

*Full Length Research Paper*

# Small scale farmers' perception of institutions and information channels on climate change and adaptation, Embu County, Kenya

Ruth Kangai<sup>1\*</sup>, Wemali Evelyn Chitechi<sup>1</sup>, James Koske<sup>1</sup>, Boaz Waswa<sup>2</sup> and Innocent Ngare<sup>1</sup>

<sup>1</sup>Department of Environmental Science and Education, School of Environmental Studies, Kenyatta University, Nairobi, Kenya.

<sup>2</sup>The International Center for Tropical Agriculture, Kenya.

Received 25 August, 2020; Accepted 15 January, 2021

**This study assessed the small scale farmers' perception of institutions and information channels on climate change and adaptation in Embu County, Kenya. A survey was conducted on 411 households and 25 key informants on their perception of institutions and information channels towards climate change and adaptation where stratified random and purposive sampling was done respectively. The data were subjected to descriptive statistics, chi-square, linear regression, and Likert scale analysis. The results showed that formal institutions are more likely to influence small scale farmers' ability to perceive climate variability risks and opt for adaptation mechanisms. Out of twelve information channels identified by the farmers, only five are more likely to influence climate variability adaptation mechanisms. While life-experience was the only channel significant to perception on climate variability impacts on agriculture. On the access and utilization of climate-related information, small-scale farmers are in a position to implement although many barriers were cited. The results indicate the need for the farmers, agricultural, and climate-related institutions to work closely to enable co-learning to raise awareness and to help disseminate agricultural-related information.**

**Key words:** Institutions, information channels, climate change, adaptation, perception.

## INTRODUCTION

Climate change adversely impacts all aspects of agriculture such as supply, production, access to food, and prices which results in global food insecurity (Tai et al., 2014). Sub-Saharan African regions are vulnerable to climate change with its highest impacts on the rural population that depend on rain-fed agriculture (Diao et al., 2010). Kenyan economy relies on the agriculture sector where 24% directly and 27% indirectly is channeled into the national Gross Domestic Product (GDP) and also a means of livelihood for the majority of its citizens

(Mutune, 2017). This sector is susceptible to a rise in temperature and unreliable amounts of rainfall which leads to low and declined crop productivity (Kabubo-Mariara, 2015). It is therefore paramount for farmers to adapt to the changing climatic conditions to reduce the adverse impacts on productivity (Herrero et al., 2010).

Factors that hinder adaptation to the changing climatic conditions have been documented and institutional barriers have occupied a central position as a cause for ineffective adaptation (Islam and Nurse-Bray, 2017). This

\*Corresponding author. E-mail: [aymanhassan09@yahoo.com](mailto:aymanhassan09@yahoo.com).

is because of the slow pace of transformational adaptation in multiple groups, large scale management, and by sectors that deal with climate-related information (Raymond and Robinson, 2013). Therefore an approach to encourage communication that leads to adaptation from institutions to farmers at the farm level is necessary (Adger, 2009). Furthermore, the capacity to adapt depends on the way institutions structure and regulates their interactions with the farmers (Agrawal, 2008). According to Thi Hong Phuong et al. (2017) institutional failure to address climatic change worsens vulnerability. As observed by Gartner (2015) institutions play the role of providing and distributing water to farmers for irrigation purposes. Furthermore, local institutions have been associated with capacity building and provision of funds to members to ensure resilience to harmful climatic conditions (Tari et al., 2015). Raymond and Robinson (2013) argues that local institutions spearhead environmental initiatives that enable adaptation to climate change. Local institutions are used as channels for information on climate change and marketing by both crop and livestock farmers (Nyong et al., 2007). However, the practicality of climate forecast from institutions to farm level is determined by the type of information channels available to the farmers (Oyekale, 2015). Studies show that for disseminated information to attain desired purposes there must be a corporation among end-users, the institutions, and communication channels (Oyekale, 2015).

Institutions refer to developments of behavior and norms that organize individuals in all forms of structural interactions in a society (Ostrom, 2008). According to Adger (2009), institutions are collective actions that involve groups of individuals, organizations, and governments on behalf of communities. As observed by Raymond and Robinson (2013) there are two types of institutions; formal and informal institutions. The formal institutions are groups that follow guidelines and procedures laid down by courts, bureaucracies, and legislatures whereas informal institutions are a community of practice that involves informal structures brought about by social knowledge and constructions. These informal structures occur when individuals share common interests, roles, opportunities, and goals in a given space (Mearns and Norton, 2010). According to Agrawal (2008) farmers in common social networks learn new adaptation technologies and easily disseminate agricultural developments and research. This study was conducted to assess the small scale farmers' perception of institutions and information channels concerning climate change and adaptation mechanisms applied to their farms.

## METHODOLOGY

### Study area

Embu County is within the foot of the eastern slopes of Mount

Kenya (5199 m) in Kenyan Highlands. The altitude range between 1080 m to over 4700 m above the sea with an area of 2,818 km<sup>2</sup> and latitude of 0° 8' and 0° 50' South and longitude 37° 3' and 37° 9' East (Embu County Government Integrated Development Plan, 2013). The County has five sub-counties namely Embu North, Embu West, Embu East, Mbeere North, and Mbeere South (Figure 1). As observed by Ayuke et al. (2009) the total rainfall range between 1200 to 1500mm in two seasons with long rains in March to June and short rains from October to December. The minimum temperatures of about 12°C are experienced in July while a maximum of 30°C in March and in September with 21°C as the mean. The County has a total population of 513,363 where 70.1% are supported by agriculture and 87.9% are directly employed within the 59.06% of the arable land (Embu County Government Integrated Development Plan, 2013). This arable land is for both crops and livestock production. The major crops planted in the region include maize, beans, sorghum, millet, sweet potatoes, cotton, coffee, and tea. The livestock includes cattle, sheep goats, poultry, and pigs. The majority of the farmers practice farming on a small-scale with an average land size of 1.4 acres.

### Data collection

A study was done in the County to help enhance an understanding of small scale farmers' perception of both formal and informal institutions towards climate change and adaptation. The sample size for the study was calculated by the use of a formula by Yamane (1967). The formula helps to determine the sample size (n), from a given finite population (N) with  $\pm 0.05$  level of precision and confidence level of 95%. As a result, 399 simple size was obtained, however, 411 participants were considered to account for absentee and non-responses. A semi-structured questionnaire was administered to the respondents between March and April 2018. The five sub-counties were used as strata and divisions as sub-strata through stratified random sampling and proportional sample sizes for each division were acquired. The questionnaires captured data on demographic, socio-economic characteristics, agricultural practices, and perception of institutions towards climate change and adaptation options. Local field enumerators with undergraduate education level were trained on how to administer the questionnaires and a pilot study was done before the start of the interviews. This was to reduce biases and errors in data collection. Focus Group Discussions (FGDs) were selected by the use of quota sampling procedure where gender and age cohorts were considered. Every sub-county generated one group which comprised of 8-12 smallholder farmers. Key informant interviews were conducted on 25 personnel within the government, development partners, faith-based organizations, and Non-Governmental organizations to get more information on institutions concerning climate change and adaptation. Rainfall and temperature data relevant to this study were obtained from the Kenya Meteorological Department (KMD).

### Data management and analysis

The data collected in the questionnaires were subjected to descriptive statistics by use of Ms-excel. Whereas IBM SPSS statistics 23 was used to generate Chi-square to test the degree of relationship in variables and linear regression for marginal effects. Likert scale analysis was subjected to household data to generate the attitudes and opinions of small-scale farmers on institutions about climate change and adaptation. The ranking scale was done of the institutions and information channels used in the study area. Data from FGDs and Key informant interviews were summarized according to themes and relationships and conclusions drawn in line with the study objectives (Elmusharaf, 2012). This information

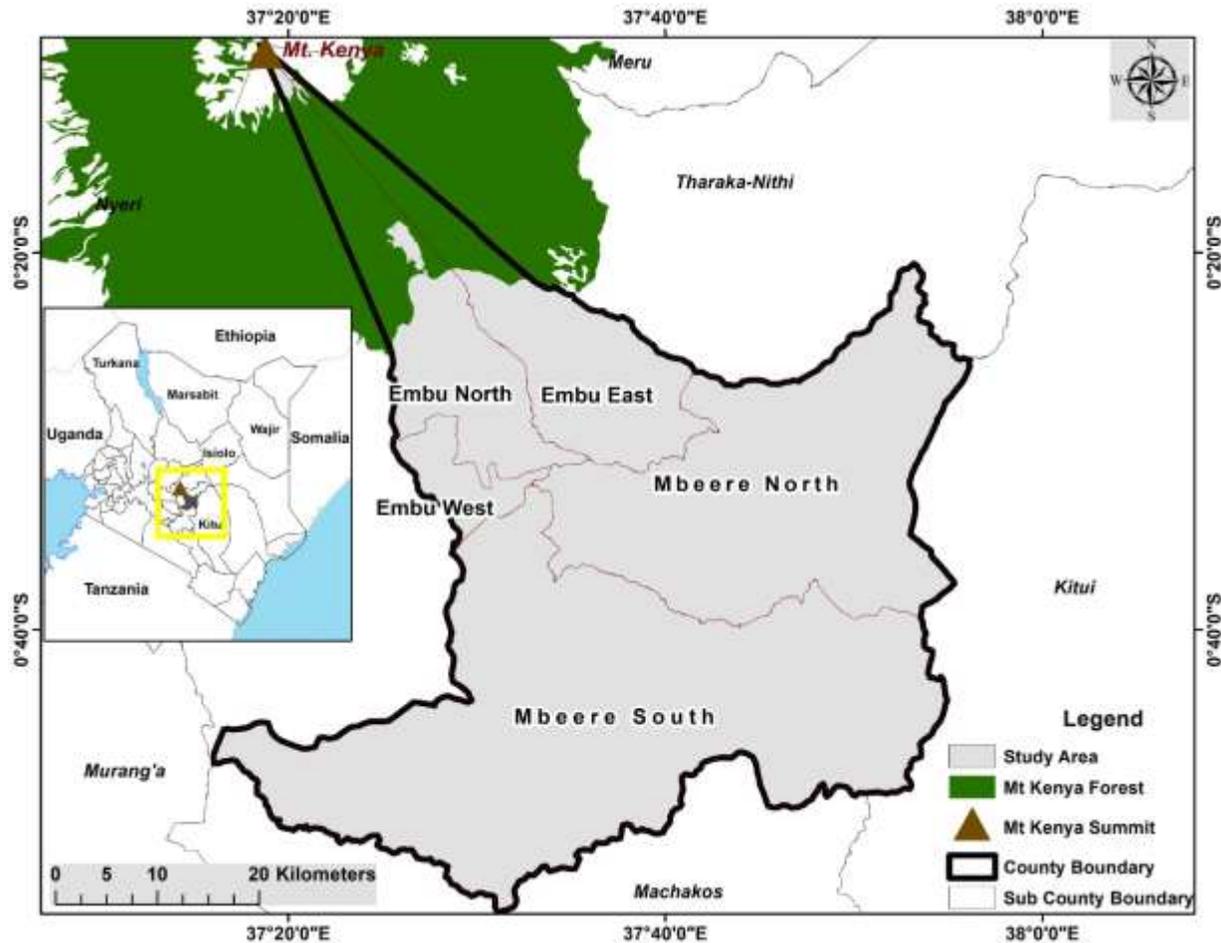


Figure 1. Map of the study area.

provided an insight into the small scale farmers' perception of climate change and adaptation mechanisms in the county.

## RESULTS AND DISCUSSION

### Socio-economic characteristics of the farmers

Out of the 411 households interviewed 59.1% were females with 67.6% of the total interviewees between the ages of 18 to 50 years. This is a positive sign in the study area because youths are energetic, knowledgeable, have the access to the latest information and technology on climate change adaptation. According to Ajuang et al. (2016), middle-age perceives climate change better than old age farmers. The majority (74.7%) of the respondents indicated dual participants in decision making regarding agricultural activities with 9.2% males and 16.1% females making decisions separately. The average household size was 4 members where 86.6% had between 2 to 4 dependents and 2.4% above 6. This indicates a level of dependence on the respondent for food. About 32.1 and

15.8% of females and males respectively have attained upper primary education which translates to 8 years of acquiring knowledge; whereas 15.3 and 15.6% of females and males respectively have attained secondary education (12 years). Those with less than 8 years of education are represented by 15.1% of both females and males. The average farm size is 1.4 acres of land with 69.3% of farmers with less than 20 years' experience in farming. The most dominant land ownership type is privately owned land with 91% of the farmers with 90.5% relying upon on-farm activities as a source of family income.

### Formal institutions in climate-related information

The small scale farmers were requested to list all the formal institutions they have interacted with in one way or another in the last 5 years about the farming activities. The majority of the interviewed (97.32%) indicated they have interacted with Faith-Based Organizations (Table 1). There was a significant relationship between the

**Table 1.** Formal institutions within Embu County.

Formal institutions	%	n	X <sup>2</sup> P value	
			Adaptation	Risk perception
Department of Agriculture	59.61	245	NS	0.013
Department of Livestock Development	31.39	129	0.001	0.040
Development partners	24.33	100	0.001	NS
Non- Governmental Organization	74.21	305	NS	NS
Faith-based Organization (FBOs)	97.32	400	NS	NS
Cooperatives	69.83	287	0.014	NS
Ministry of land	1.46	6	NS	NS

\*NS – Not Significant

Department of Agriculture and small-scale farmers' risk perception ( $p < 0.001$ ) towards climate variability. This implies that small-scale farmers in Embu County are more likely to get influenced on what and how they perceive the climate-related risks towards their farming activities and productivity. This could be because the farmers reported getting extension services and visiting demonstration centers on how to adapt to the changing climate although the actual implementation was yet to occur.

Risk perception and adaptation of climate variability mechanisms were statistically significant to the Department of Livestock and Development at  $p < 0.040$  and  $p < 0.001$  respectively. This implies that the Department was influential in improving farmers' perception and adaptation to changing climatic conditions. According to the respondents, veterinary services are provided to livestock at the farm level and therefore more advice is sought on how to feed and manage the animals.

Development partners in agricultural and climate-related fields were significant to adaptation ( $p < 0.001$ ) of climate variability by the Embu small scale farmers. The development partners comprised of individual marketers of different agricultural products such as maize, beans, milk, eggs, and meat. This implies that the small scale farmers were more likely to adapt to climate change and variability when the marketers give them advice on what and how to protect the agricultural crop for better yields and improved market value. There was a significant connection between cooperatives and adaptation of climate change and variability ( $p < 0.014$ ). As explained by farmers these cooperatives assist in marketing farm produce and provide an easy avenue for microcredit. This implies that small scale farmers were more likely to practice adaptation mechanism when information is passed by cooperatives. The reason may be because these farmers look forward to selling their farm produce to the same institutions and therefore will tend to follow the instructions given. On the other side, the microcredit given to the farmers motivates them to adapt to climate change and variability to be able to repay the loans. These findings were confirmed by the Key Informant and

FGDs respondents who were quick to note that the Department of Agriculture and Livestock Development provides extension services. Below is a scenario from Key Informant;

*..... the office is mandated to provide extension services to livestock farmers however we only visit farms within our vicinity due to inadequate personnel and funds to send our officers to the field. Therefore the farmers who need our services have to travel to our offices for assistance.*

According to Key Informants, these institutions play several roles such as the creation of awareness, provision of credit facilities, marketing strategies, extension services, capacity building, and enhancement of land adjudication (Table 2).

This implies that the institutions have clearly defined roles on how to assist the farmers to improve their risk perception and shield their farming activities from scathing effects of rising temperatures. According to Islam and Nursey-Bray (2017) failure to visit farmers at the farm level results in insufficient information that is not adequate for adaptation to climate change and variability.

### Informal institutions in climate-related information

Out of 411 respondents interviewed 71.05% are not members of any farmer organization whereas 28.95% are members. These farmers' organizations provide several benefits as reported by the respondents. For instant access to credit (56.31%) and need to learn new methods of farming (52.94%) had the highest percentage of respondents (Table 3). There was a significant connection between access to credit, access to extension services, market facilitation, farmer's organization, and new ways of farming ( $p \leq 0.05$ ) in Embu County. This implies that farmers are more likely to join these organizations for various benefits. According to respondents, the farmer organization is closer to their vicinity which makes services delivery faster as compared

**Table 2.** Initiatives of the formal institutions in the agricultural sector of Embu County.

Institution	Role
Department of Agriculture	Give awareness on the available farm inputs in the market e.g. fertilizers, hybrid seed Provides extension services to the small scale farmers
Department of Livestock Development	Provided information and services to the Livestock farmers e.g. the best medicines to control pests and diseases, Artificial Insemination
Development partners (e.g. marketers)	Provide market information e.g. the prices of different farm products Capacity building for farmers and officials Provide information and awareness to the farmers on market issues
Non- Governmental Organization	Provided farm inputs at subsidized rates Financial support Promotes new crops varieties and animal breeds
Faith-based Organization (FBOs)	Deals with soil and water conservation programs e.g. organic farming Encourages in forest conservation: afforestation and reforestation Promotes new crops varieties and animal breeds
Cooperatives	Enable market accessibility to the farmers Credit facilities
Ministry of land	Value-adding on the farm produce Enhances land adjudication and settlement

**Table 3.** Benefits of farmer organization on small scale farmers in Embu County.

Benefits	n	%	X <sup>2</sup> p<0.05
Access to credit	67	56.31	0.000
Access to extension services	33	27.74	0.000
Facilitates the market for agricultural produce	28	23.53	0.009
Learn new methods of farming	63	52.94	0.001
Access to inputs	15	12.60	NS

to the formal institutions. A Key informant indicates that;

*“.....farmers’ organization have shorter bureaucratic procedures and therefore farmers can access credit faster than the formal institution. On the other hand, these organizations are within the locality of the farmers and therefore marketing of agricultural produce is done on time especially the perishable ones”*

This finding suggests that farmers’ organizations are very effective in assisting farmers to adapt to the climate variability and therefore can be used to bridge the persistent gap between information generators and the end users – farmers. On the other hand, farmers’ organizations assist to facilitate microcredits to individual farmers. The availability of credit facilities may result in a better decision on the type and level of adaptation to climate variability. Furthermore, farmers are in a better position to gain knowledge about farm prices and possible marketing strategies because of the presence of collective bargain (Barham and Clarence, 2008).

### **Marginal effects on institutions on climate-related risk perception and adaptation mechanisms**

The marginal effects of formal and informal institutions were analyzed and only formal institutions were statistically significant about climate variability risk perception and adaptation mechanisms employed by the small scale farmers with p values  $\leq 0.05$  (Table 4). This indicates that the presence and engagement of formal institutions in various agricultural activities promote the farmer’s resilience levels towards climate variability. Adaptation to climate variability is only possible if grounded on comprehensive information on farmer’s requirements and concerning their geographical location. On the other hand, formal institutions are more likely to negatively influence the farmers’ risk perception. This is because farmers’ perception is not only formulated by constant interaction with experts but also on other factors like cultural background, prior experience, and socioeconomic factors (Ayal and Filho, 2017). Knowledge precedes action and therefore emphasis on farmer

**Table 4.** Formal and informal institutions marginal effects in Embu County.

Dependent variables	Coefficient	
	Informal	Formal
Climate variability risk perception	0.004	-0.065*
Adaptation mechanisms	0.051	0.094*

\*p-value  $\leq$  0.05.

tailored services promotes shielding of climate variability on the agricultural activities. Farmer organizations (Chama) are not statistically significant and this could be because of a lack of central coordination. These organizations are productive if well organized and managed from a central point (Barham and Clarence, 2008).

### Information channels on climate change and variability in Embu County

The use of radio and nature (lifetime experience) had an equal number of respondents (59.37%) who reported the two channels as the most used when in need of agricultural information (Arnell, 2010) (Table 5). These were closely followed by 49.88% of respondents who obtained climate change information from other farmers within their vicinity. Use of Televisions and County extension providers scored 25.06 and 22.63% respectively. Agro vet shops (18.25%) are also involved in giving farmers information on the crop variety, pest and diseases, fertilizer application, and other farm chemical use. Other respondents indicated getting information from the Agricultural show (3.65%) that are held annually whereas 2.92% of respondents get information from the demonstration centers organized by formal institutions within the County Use of teachers in schools and reading books or newspapers scored 0.49 and 2.43% respectively.

These results concur with those of the Key Informants that indicated that information on the weather forecasts is communicated through government-owned print or and mass media. The print media comes in either English or Kiswahili language in form of newspapers, booklets, and bulletins while the mass media is in form of Radio and Television which are the majority among the small-scale farmers because of the availability of Kiembu language channels with farming information. Marginal effects of twelve information channels show farmer to farmer, agro Vets, radio, nature (lifetime experience) and knowledge obtained from teachers in school were statistically significant with a p-value  $\leq$ 0.05. This implies that regardless of many information channels existing in the study area only five made an impact on the adaptation aspects. Farmer to farmer communication is likely to influence adaptation mechanisms because the farmers

may feel comfortable to watch and ask questions from fellow farmers who had succeeded in implementation. Furthermore, the Agro-Vet shop is statistically significant which implies that the small-scale farmers are more likely to be influenced by the adaptation to climate variability. This is because small scale farmers reported getting assistance on the type of crop variety, when to plant, type of fertilizers, pesticides, type of livestock feeds, vaccination services, and pests and disease control methods. Besides, the use of radios was likely to influence the small scale farmers to adapt to climate change. This implies that households with radios and listening to farming and climate-related information are more likely to get influenced to shield from harsh climatic conditions. The farmers reported relying on radio to get information on the type of animal breeds to keep, feeding management, and zero-grazing options. Climate-related information obtained from the formal school curriculum was also significant. This implies that the formal school curriculum is equipped with climate-related information that can influence the small-scale farmers to adapt to the changing climatic conditions. Nature or lifetime experience was also significant and this implies that small-scale farmers headed by elderly people were more likely to perceive risks and adapt to climate variability as well.

Information on climate change has lately become widely available although still far-fetched by many small scale farmers in developing countries (Kellstedt et al., 2008). However small-scale farmers can get agricultural information from agronomists hired by farm goods and services companies or independent farm consultants. According to Mugi (2014), small-scale farmers have relied on indigenous knowledge for centuries which has helped them to predict harsh climatic conditions and design adaptation mechanisms for resilience. However, Anderson et al. (2009) observed that adaptation by small-scale farmers can be reinforced through diverse channels.

### Access and utilization of climate change and variability information on agricultural practices

The majority of the respondents (55.47%) indicated receiving climate change information and applying it to the various agricultural activities whereas 44.53% who received the information did not use it. This implies that not all information passed to the farmers is applied in the

**Table 5.** Information channels on climate change and variability in Embu County.

Information channels	(%)	(n)	Coefficients	
			Adaptation	Risk perception
From other farmers	49.88	205	0.0394*	-0.0123
Extensions provider	22.63	93	0.0378	-0.0018
From agricultural shows	3.65	15	0.0508	-0.0769
Demonstration centers	2.92	12	-0.0397	0.0217
Field days	3.89	16	-0.0171	0.0420
Agro Vert shops	18.25	75	0.0175*	-0.0047
From books/newspapers	2.43	10	0.0531	0.0400
Radio	59.37	244	-0.0388*	-0.0172
TV	25.06	103	-0.0090	0.0057
Internet	4.62	19	-0.0784	0.0276
From teachers in school	0.49	2	0.5338*	-0.0207
Nature	59.37	244	-0.0637*	0.0059*

**Table 6.** Livestock production and utilization of climate variability information IN Embu County.

Information	Frequency (n=228)	Percentage
Reduce the livestock herd size	73	32.02
Improve the pasture or feed management	158	69.3
Relocation or migration of the herd	8	3.51
Vaccination/Animal health management	35	15.35
Change of animal type	13	5.7
Intensive/Zero grazing	4	1.75

farming activities and therefore the farmer may have all the required information to adapt to climate variability and yet continue being vulnerable.

In livestock production, 228 respondents reported having used climate change and variability information where 69.3% used the information to improve the livestock pastures and or feed management (Table ). This included sourcing for better fodder for animals that led to an increase in milk and meat production, the purchase of quality commercial feeds, integrating high-quality animal fodder with crop production, and storage of these fodder for later use. Other respondents (32.02%) reported having reduced the livestock herd size due to increased drought to ensure the animals are within the carrying capacity of the available land. This is distantly followed by 15.35% of the respondents who have used climate change and variability information on bettering animal health. This information included animal vaccination especially on poultry production, artificial insemination for cattle, and animal drugs to deal with pests and diseases. A mere 5.7% of the respondents have changed the type of animal they're rear on their farms due to exposure to climate change and variability information. These small scale farmers indicated to have purchased cattle breeds that can cope with extreme

weather conditions while 3.51% of respondents have the information on how and when to move the animals from one piece of land to another for better management of the herd size. However, this percentage of the respondents was found within those farmers who have more than 6 acres of land. Information on intensive zero-grazing was reported by 1.75% of the respondents.

In crop production, the information received was used to select crop varieties (42.11%) that would cope with climate variability while 35.09% used this information to purchase the farm inputs like the seeds and fertilizers (Table 7). The climate change information was critical for 21.05 and 17.11% of the small-scale farmers who received the information on planting dates and need to have mixed cropping respectively. About 1.32% indicated that climate change information assisted them to harvest their crops on time before they were damaged by the extreme weather conditions whereas 0.88% reported how climate change information assisted them on pest control and storage of produce. This implies that small-scale farmers in Embu County are willing to use climate variability information when packaged in a way that there can interpret. Marginal effects show statistical significance between the utilization of livestock production information and adaptation ( $p \leq 0.05$ ) (Table 8). However,

**Table 7.** Crop production and utilization of climate variability information in Embu County.

Information	Frequency (n=228)	Percentage
Planting date	48	21.05
Variety selection	96	42.11
Mixed cropping	39	17.11
Input use (seeds, fertilizer)	80	35.09
Harvest time	3	1.32
Others (storage, soil testing, pest control irrigation)	2	0.88

**Table 8.** Marginal effects of information use on adaptation and climate variability risk perception.

Use of received agriculture-related information	Adaptation	Risk perception
Received information on animal management	-0.0676*	0.0040
Received information on crop management	0.0349	0.0166

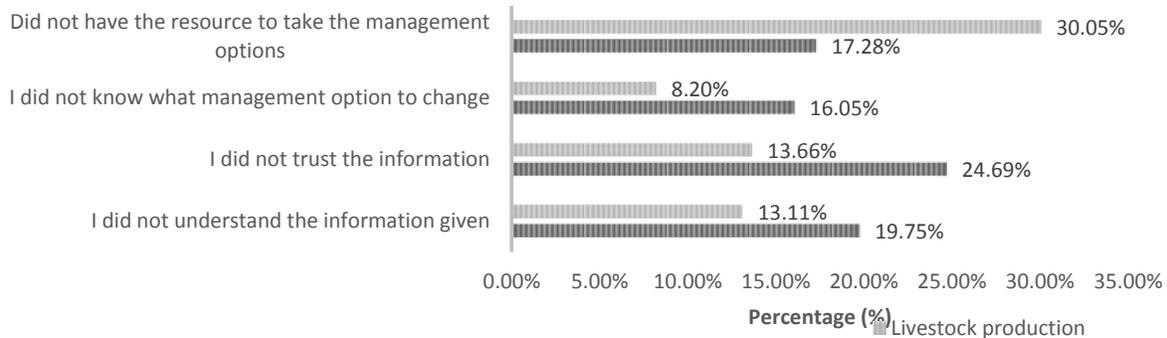
the influence was negatively affecting animal management. This indicates that regardless of the access to this kind of information the animal management did not directly benefit from it. On the other hand, utilization of both livestock and crop production did not influence the small-scale ability to perceive climate-related risks. About 44.53 and 19.71% of the respondents did not make use of the climate variability information on their livestock and crop production respectively. Several reasons were given as shown in Figure 2. About 19.75 and 13.11% of the respondents did not understand the information given on crop and livestock production respectively. On the other hand, 24.69 and 13.66% of the respondents did not trust the source of the information they were getting for crop and livestock production respectively. Also, 16.05% of the respondents dealing with crop production and 8.2% of livestock farmers indicated that they did not know how and where to apply the available management options. Limited resources were reported by 17.28 and 30.05% of crop and livestock farmers respectively. These limited resources include inadequate funds, land, inputs for crop farmers, and human labor to try the given management options.

This implies that the small scale farmers are willing to utilize the climate information passed to them although there are limiting factors beyond their reach that affect their ability. As observed by Srinivasan et al. (2011) effective utilization of climate information to succeed in the current climate risks and implement adaptation mechanisms to face future changes is paramount. Farmers are likely to deploy any information if they perceive it to be timely and relevant. On the other hand, farmers go through a process of evaluation on the credibility and accuracy of the information before the implementation (Cash et al., 2003). However, small-scale farmers tend to resist new knowledge due to fear of failure and unwillingness to change from the well-

established routines and knowledge (Rice et al., 2009). These farmers will assess this information based on authentic, responsive, flexible, dependable, usable, and timelines to utilize the information.

## Conclusion

The study reviews that youths are directly involved in farming activity therefore are more knowledgeable and have a better perception of climate change adaptation. Many formal and informal institutions exist in the study area where the majority of the respondents interacted with Faith-Based Organizations while the Ministry of land had the least number of interactions. However, there was a significant relationship between the Department of Agriculture and small-scale farmers' risk perception of climate variability. Besides, the Department of Livestock and Development was significantly influencing the farmers' perception of risks, and adaptation of climate variability. Also, the Development partners in agricultural and climate-related fields and cooperative societies were significant to the adaptation of climate variability. Besides, the small-scale farmers in the study area have invested in the Informal institutions that provide access to credit, new methods of farming, extension service, marketing of agricultural produce, and access to farm inputs. There was a significant connection between access to credit, access to extension services, market facilitation, farmer's organization, and new ways of farming. However, the marginal effects of formal and informal institutions showed that only formal institutions were statistically significant to climate variability risk perception and adaptation mechanisms. Furthermore, twelve information channels exist in the study area. Out of the twelve, only five are more likely to influence climate variability adaptation mechanisms. These included farmer



**Figure 2.** Reasons for not utilizing the climate variability information both crop and livestock production in Embu County.

to farmer, agro Verts, radio, nature (life-time experience), and knowledge obtained from teachers. While life-experience was the only channel significant to perception on climate variability impacts on agriculture. The majority of the respondents indicated receiving climate change information and applying it to the various agricultural activities. These farmers used the information in various ways in both livestock and crop production. For instance, in livestock production, the small-scale farmers were able to reduce the herd size, improve feed, and animal health management. In crop production, the information received was used to select crop varieties, purchase the farm inputs, changing planting dates, and input use. The minority of the respondents cited barriers to the utilization of climate information received from the various information channels. These barriers included a lack of understanding of the given information, lack of trust in the source of the information, limited resources, lack of know-how, and where to apply the available management options. To address these barriers, there is a need for agricultural and climate-related institutions to partner with the small-scale farmers to enhance co-learning to raise awareness and to help disseminate agricultural-related information. Also, there is a need to strengthen institutions and information channels for the small-scale farmers to be able to address climate change risks which may target various value chains within agricultural practices.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

## REFERENCES

- Adger WN (2009). Social Capital, Collective Action and Adaptation to Climate Change. *Economic Geography* 79(4):387-404. Available at: <https://doi.org/10.1111/j.1944-8287.2003.tb00220.x>
- Agrawal A (2008). The Role of Local Institutions in Adaptation to Climate Change. Paper prepared for the Social Dimensions of Climate Change, Social Development Department. March. Available at: <https://openknowledge.worldbank.org/bitstream/handle/10986/28274/>

- 691280WPOP11290utions0in0adaptation.pdf?sequence=1
- Ajuang CO, Abuom PO, Bosire EK, Dida GO, Anyona DN (2016). Determinants of climate change awareness level in upper Nyakach Division, Kisumu County, Kenya. *SpringerPlus* 5(1):1-20. Available at: <https://doi.org/10.1186/s40064-016-2699-y>
- Anderson S, Geoghegan T, Ayers J (2009). An assessment of channels to support climate adaptation by the poorest. *IOP Conference Series: Earth and Environmental Science* 6(36):362016. Available at: <https://doi.org/10.1088/1755-1307/6/6/362016>
- Arnell NW (2010). Adapting to climate change: An evolving research programme. *Climatic Change* 100(1):107-111. Available at: <https://doi.org/10.1007/s10584-010-9839-0>
- Ayal DY, Filho LW (2017). Farmers' perceptions of climate variability and its adverse impacts on crop and livestock production in Ethiopia. *Journal of Arid Environments* 140(0140-1963):20-28. Available at: <https://doi.org/10.1016/j.jaridenv.2017.01.007>
- Ayuke FO, Karanja NK, Muya EM, Musombi BK, Mungatu J, Nyamasyo GH (2009). Macrofauna Diversity and Abundance across Different Land Use Systems in Embu, Kenya. *Tropical and Subtropical Agroecosystems* 11(2):371-384.
- Barham J, Clarence C (2008). Collective action initiatives to improve marketing performance: Lessons from Farmer Groups in Tanzania *Food policy* 34(1):53-59.
- Cash DW, Clark WC, Alcock F, Dickson NM, Eckley N, Guston DH, Jäger J, Mitchell RB (2003). Knowledge systems for sustainable development. *Proceedings of the National Academy of Sciences of the United States of America* 100(14):8086-8091. Available at: <https://doi.org/10.1073/pnas.1231332100>
- Diao X, Hazell P, Thurlow J (2010). The Role of Agriculture in African Development. *World Development* 38(10):1375-1383. Available at: <https://doi.org/10.1016/j.worlddev.2009.06.011>
- Elmusharaf K (2012). Qualitative sampling techniques. Training Course in Sexual and Reproductive Health Research, Geneva. Available at: <http://www.gfmer.ch/SRH-Course-2012/research-methodology/Qualitative-samplingtechniques-Elmusharaf-2012.htm>
- Embu County Government integrated Development Plan (2013). Republic of Kenya Embu County Government Theme: A prosperous and united county. August 2013.
- Gartner K (2015). Liquid Assets, Institutions, Climate Change and Conflict: The Political Ecology of Water in Maji Moto Group Ranch, Narok South, Kenya A Case Study of Water-Related Conflict in a Maasai Community. Master's thesis pp. 1-116.
- Herrero M, Thornton PK, Notenbaert AM, Wood S, Msangi S, Freeman HA, Bossio D, Dixon J, Peters M, Van De Steeg J, Lynam J, Rao P, MacMillan S, Gerard B, McDermott J, Seré C, Rosegrant M (2010). Smart investments in sustainable food production: Revisiting mixed crop-livestock systems. *Science* 327(5967):822-825. Available at: <https://doi.org/10.1126/science.1183725>
- Islam MT, Nursey-Bray M (2017). Adaptation to climate change in agriculture in Bangladesh: The role of formal institutions. *Journal of Environmental Management* 200:347-358. Available at: <https://doi.org/10.1016/j.jenvman.2017.05.092>

- Kabubo-Mariara J (2015). Climate Change and Food Security in Kenya Does Climate Change Affect Food Insecurity in Kenya?
- Kellstedt PM, Zahran S, Vedlitz A (2008). Personal efficacy, the information environment, and attitudes toward global warming and climate change in the United States. *Risk Analysis* 28(1):113-126. Available at: <https://doi.org/10.1111/j.1539-6924.2008.01010.x>
- Mearns R, Norton A (2010). Social Dimensions of Climate Change: Equity and Vulnerability in a Warming World. In *Social Dimensions of Climate Change: Equity and Vulnerability in a Warming World*. Available at: <https://doi.org/10.1596/978-0-8213-7887-8>
- Mugi EW (2014). Knowledge-based climate forecast for farmers' enhanced adaptation to climate variability in Tharaka-Nithi and Kitui counties (BSc.) A Thesis Submitted in Partial Fulfillment for the Degree of Master of Environmental Studies.
- Mutune JM (2017). Gender and Generational Aspects of Sustainable Intensification-Social-Economic Dimensions of Kenyan Smallholder Based Agriculture and Food Security. *AgriFoSe* 2030:1-25.
- Nyong A, Adesina E, Osman E (2007). The Value of Indigenous Knowledge in Climate Change Mitigation and Adaptation Strategies in the African Sahel. May 2015. Available at: <https://doi.org/10.1007/s11027-007-9099-0>
- Ostrom E (2008). Doing Institutional Analysis: Digging Deeper than Markets and Hierarchies. *Handbook of New Institutional Economics* 819-848. Available at: [https://doi.org/10.1007/978-3-540-69305-5\\_31](https://doi.org/10.1007/978-3-540-69305-5_31)
- Oyekale AS (2015). Factors Explaining Farm Households' Access to and Utilization of Extreme Climate Forecasts in Sub-Saharan Africa (SSA). *Environmental Economics* 6(1):91-103. Available at: [http://businessperspectives.org/component/option,com\\_journals/task,allissues/id,9/Itemid,74/%0Ahttp://search.ebscohost.com/login.aspx?direct=true&db=eoh&AN=1519542&lang=fr&site=ehost-live](http://businessperspectives.org/component/option,com_journals/task,allissues/id,9/Itemid,74/%0Ahttp://search.ebscohost.com/login.aspx?direct=true&db=eoh&AN=1519542&lang=fr&site=ehost-live)
- Raymond CM, Robinson GM (2013). Factors affecting rural landholders' adaptation to climate change: Insights from formal institutions and communities of practice. *Global Environmental Change* 23(1):103-114. Available at: <https://doi.org/10.1016/j.gloenvcha.2012.11.004>
- Rice JL, Woodhouse CA, Lukas JJ (2009). Science and decision making: Water management and tree-ring data in the western United States. *Journal of the American Water Resources Association* 45(5):1248-1259. Available at: <https://doi.org/10.1111/j.1752-1688.2009.00358.x>
- Srinivasan G, Rafisura KM, Subbiah AR (2011). Climate information requirements for community-level risk management and adaptation. *Climate Research* 47(1-2):5-12. Available at: <https://doi.org/10.3354/cr00962>
- Tai APK, Martin MV, Heald CL (2014). Threat to future global food security from climate change and ozone air pollution. *Nature Climate Change* 4(9):817-821. Available at: <https://doi.org/10.1038/nclimate2317>
- Tari D, King-okumu C, Jarso I (2015). Strengthening Local Customary Institutions: A Case Study in Isiolo County, Northern Kenya. May.
- Thi Hong Phuong L, Biesbroek GR, Wals AEJ (2017). The interplay between social learning and adaptive capacity in climate change adaptation: A systematic review. *NJAS - Wageningen Journal of Life Sciences* 82:1-9. Available at: <https://doi.org/10.1016/j.njas.2017.05.001>
- Yamane T (1967). *Statistics, An Introductory Analysis* (2nd Ed). Harper and Row. New York