate coupled with change in seasonal patterns has, posed significant and multiple risks such as crop and livestock losses (Thornton *et al.,* 2009). Studies on negative impacts of climate change and variability on agriculture in Sub-Saharan Africa and in Kenya indicate significant mean changes in crop yields (Schlenker *et al.,* 2010; Mburu, 2013: IFPRI, 2004). These have disproportionately affected small scale farmers particularly in Kenya, because of existing vulnerabilities (Fischer *et al.,* 2005; IPCC, 2007; Thornton *et al.,* 2009; Mburu, 2013).For instance La Nina droughts of 1999/2000 in Kenya contributed to starvation of approximately five million people in Kenya mainly small scale farmers (Ngecu *et al.,* 1999). A recent study on the effects of climate variability and change on the food security in Yatta District in Kenya, affirmed the severe and adverse effects in terms of access, availability and sufficiency of food among small scale farmers (Mburu *et al.,* 2014). The interactions of several factors such as temporal and spatial variability of climate, change in seasonal patterns, degraded soil and uncertain future climate scenario will likely pose further drop in production and consequently lead to enhanced food insecurity, retardation in economic growth and increased poverty among close to 80% of small scale farmers who depend on agriculture for their livelihood in Kenya (Thornton *et al.,* 2009). Efforts towards addressing climate change effects in agriculture and particularly among small scale farmers, have often sought to enhance innovation and improve their access to technologies and practices (Howden *et al.,* 2007), and as such there have been efforts towards best practices for adapting to the effects of climate change and variability (Beddington *et al.,* 2011). In this regard, climate smart practices have been highly touted and recommended(FAO, 2010; FAO, 2013; FAO, 2015). Most of these practices are not new but are met with limited adoption by smallholder farmers world over, in Africa, and in Kenya (FAO, 2010; FAO, 2013; Fanen *et al.,* 2014; Ogada *et al.,* 2014).

Key factor that has been argued to influence adoption of agricultural practices is perception of the problem and characteristics of the practices (Adesina and Zinnah, 1993; Prager and Posthumus,2010). The adopter perception paradigm posits that the adoption process starts with the adopter's perception of the problem and technology proposed (Adesina and Zinnah, 1993). Prager and Posthumus, (2010) indicated that perceptions of adopters significantly influence adoption decisions. Smithers and Smit, (2009) also contends that environmental perceptions are key elements influencing adoption of adaptation strategies. Weber, (2010) further affirmed that decisions and actions with regard to development and adoption of adaptation strategies are informed to a great extent by perception of the climate risks. Wossink and Boonsaeng, (2003) similarly, observed that farmers perception was crucial for successful design of relevant development strategies because it sheds light on their needs and aspirations. This argument has been confirmed by several findings (Nyanga *et al.,* 2011; Kalungu *et al.,* 2013) Study by Nyanga *et al.*(2011) among small scale farmers in Zambia that examined the relationship between perception of climate change and conservation agriculture as an adaptation strategy, established that most small scale farmers attributed climate change to supernatural forces and did not consider conservation agriculture as an adaptation strategy. While a similar study by Kalungu *et al.,* 2013 in Kenya in the semi-arid areas indicated a positive and significant link between perception of climate change and adaptation strategies.Several other studies (Deressa *et al.,* 2009; Dulal *et al.,* 2010) have also shown the crucial role perception of climate change characteristics such as precipitation, temperature and increased incidence of extreme events has played towards small scale farmers' adoption of adaptation strategies. In spite of the critical role perception plays in development and adoption of innovations, information on small scale farmer's perception of climate change risks and its influence on the adoption of climate smart practices remain scanty in the study area. Kalungu *et al*., (2013) contends that not much is known about rural farming house holds perceptions of the impacts of climate change on agricultural practices. It has also been noted that perceptions are context and location specific due to heterogeneity in factors that influence them such as culture, education, gender, age, resource endowments and institutional factors (Posthumus, Gardebroek, & Ruerd, 2010). The objective of the study was therefore to examine perception of climate change effects on farming and its influence on adoption of climate smart practices among small scale farmers of Kisii County.

MATERIALS AND METHODS

Study Area

The study area was the former Kisii central district, currently divided into 3 sub counties namely Kitutu Chache North (Marani, Kegogi, Ngenyi), Kitutu Chache south (Nyakoe, Kitutu chache and Kisii municipality) and Nyaribari Chache (Nyaribari Kiogoro, Nyaribari keumbu and Nyaribari central) (Figure 1). The area is further divided into 15 wards covering a total area of 361km^2 , with a population of 336,149 persons and average farm size of 0.5ha (GoK, 2009). The study area has a hilly topography and is endowed with several permanent rivers flowing from East to West into Lake Victoria. Soils are 75% red volcanic (nitosols) and therefore generally good and fertile allowing for agricultural activities. While the remaining area is comprised of clay, red loams, sandy soils, black cotton soils (verisols) and organic peat soils (phanosols) (Jaetzold *et al.,* 2009). Natural vegetation is very partial with 90% of the total area under cultivation (Ogechi and Hunja, 2014). This area is characterized by three agro ecological zones; Lower Highland Zone (LHI) (Keumbu and Kilgore), Upper Midland Zone (UMI) (Kiogoro and Marani) and Lower Midland Zone (LMI) (Nyakoe and Township) (Jaetzold *et al.,* 2009).The region has a highland equatorial climate resulting into two rainy seasons. The long rains occur between February and June, while short rains are experienced between September and early December in all areas. The area receives an average annual rainfall of 1500mm. Dry spell is generally experienced in January and July**.**The maximum temperatures in the area usually range between 21°C–30°C, while the minimum temperatures range between 15°C–20°C (Jaetzold *et al.,* 2009). Agriculture, though practiced on small scale, plays a crucial role in socio economic development of the area. It supports livelihood for majority of the rural dwellers and is a source of employment for a workforce of over 80% and raw materials for agro-based industries. In spite of the critical role agriculture plays, high population density coupled with high demand for food has exerted a lot of pressure on land resources. This has subsequently led to declining farm sizes and continuous cultivation without fallow periods resulting into deterioration of soil fertility and depression of productivity. While acknowledging land degradation, study by Ogechi and Hunja (2014) on land use/cover changes and main drivers of agricultural land degradation in Keumbu (Nyaribari Chache Sub County), revealed expansion of cropland, human settlement with consequent reduction in forest and grassland, exacerbation of soil erosion, decline in crop yield and upsurge in food insecurity. The declining productivity has been further aggravated by unpredictable weather changes attributed to climate change. In spite of the challenges the area is considered suitable for growing of crops like tea, coffee, maize, beans, bananas, fish farming and livestock rearing.

The area was selected for the study because of the dwindling performance of crops as a result of poor agronomic practices, unpredictable weather changes, and low soil fertility due to over use of same land parcels over a long time.

Data collection

The research adopted a survey research design, where both quantitative and qualitative research strategies were used. This research design facilitated triangulation and dovetailing of the findings and helped to offset the weaknesses of either qualitative or quantitative approach (Bryman, 2008). The study population included the entire population of Kitutu and Nyaribari Chache sub counties in Kisii County, and key informants were mainly managers and technical officers from relevant public and private institutions. Both probability and non-probability sampling techniques (simple random and purposive sampling) were used in this study. Simple random sampling technique was used in determining individuals for administration of questionnaires. Purposive sampling was on the other hand, used in identifying key informants and Focus group discussions participants. The sample size for the study was arrived at by use of Krejcie and Morgan (1970) formula normally used to determine a sample size(s), from a given fixed population (P) in such a way that the sample size was within plus or minus 0.05 of the population proportion with a 95 percent level of confidence. This formula is presented below (Equation 1)

$$S = \frac{X^2NP\,(1 - P)}{d^2\,(N - 1) + X^2P\,(1 - P)}$$

Equation 1: Krejcie and Morgan (1970)

x^2 = table value of Chi-Square for 1 degree of freedom at the desired confidence level (in this case3.84),
N = the population size, in this case 336 149
P = the population proportion (assumed to be 0.5 since this provides the maximum sample size),
d – The degree of accuracy expressed as a proportion (0.05).

The formula gives 384 as the sample size for the study. The study adopted a sample size of 420 participants who were randomly selected from each of the 15 wards of Kitutu and Nyaribari Chache sub counties in Kisii County from the list of farmers provided by extension officers of agriculture, livestock and fisheries. Data was collected using questionnaires, focus group discussions, key informant interviews, observations and desk reviews, however before the actual data collection, pretesting of tools to determine their reliability and validity using a selected sample of 30 farmers and technical officers of agriculture was conducted in June, 2015. The actual data collection was conducted between June and December, 2015. Both primary and secondary data was collected based on the objectives of the study. The questionnaires were administered to 420 farmers selected randomly for the study.Likewise 4 Focus group discussions (FGDs) were undertaken, 2 with service providers and another 2 with farmers. These discussions, involved small groups of 8 to 10 people guided by skilled moderator.While key informant interviews, were conducted with a broad array of actors (30) drawn from public and private agencies with specific mandate in Agriculture and climate change.

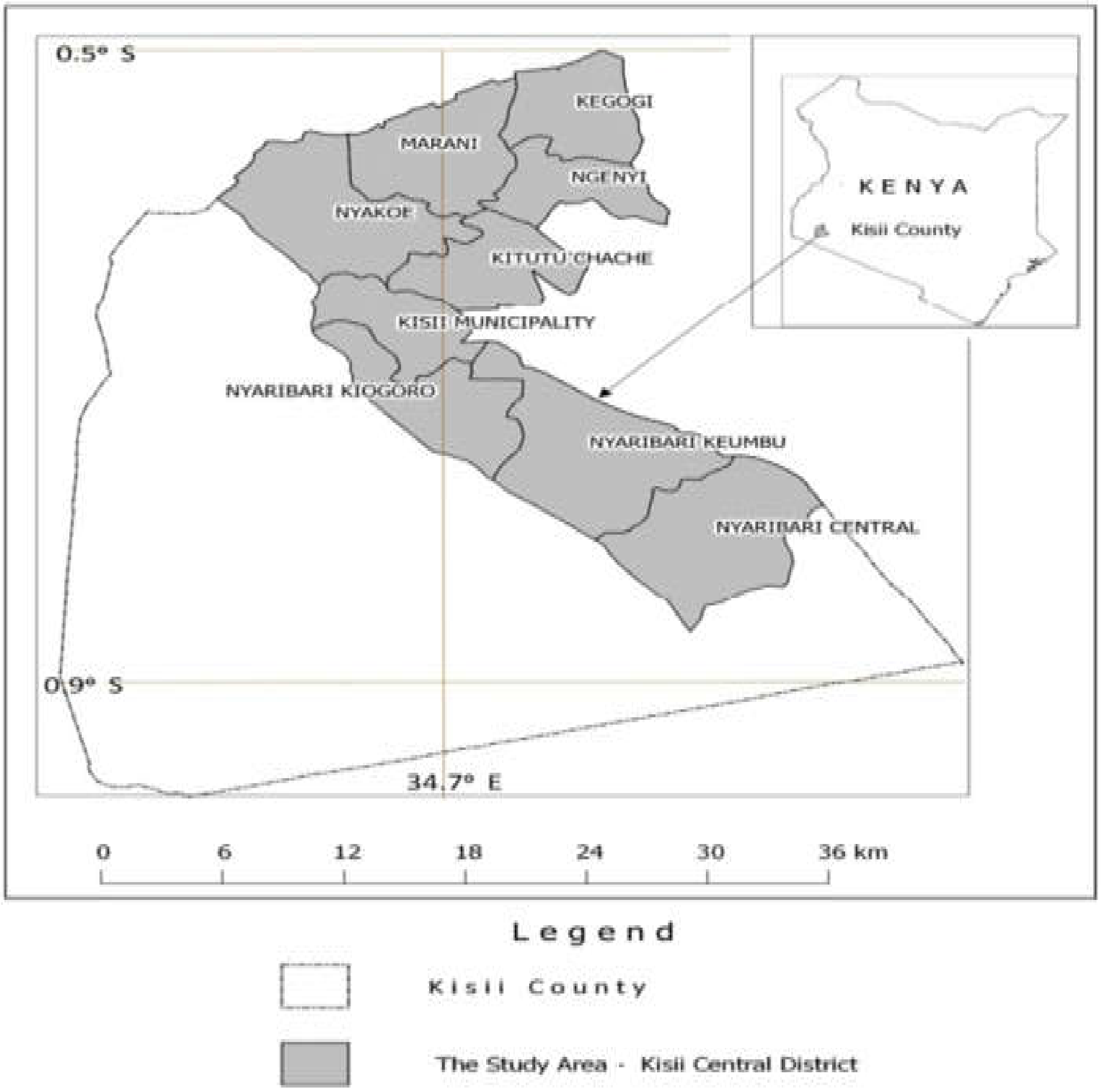

Figure 1. Map of the study area

Observations were made to confirm and gain a clear picture of climate smart technologies practiced in the study area in response to climate change. While desk reviews were made concerning production statistics and climate data.

Data Analysis

Data was analysed by use of both qualitative and quantitative approaches. The quantitative data mainly questionnaire items were coded analysed using SPSS version 16. While qualitative data from key informant interviews, FGD notes and desk review of policies was analysed by establishing the categories and themes, relationships/patterns and conclusions in line with the study objectives (Gray, 2004). To test the statistical significance of the findings of this study and establish relationship between independent (perception of climate change effects) and dependent variable (adoption of climate smart practices), chi-square ($\times^2$) statistical test was used. This is because it allows the establishment of confidence that there is a relationship between two variables in the population. ($\times^2$) value can only be interpreted in relation to its associated level of statistical significance, which in this case was $p < 0.05$ (Bryman, 2008).

RESULTS AND DISCUSSION

Perceived and observed Climate Change

Almost all respondents (97.4%, n=409) were in agreement that climate change was a reality. Similarly, majority (63.1%, n=265) felt strongly that climate change was evident in the study area (Table 1). These findings showed that farmers from, what are perceived as high rainfall and potential areas were equally affected and aware of climate change phenomenon. Similarly, majority indicated increase in temperature (48%), change in rainfall patterns (24.3%) and increase in rainfall 17.4%) as the main climate change variables that had been observed for the last 30 years (Table 2). Other observed changes included decrease in rainfall (5.7%), temperature (1.2%) and increase in wind (0.5%) (Table 1).These results showed clearly that the main climate attributes that had changed in this area were temperature, rainfall and rainfall patterns. These findings were in agreement with several studies that had shown increasing awareness of farmers with regard to climate variability and change in Kenya and other parts of East and Central Africa in both drier and humid areas (Oremo, 2013; Legesse *et al.,* 2012; Mburu, 2013; Kalungu *et al*., 2013; Nyanga *et al.,* 2011).

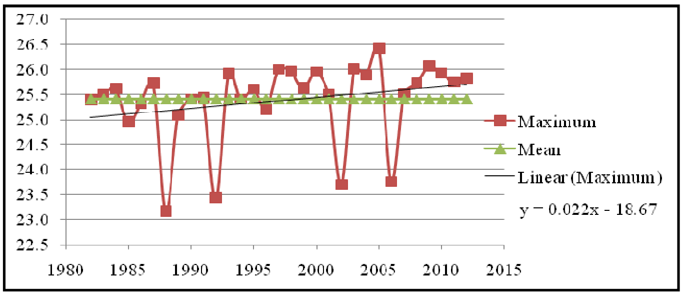

Figure 2. Kisii Average Annual Temperature

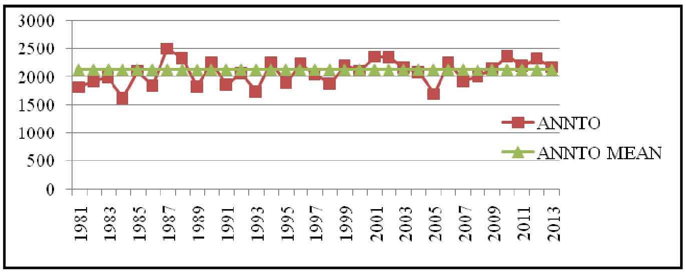

Figure 3. Annual total mean rainfall for Kisii County

Table 1. Perceived and observed Climate Change in Kitutu and Nyaribari Chache of Kisii County

Perceived Climate change	F	%
Strongly agree	265	63.1
Agree	144	34.3
I don't know	11	2.7
Observed Climate Change		
Increase in temperature	202	48.1
Decrease in temperature	5	1.2
Increased wind	2	.5
Increase in rainfall	73	17.4
Decrease in rainfall	24	5.7
Change in rainfall patterns	102	24.3
No Observation	12	2.9

An interview with key informants, particularly service providers in the agriculture sector affirmed growing realization of climate change among the farmers. In spite of the emerging appreciation of climate change concern, there were still other farmers, who still held the belief that the area was humid with adequate rainfall from both long and short rain seasons (FGDs). There is therefore need for further sensitization to affirm and deepen grasp of the climate change problem in the study area. Similarly, in spite of the glaring observation, analysis of County Government documents clearly demonstrated that most County Government officials were still oblivious of, and not concerned about climate change (Kisii County Government, 2014). Based on this perspective, there were no clear policy guidelines on climate change adaptation in agriculture. This implies that there is need for enhanced efforts towards creation of awareness on the causes and risks associated with climate change among the policy makers at the County level. Observations were also in agreement and resonated well with predicted changes by IPCC scientists (IPCC, 2007). These findings were also similar to what had been observed in Uasin Gishu County,Kenya Agricultural Research Institute (KARI) Kabete in Kikuyu and KARI Muguga in Limuru, where most of the farmers indicated change in rainfall patterns and increase in temperature (Kalungu *et al.,* 2013; Murgor, 2014). Key informants and Focus group discussion participants, also acknowledged climate change occurrence as evidenced by change in rainfall patterns, rise in temperature to about 32^{0}C from previous 26^{0}C, prolonged dry spells from the usual period of January - February to April, shortening of the long rainfall season from the previous March- July to April-June, change in humidity level and emergence of new pests and diseases. They also indicated increased occurrence of floods, mudslides and change in rainfall in terms of distribution but not in the amounts. An ASDSP survey, similarly found out that most of the households (81%) had noticed changes in terms of poor rainfall distribution, increased drought, degraded soils, drying up of wells and rivers, and incidence of diseases and pests (ASDSP, 2014). The findings were also in agreement with analysis of climatic data from Kenya Meteorological services station in Kisii from 1980 to date which revealed rise in temperature and rainfall (Figure 2 and3)

Perceived and actual effects of Climate Change Attributes on Farming Activities

Farmers cited different effects both in general and with regard to different aspects of climate change such as temperature, rainfall, change in rainfall patterns, droughts and floods. In terms of general effects of climate change, most of the respondents indicated inability to plan their farming activities (81.9%, n=344) and decline in crop yields (11.2%, n= 47) as the main effects of climate change. Other effects of climate change cited included livestock deaths (1.2%); destruction of crops and insufficiency of pastures (1.7%) (Table 2).This showed that farmers were mostly being affected by shift in seasonal and erratic weather patterns, as shown by difficulties in planning farming activities. The findings also implied some element of flooding and drought occurrence in Kitutu and Nyaribari Chache as evidenced by destruction of crops, livestock deaths and insufficiency of pastures though to a small extent (Table 2). This study affirmed the findings in Yatta, Africa and other parts of the world, which showed decline in Agricultural production and enhanced food insecurity as a result of climate change (Mendelsohn *et al.,* 2000a; Boko *et al.,* 2007; Mburu *et al.,* 2014; Oromo, 2013). These findings were corroborated by key informants, who indicated negative effects of climate change such as increased food insecurity, as a result of decline in food production. Other effects mentioned by key informants included increased leaching of nutrients and soil erosion as a result of surface runoff, and emergency of diseases such as Maize Lethal Necrosis Disease (MLND), Mites on Eucalyptus, and Tuta absoluta pest on tomatoes. With regard to effects of increase in temperature on farming, emergence of new strains of pests and diseases (40.7%, n=171), decline in crop yield (24%, n=101) and wilting of crops (5.2%, n=22) were the main effects which were cited. At the same time a significant number (30%, n=126) of respondents showed unawareness with regard to the likely effects of temperature on farming activities (Table 2). These findings were a reflection of the significant impact that shift in average temperature as a result of climate change has caused on food production in the study area. These results are consistent with IPCC report, which suggests that while temperate regions are likely to benefit in terms of crop yield as a result of increase in temperature, the tropical regions and semi-arid areas are likely to experience negative impacts such as decline in crop yield even with moderate temperature of 1-2^{0}C. The report indicates possibility of all regions in the world experiencing negative impacts as a result of further upsurge in temperature by the end of 21st Century (IPCC, 2007).

Table 2. Effects of Climate Change on Farming Activities in Kitutu and Nyaribari Chache, Kisii County

General effects of Climate Change	F	%
Difficulties in Planning Farming Activities	344	81.9
Declining Crop Yields	47	11.2
Destruction of Crops and Livestock deaths	5	1.2
Insufficient Pasture for Livestock	7	1.7
Not aware	17	4
Effects of Temperature Change		
Emergence of new strains of pests and diseases	171	40.7
Decline in crop yield	101	24.0
Wilting of crops	22	5.2
Not Aware	126	30
Effects of Increase in Rainfall and floods		
Exacerbated Soil Erosion	94	22.4
Destruction of Cops as a Result of Flooding	18	4.3
Decline in Crop Yield	26	6.2
Pests and Diseases Outbreak	13	3.1
Poor Quality Pasture as Result of Nutrient Leaching	17	4
Low Production of Milk and Meat	10	2.4
Effects of Erratic Rainfall Patterns		
Decline in Crop Yield	296	70.5
Inability to Pan Farming Activities	100	23.8
Instability in Production	23	5.5
Not Aware	1	.2
Effects of Droughts		
Crop Failure	114	27.1
Livestock Deaths	59	14.0
Not Aware	247	58.8

Table 3. Maize Area, Production and yield trends in Kitutu and Nyaribari Chache in Kisii County

Year	Area	Production (Metric tons)	Yield (tons/ha)
1996	19, 800	75, 232	3.8
1997	14, 545	45, 821	3.2
1998	13, 600	40, 054	2.9
1999	-	-	-
2000	14, 250	44, 986	3.2
2001	15, 400	52, 673	3.4
2002	22, 200	54, 005	2.4
2003	23, 200	67, 956	2.9
2004	23,050	68, 465	3.0
2005	21, 835	52, 565	2.4
2006	23, 700	53, 330	2.3

Source: Crop Annual reports of Kitutu and Nyaribari Chache sub counties from 1996-2006)

In terms of effects of increase in rainfall and floods on farming, results showed that majority (58%, n=242) of the farmers were not aware. The effects, which were known to them as a result of increase in rainfall were soil erosion (22%, n=94) (Table 3), probably due to the fact that the area is hilly and prone to soil erosion. Other effects noted were decline in crop yield (6%, n=26), and destruction of crops as result of flooding (4%, n=18), poor quality pasture as result of nutrient leaching (4%, n=18) and pests and diseases (3%, n=13) (Table 2). Compared to other climate change variables, the impact of irregular rainfall patterns was highly pronounced in the area. Almost all (99.8%, n=419) of the respondents underscored the effects of erratic rainfall patterns on farming. Majority (70.5%, n=296) identified decline in crop yield as the most serious effect, followed by inability to plan farming activities (23.8%, n=100) and instability in production (5.5%, n=23) (Table 2). These results were validated by Huho *et al*. (2012), who affirmed changing rainfall patterns in Laikipia County with overall decline in growing period of crops and yield. Similar results were also obtained by Arukulem *et al.* (2015) at Senetwo Location in West Pokot County, who indicated reduced growing period, erratic planting dates, and overall decline in yield as a result of changing rainfall pattern. This showed the need to provide timely weather information to farmers to help them plan and mitigate the effects of erratic rainfall patterns. With regard to effects of drought, majority (58.8, n=247) of the respondents apparently were unaware of the drought phenomenon in the study area, because it was not a common feature. However, few farmers noted crop failure (27.1%, n=114) as a result of drought (Table 2). This findings indicated that majority of the farmers were unaware of the likely impacts of drought; however, few of them were gaining appreciation of the adverse effects of drought that were emerging under climate change scenario in the area, between the rainfall seasons. These results were supported by a study by Porter and Semenov, (2005) on crop responses to climatic variation, who indicated anticipated increases in production losses under increased frequency and intensity of extreme events.

Maize Area, Production and yield trends in Kitutu and Nyaribari Chache in Kisii

Counts

Production of maize showed decline from 75 232 metric tons in 1996 to 53 330 metric tons in 2006 in spite of increase in production area (Table 3). It should however, be noted that the decline in production was not entirely as a result of climate change, but was also attributed to decline in soil fertility as a result of continuous cultivation and poor farming practices (Key Informants).

Table 4 Farmers Degree of Perception and Concern about Climate Change Effects on Farming in Kitutu and Nyaribari Chache of Kisii Counts

Perceived Effects of Climate Change	F	%
Strongly agree	227	54.0
Agree	182	43.3
I don't know	11	2.7
Concern about climate change effects		
Yes	385	92
No	35	8

Table 5. Response to Climate ChangeamongRespondents of Kitutu and Nyaribari Chache in Kisii County

Response to climate change	F	%
Yes	309	73.6
No	111	26.4
Adaptation measures		
Suitable varieties of crops and livestock	250	59.6
Non-farming activities	6	1.4
Increased water conservation	11	2.6
Varying planting date	38	9
Insuring crops/livestock	3	0.7
Agroforestry	2	0.5
No measure undertaken	110	26.2

Farmers Degree of Perception and Concern about Climate Change effects on Farming

In agreement with the above findings, majority (97.3%, n=409) of farmers agreed that climate change had negatively affected their farming activities (Table 5), and most (92%, n=385) of them were concerned (Table 4). Similarly, majority (54%, n=227) strongly felt climate change had serious implications on farming enterprises (Table 4). Key informants attested to the concerns farmers had with regard to climate change that had been demonstrated by frequent visits of farmers seeking for information on adaptation to the changing conditions. These findings were in agreement with a study by Arbuckle *et al.* (2013) among Iowa farmers in the United States of America, who showed concern about climate change effects and pursuit of adaptation strategies to climate change. The high concern about climate change effects among farmers in the study area, pointed to their serious need for adaptation.

Adaptation to Climate Change effects

Most (74%, n=311) of the respondents acknowledged efforts towards mitigation of climate change effects (Table 5). This revealed considerable emphasis on adaptation to climate change effects in the study area among the majority farmers. However, majority (59.6%, n=250) could only indicate adaptation to climate change through adoption of appropriate crop and livestock varieties. Very few farmers thought of diversification to other non-farming activities (1.4%), increased water conservation (3%), varying planting date (9%), insuring of crops and livestock (1%) as adaptation measures to climate change (Table 5). These results showed farmers high consideration of planting and rearing suitable varieties as key measure of adaptation to climate change, however, they demonstrated limited understanding of many other adaptation options such as agroforestry, insurance, water conservation etc. The results were also in congruence with several studies (Deressa *et al.,* 2009; Legesse *et al.* 2012) in Ethiopia, which showed adoption of suitable varieties as one of the key response strategies to climate change effects. This is also in agreement with IPCC (2007) which considers adoption of appropriate varieties of crops and livestock as a key element in combating the threat of climate change to food security. Key informant interviews with technical officers of Agriculture, also affirmed shift towards climate smart practices such as greenhouse and water harvesting technologies in response to perceived climate change among farmers.

Relationship between Change in Rainfall Patterns and Adoption of Climate Smart

Practices

Based on the Chi square tests results, change in rainfall patterns had strong influence on adoption of all climate smart practices(Improved fallowingx^2=21.572, df= 6, p=0.001, Agroforestry$\boldsymbol{x}^{\mathbf{2}}$=20.905, df=6,p=0.02,Crop rotation x^2=17.924, df= 3, p=0.00,Rainwater harvesting $\boldsymbol{x}^{\mathbf{2}}$=10.441, df=3, p=0.015,Planting cover crops x^2=10.279, df=3, p=0.016, Mulchingx^2 =11.873,df=3, p=0.008, Farm yard composting x^2 =13.742, df=3, p=0.003, Hay making x^2=23.110, df=3, p=0.00,Pasture management x^2=11.162, df=3, p=0.011,Organic manure x^2=11.433, df=3, p=0.010, Agro weather advisories x^2=10.507, df=3, p=0.015, Index based agricultural insurance x^2=11.981, df=3, p=0.007.These findings were in agreement with several other studies (Oloo, 2013; Mburu *et al.,* 2015; Bryan *et al.,*2011; Stefanovic, 2015) in both humid and semi-arid areas of Bungoma, Yatta, Garissa, Mberee, Njoro, Othaya, Siaya and Laikipia in Kenya, which showed adoption of diverse climate smart practices in response to climate change effects among farmers. According to Oloo (2013) farmers were adapting to climate change by adopting mulching and soil fertility improvement strategies in Bungoma. In Yatta a study by Mburu *et al*. (2015) showed farmers embraced drought tolerant crops, charcoal burning and rainwater harvesting. While a study by Bryan *et al*. (2011) indicated change in crop varieties, change of planting dates, planting of trees, decrease in number of livestock and soil and water conservation in response to climate change effects in Garissa, Mbere, Njoro, Othaya, Gem and Siaya.

Summary of findings, Conclusions and Recommendations

These findings established growing appreciation of climate change problem among the farmers. The appreciation was based on the observed increase in temperature, change in rainfall patterns, emergence of new strains of pests and diseases and increase in rainfall over3 decades. This perception was in tandem with the observed changes by weather experts and crop production statistics. The study also noted high concern among small scale farmers as a result of the negative effects of climate change such as difficulties in planning their farming activities, decline in crop yield, wilting of crops and failure, instability in production and exacerbated soil erosion. In spite of the emerging appreciation of climate change concern, there were still other farmers, who still held the belief that the area was humid with adequate rainfall from both long and short rain seasons (FGDs). Similarly, county Government officials appeared casual about climate change, as reflected in lack of clear policy guidelines on climate change adaptation in agriculture. The findings also demonstrated considerable efforts towards adaptation to climate change effects in the study area among the majority farmers.However, adoption was limited to uptake of suitable varieties due to lack of knowledge with regard to other climate smart practices. The corresponding adoption efforts to perceived climate change were corroborated by chi square tests results, which revealed significant relationship between perception of climate change risks and adoption of several climate smart practices.The study concluded that farmers from, what are perceived as high rainfall and potential areas were equally affected, aware of climate change phenomenon, highly concerned and striving towards resilience to climate change but were constrained by lack of knowledge of climate smart practices. In line with these findings, the study recommends the need for enhanced knowledge among small scale farmers with regard to climate change effects and climate smart practices.

REFERENCES

Adesina, A., and Zinnah, M. 1993. Technology characteristics, farmers perceptions and adoption decisions: A Tobit model application in Sierra Leone, Agricultural Economics. *Agricultural Economics,* 9 (4), 297-311.

Arbuckle, Jr, J. G., Morton, L.W., and Hobbs, J. 2013. Farmer Beliefs and Concerns about Climate Change and Attitude toward Adaptation and Mitigation: Evidence from Iowa. *Climate change,* 118 (3), 551-563.

Arukulem, E.Y., Makindi, M.S., and Obwoyere, G.O. 2015. Climate Variability and the Associated Impacts on Smallholder Agriculture in Senetwo Location, Kenya. *International Journal of Science and Research(IJSR),*4(8), 845-850.

ASDSP, 2014. *Household Baseline Survey.* Nairobi: Agriculture Sector Development Support programme.

Beddington, J., Asaduzzaman, M., Fernandez, A., Marrion G., Erda, L., *et al.* 2011. *Achieving Food Security in the Face of Climate Change:Summary for Policy Makers from The Commission on Sustainable Agriculture and Climate Change.* copenhagen, Denmark: CGIAR Research program on Climate Change, Agriculture and Food Security.

Boko, M., I. Niang, A. Nyong, Vogel, C., A.Githeko, M. Medany, *et al.* 2007. Africa. Climate Change 2007:Impacts, Adaptation and Vulnerability. In M. Parry, J. P. O.F. Canziani, P. v. Linden, and C. Hanson (Ed.), *.Contribution of Working Group 11 to the Fourth Assesment Report of the Intergovernmental Panel on Climate Change* (pp. 433-467. Cambridge.UK: Cambridge University Press.

Bryan, E., Ringler, C., Okoba, B., Roncoli, C., Silvestri, Silvia.and Herrero, M. 2011. *Adapting Agriculture to Climate Change in Kenya:Household and Community Strategies and Determinants*. Presented at George Washington University,Washington, D.C., 19 May 2011.

Bryman, A. 2008. *Social research methods* (3rd ed.. New York: Oxford University Press Inc.

Burton (Ed.), *Adaptation to Climate Change* (pp. 15-33. London: Earthscan.

Christensen, J., Hewitson, B., Busuicoc, A., Chen, A., Gao, X., Held, I., *et al.* 2007. Regional Climate Projections. In S. Q. Solomon (Ed.), *Climate Change 2007:The physical Science Basis.Contribution of the working group I to the Fourth Assesment Report of the Intergovernmental Panel on Climate Change.* Cambridge, UK: Cambridge University Press.

Collier, P., Conway, G., and Venables, T. 2008. Climate Change in Africa. *Review of Economic Policy,* 2(19), 337-353.

Deressa, D., Hassan, R., Ringler, C., Alemu, T., and Yesuf, M. 2009. Determinants of Farmers Choice of Adaptation Methods to Climate Change in the Nile Basin of Ethiopia. *Global Environmental Change,* 2(19), 248-255.

Dulal, H., Brodnig, J., Onoriose, C., and Thakur, H. 2010. Capitalising on Assets; Vulnerability and Adaptation to Climate Change in Nepal.*World Bank Social Development Papers No*, *121.*

Fanen, T. 2014. Assesing the role of Climate Smart Agriculture in combating Climate Change, desertification and improving rural livelihood in Northern Nigeria . *African Journal of Agricultural Research, 9*(15), 1180-1191.

FAO, 2010. *Climate Smart Agriculture Policies, Practices and Financing for Food Security, Adaptation and Mitigation.* United Nations. Rome Italy: Food and Agriculture Organisation.

FAO, 2013. *Climate Smart Agriculture Source Book.* United Nations . Rome, Italy: Food and Agriculture Organisation.

FAO, 2015. *Barriers, Incentives and Benefits in the adoption of Climate Smart Agriculture: Enhancing Agricultural Mitigation Within East Africa Dairy Development project(EADD) in Kenya.* Rome: FAO.

Fischer, G., Shah, M., Tubiello, F., and Van Velhuizen, H. 2005. Socio-economic and Climate Change Impacts on Agriculture:An Intergrated Assesment,1990-2080. *Philosophical Transaction Son Royal Society*, 360 (1463), 2067-2083.

Funk, C., Dettinger, M., Mitchaelsen, J., Brown, M., Barlow, M., and Hoell, A. 2008. Warming of the Indian Ocean threatens Easten and Southern African Food Security but could be mitigated by Agricultural Development. *PNAS*(105), 11081-11088.

Go, K. 2009. *Kisii Central District Development Plan.* Nairobi: Government Printer.

Gray, D. 2004. *Doing Research in the Real World, London.* Oxford: Sage Publications.

Howden, S., OIS Soussana, J., Tubiello, F., Chhetri, N., Dunlop, M., and Meinke, H. 2007. *Adapting Agriculture to climate change*. Retrieved July 9, 2014, from http://www.pnas.org/content/104/50/19691.full.pdf+html.xii

Huho, J.M., Ngaira, J.K.W., Ogindo, O. H., and Masayi, N. 2012. The Changing Rainfall Pattern and the Associated Impacts on Subsistence Agriculture in Laikipia East District, Kenya. *Journal of Geography and Regional Planning*, 5(7),198-206.

Hulme, M., Doherty, R., Ngara, T., New, M., and D., L. 2001. African Climate Change:1900-2100. *Climate Research, 2*(17), 145-168.

IFPRI, 2004. *Ending hunger in Africa: Prospects for the small scale farmer.* International Food Policy Research Institute, Washington DC.

IPCC, 2007. Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University press.

IPCC, 2007. *The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge, UK: Cambridge University press.

IPCC, 2012. Managing the Risks of Extreme Events and Disasters to advance Climate Change Adaptation. A special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. In C. Field, T. Barros, D. Stocker, D. Qin, K. Dokken, M. Ebi, et al. Ed.. Cambridge, UK and New York, NY, U.S.A: Cambridge University Press.

Jaetzold, R., Schmidt, H.,Hornetz, B.,Shisanya,C.(2009) *Natural Conditions and Farm Management Information(2nd ed.).*Farm Management Handbook of Kenya (Part A: West Kenya. Subpart A2: Nyanza Province. Nairobi. Ministry of Agriculture in Kenya, in cooperation with Germany Agency for Technical Cooperation(GTZ).

K.C.G. 2014. *Kisii County Integrated Development Plan.* Kisii: Kisii County Government.

Kalungu, J. W., R, F. W., and David, H. 2013. Small Holder Farmer Perception of the Impacts of Climate Change and Variability on Rainfed Agricultural Practices in Semi-Arid and Sub-humid Regions of Kenya. *Journal of Environment and Earth Science, 3*(7), 129-141.

Krejcie, R., and Morgan, D. 1970. Determining Sample Size for Research Activities. *Educational and Psychological Measurement, 3*(30), 607-610.

Legesse, B., Ayele, Y., andBewket, W. 2012. Smallholder Farmers' Perceptions and Adaptation to Climate Variability and Climate Change in *Doba District*, West Hararghe, Ethiopia.*Asian Journal of Empirical Research,* 3(3), 251-265.

Mburu, B., Muriuki, J., and Kungu, J. 2014. Effects of Climate variability and Change on Household Food Sufficiency among Small Scale Farmers of Yatta District, Kenya. *Journal of Environment*, 3(2), 19-27.

Mburu, K. 2013. *Effects of Climate Variability and Change on Dry land Agriculture and the adaptation strategies by small scale farmers in Yata District.* Kenyatta University.

Mendelsohn, R., A.Dinar, and A.Dalfelt. 2000b. *Climate Change impacts on African Agriculture. Preliminary Analysis prepared for the World Bank.* Washington, District of Columbia.

Mendelsohn, R., W.Morrison, M.E.Schlesinger, and N.G.Androva. 2000a. Country- Specific Market Impacts from Climate Change. *Climatic Change,* 45(3-4), 553-569.

Murgor, D. 2014. *Farmers Access to Climate and Weather Information and its Impact on Maize and Wheat Production in Uasin Gishu County, Kenya.* Eldoret: University of Eldoret.

Ngecu, W., and Mathu, E. M. 1999. The El Nino Triggered Landslides and Their Socio-economic Impacts on Kenya. *Episodes, 22*(4), 284-288.

Nyanga, P. H., Johnsen, F. H., Anne, J. B., and Kalinda, T. H. 2011. Smallholder Farmers Perceptions of Climate Change and Conservation Agriculture: Evidence from Zambia. *Journal of Sustainable Development, 4*(4), 73-85.

Ogada, M., Mwambu, G., and Muchai, D. 2014. Farm Technology Adoption in Kenya: a Simultaneous Estimation of Inorganic Fertiliser and Improved Variety Adoption Decisions. *Agricultural and Food Economics*, 2 (1), 1-18.

Ogechi, B., and Hunja, W. 2014. Land Use / Land Cover Changes and Implications For Food Production: A Case Study of Keumbu Region Kisii County, Kenya. *International Journal of Science and Research,* 3(10), 752-758.

Oloo, I.G. 2013).Evaluation of Climate Change Adaptation strategies and their effect on Food Production among Smallholder farmers in Bungoma County, Kenya. Master's Thesis. Egerton University.

Oremo, F.O. 2013. Small-Scale Farmers' Perceptions and Adaptation Measures to Climate Change in Kitui County, Kenya. Master Thesis. Nairobi University.

Osbahr, H., and Viner, D. 2006. *Linking Climate Change Adaptation and Disaster Risk Management for Sustainable Poverty Reduction. Kenya Country Study. A study carried out for the Vulnerability and Adaptation Resource Group (VARG) with support from the European Commission.*

Porter, J. R., and Semenov, M. A. 2005. Crop Responses to Climatic Variation. *Philosophical Transactions of the Royal Society B-Biological Sciences, 360* (1463), 2021–2035.

Posthumus, H., Gardebroek, C., and Ruerd, R. 2010. From Participation to Adoption: Comparing the Effectiveness of Soil Conservation Programs in the Peruvian Andes. *Land Economics, 4*(86), 645-667.

Prager, K., and Posthumus, H. 2010. Socio-Economic Factors Influencing Farmers' Adoption of Soil Conservation Practices in Europe. In T. L. Napier (Ed.), *Human Dimensions of Soil and Water Conservation* (pp. 203-223. Europe: Nova science publishers.

Schlenker, W., and Lobell, D. 2010. Robust Negative Impacts of Climate Change on African Agriculture. *Environmental Research Letters,* 5(1)*,*1-8

Sivakumar, M., Das, H., and Brunini, O. 2005. Impacts of Present and Future Climate Variability and Change on Agriculture and Forestry in the Arid and Semi-arid Tropics. *Climatic Change,* 70(1-2), 31–72.

Smithers, J., and Smit, B. 2009. Human Adaptation to Climatic Variability and Change. In L. E. Schipper, and I.Burton (Ed.), Adaptation to Climate Change, London: Earthscan.15-33

Stefanovic, J.(2015).Smallholder Farming Systems in Kenya:Climate Change Perception, Adaptation and Determinants. Master Thesis.Swiss Federal Institute of Aquatic Science and Technology (EAWAG).

Thornton, P. K., Jones, P. G., Alagarswamy, G., and Andresen, J. 2009. Spatial Variation of Crop Yield Response to Climate Change in East Africa. *Global Environmental Change,* 19(1), 54–65.

UNEP/GOK. 2000. *Devastating Drought in Kenya. Environmental Impacts and Responses.* UNEP/GOK. Nairobi, Kenya: United Nations Environment Programme and Government of Kenya.

Weber, E. U. 2010. What shapes perceptions of climate change? *Wiley Interdisciplinary Reviews: Climate Change,* 1(3), 332-342.

Wossink, A., and Boonsaeng, T. 2003. *Farmers' Knowledge and Perceptions of Animal Waste Management Technologies: An Explorative Study for North Carolina.* North Carolina: ARE Report.

WRI, 2007. *Nature's Benefits in Kenya, An Atlas of Ecosystems and Human Well-Being.* World Resources Institute, WRI Department of Resource Surveys and Remote Sensing, Washington, DC, USA; Ministry of Environment and Natural Resources, Nairobi, Kenya.

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