STUDY ON FARMERS' UNDERSTANDING OF CLIMATE CHANGE AND THEIR RESPONSE STRATEGIES TO THE EFFECTS OF CLIMATE CHANGE IN THEIR FARM LANDS IN KENYA

FINAL REPORT

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Acronyms and Abbreviations

AEZ	Agro-Ecological Zones
CEST	Cleaner Energy Sources and Technologies
CCD	Climate Change Directorate
CCVI	Climate Change Vulnerability Index
CLI	Crop-Livestock Integration
CIDP	County Integrated Development Plan
CSA	Climate Smart Agriculture
CA	Conservation Agriculture
EWS	Early Warning System
FGD	Focus Group Discussion
GoK	Government of Kenya
IKS	Indigenous Knowledge Systems
INDC	Intended Nationally Determined Contributions
IWM	Integrated Water Management
NCCAP	National Climate Change Action Plan
NCCRS	National Climate Change Response Strategy
ODK	Open Data Kit
R&D	Research and Development
SALM	Sustainable Agricultural Land Management
WKS	Western Knowledge Systems

Executive Summary

This study was commissioned by Biovision Africa Trust (BvAT) on behalf of the other partners PELUM Kenya and World Agroforestry (formerly ICRAF), with support from the Swedish Society for Nature Conservation (SSNC) toward the Ecological Organic Agriculture Initiative (EOA-I). The overall goal was to investigate how farmers understand the phenomenon of climate change and its impact on their livelihoods. It also sought to reveal farmers' adaptation and response strategies to climate change and the motivations behind the adopted response strategies.

The specific objectives were to; i) find out farmers' understanding and perception of the climate change phenomenon, ii) identify the impacts of climate change on farm lands from the perspective of the farmers themselves, iii) identify and document farmers' intrinsic and extrinsic adaptation and response strategies to the climate change impacts, and iv) analyse the effectiveness and contribution of the adopted adaptation strategies to farmers' livelihoods. Methodologically, semi-structured questionnaires, focus group discussions (FGD), and direct observation were used to collect data in each of the three target counties of Bungoma, Nakuru and Kirinyaga between 16th and 31st January 2017. Data analysis was done using SPSS and comparative analysis.

The results show that 94% of the respondents believe that climate change exists and is occurring on their farms and locality, while opinion is almost equally divided on whether the cause of climate change is natural (51%) or man-made (49%). While most respondents (98%) perceive climate change negatively, a more nuanced view of both advantages and disadvantages emerge. Reduced yields and quality, increased incidences of disease and pests, reduced soil fertility, and reduced water supply are some of the impacts reported by farmers. A majority (96%) of respondents are influenced by climate change in making several farm-level decisions such as whether to plant short season crops, reduce or increase the size of commercial farm land vis-à-vis subsistence farming, practice crop rotation, etc. A portfolio of coping strategies is employed by farmers, including various ecological organic agriculture practices such as conservation agriculture, integrated soil and water resource management, and membership to self-help groups. Both intrinsic (e.g. tradition, agriculture being a hobby, etc.) and extrinsic (e.g. influence of experts and economic considerations) motivations influence the choice of response strategies adopted. From the FGD sessions, most participants believe that their adopted coping/adaptation strategies are effective, i.e. they solved or reduced the severity of the perceived climatic impact and/or increased yields. However, the adopted strategies could be enhanced if certain barriers they face are addressed.

Despite the fact that they are rarely involved in formulation and implementation of relevant policies, regulations and plans as demonstrated by their very limited knowledge of such policies and plans, farmers consider themselves as the single most important stakeholder in addressing climate change, albeit with support from government authorities and scientific experts. The study recommends, among others, deliberate efforts to involve farmers, their experiences and voices in the development of agricultural and climate change policies and programmes. Such policies and programs should also be aligned to local cultural values and norms. More effort should be put in strengthening the capacity of farmers to develop their own knowledge base. More in-depth and extensive studies on how the interplay between intrinsic and extrinsic motivations influence farmers' adaptation and coping strategies and decision-making are needed. A follow-up survey focusing on this element is recommended.

1.0 INTRODUCTION

This Report presents the results of a **study on farmer's understanding of climate change and their response strategies to the effects of climate change in their farm lands in Kenya.** It sought to investigate how farmers understand climate change and its impact on their livelihoods; and endeavor to reveal their adaptation and response strategies to climate change in order to inform future interventions. The study was commissioned by Biovision Africa Trust (BvAT) on behalf of its partners in Kenya PELUM Kenya and World Agroforestry (formerly ICRAF), with support from the Swedish Society for Nature Conservation towards the Ecological Organic Agriculture Initiative (EOA-I). EOA-I is a continental initiative whose overall goal is to mainstream ecological organic agriculture into national agricultural production systems in order to improve agricultural productivity, food security, access to markets and sustainable development in Africa. Ecological organic agriculture is a holistic agricultural production and management system that is focused on attaining a balanced food system that enhances biodiversity, promotes a healthy environment, utilizes renewable resources, and is locally organized (EOAI 2016).

1.1 Rationale of the Study

Kenya is one of the most vulnerable countries to climate change (UNDP 2013). This is due to the fact that most economic sectors are environment and natural resource-based (e.g. rain-fed agriculture), the county suffers from high poverty levels and poor state of economic development which contribute to low adaptive capacity. Climate change, defined as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is observed over a comparable time period (UNFCCC 1992, p. 3), is already linked to increased extreme climatic events such as droughts and floods.

Agriculture, one of the most important economic sectors in Kenya, is set to be hit the hardest by climate change. It directly contributes 25% of national gross domestic product (GDP) and another 27% indirectly (GoK 2015). The crop, livestock, and fishery sub-sectors contribute approximately 78%, 20%, and 2% to the agricultural GDP, respectively. The agricultural sector employs more than 80% of Kenya's rural workforce and provides about 18% of total formal employment (World Bank and CIAT 2015). But the sector is 98% rain-fed and predominantly small-scale, with the medium- to high-potential agricultural areas covering only less than 15% of the country (GoK 2015). Unfortunately, the potential of irrigation to the agriculture sector has not been optimized. In 2012, only 0.16% of arable land was under irrigation (World Bank and CIAT 2015). This situation is occurring within the context of increased land degradation, farmers' inadequate access to land and to support services, credit and markets, absence of appropriate incentives for investment in agriculture, and weak producer associations and institutional arrangements. The result is increasing the vulnerability of farming systems and eroding productive assets and weakening their resilience, predisposing poor households to food insecurity and poverty traps (GoK 2015).

Climate change affects all the four components of food security - food availability, food accessibility, food utilization, and food system stability. Increased frequency and intensity of extreme weather events like droughts and floods leads to losses of productive assets, personal possessions and even life. This is due to reduced soil fertility, decreased livestock productivity, increased incidences of pest attacks, manifestation of vector and vector-borne diseases, and negative impacts on human health affecting human resource availability (GoK 2010). The attendant economic losses can be significant. For example, the 2008/2009 drought

is estimated to have slowed down Kenya's Gross Domestic Product (GDP) by an average of 2.8% per annum, with total damage and losses estimated at Kenya Shillings 968.6 billion. Of these, the most affected sector was agriculture (including livestock) which suffered a total loss of KShs 820.4 billion (GoK 2012). Ten years earlier, the economic losses to the agriculture sector attributed to the 1997-1998 El-Nino rains is estimated at KShs 23.6 billion (Karanja and Mutua 2000). The agricultural sector itself is also a significant greenhouse gas (GHG) emitter, contributing 58.6% of total GHG emissions in Kenya, with livestock-related emissions accounting for over 95% of those emissions (GoK 2013; World Bank and CIAT 2015). Under business-as-usual (BAU) scenario, agricultural emissions are projected to increase from 20 Mt CO_2 eq. in 2010 to 27 Mt CO_2 eq. in 2030 (GoK 2013). Climate change has a gender perspective, with women being more vulnerable primarily because they constitute the majority of the poor, are more dependent on natural resources that are threatened by climate change for their livelihood, and face social, economic, and political barriers which limit their coping capacity (UNDP 2013). Moreover, women and girls are the principal agents of food security as they are involved throughout the food production and consumption value chains (BRIDGE 2014).

Given the important role played by Agriculture in Kenya's economy and its vulnerability to climate change, the Government has developed several response policies and plans. These include the National Climate Change Response Strategy (2010), the National Climate Change Action Plan (2013-2017), the Climate Change Act 2016, the National Adaptation Plan (2015-2030), and the Climate Smart Agriculture Strategy (2017-2026). The CSA Strategy envisions a "climate resilient and low carbon growth sustainable agriculture that ensures food security and contributes to national development goals in line with the Kenya Vision 2030" (GoK 2017, p. 23). Though laudable, how far farmers' own understanding of and perspectives on climate change have been integrated into their development and implementation remains unclear.

Indigenous knowledge (IK) is the unique, traditional, local knowledge existing within and developed around the specific conditions of women and men native to a particular geographic area (Guchteneire et al. 1999). IK has been developed outside the formal educational system. Despite the dominance of the Western knowledge system (WKS), IK has for many centuries enabled communities to survive in a balanced relation with their natural and social environment. Closely related to survival and subsistence, IK provides a basis for local-level decision-making in food security, human and animal health, education, natural resource management, and other community-based activities. The growing interest in IK comes at a time when current often top-down development models have not been particularly successful, having failed to induce people to participate because of the absence of instruments and mechanisms that enable them to use their own knowledge (Guchteneire et al. 1999). Indigenous knowledge systems (IKS) constitute an important driving force for sustainable development in Africa. It provides useful frameworks, ideas, guiding principles, procedures and practices that can serve as a foundation for effective endogenous development options, and can foster a rethinking of development methods in sectors such as agriculture, natural resource management, trade and governance (Boon 2007).

A holistic understanding of farmers' attitudes and behaviour towards climate change and the environment provides a solid basis for strategies to alter or adjust the circumstances in which agricultural production takes place (Walder and Kantelhardt 2018). IKS often include years of analytical and experimental (trial and error) approaches to sustainable development rather than simply the result of accumulated passive observations (Boon 2007). Practising ecological organic agriculture which is resilient to climate change requires in-depth understanding of the perceptions and mindsets of different stakeholders, including farmers, towards climate change.

1.2. Scope of the Study

According to the Terms of Reference (ToR), the scope of the study entailed undertaking the following:

i. Formulate an appropriate objective for the study
ii. Derive appropriate methodology for the study
iii. Collect necessary data, analyse, synthesise and compile findings and make recommendations.

1.3 Objectives of the Study

The overall goal or purpose of this study was to investigate how farmers understand the phenomenon of climate change and its impact on their livelihoods, as well as reveal farmers' adaptation and response strategies to climate change. To better achieve this broad objective, and guided by the above scope, the following *specific objectives* were formulated to guide the study:

i. To find out farmers' understanding and perception of the climate change phenomenon
ii. To identify the impacts of climate change on farm lands from the perspective of the farmers themselves
iii. To identify and document farmers' intrinsic and extrinsic adaptation and response strategies to the climate change impacts
iv. To analyse the effectiveness and contribution of the adopted adaptation strategies to farmers' livelihoods

The report is structured as follows. After the introduction, the methodology applied is highlighted. Next, the results are presented and discussed. Finally, key conclusions are drawn and recommendations made.

2.0 METHODOLOGY

This section highlights the methodology which was applied to collect, process and analyse the data and information necessary to fulfil the stated objectives of the study. Key research processes which guided the study's implementation, data quality control and standards, as well as ethical considerations are highlighted.

2.1 Research Design

Cross-sectional design was used to collect data at only one point in time to provide a snapshot of the issues under investigation. Face-to face interviews, three Focus Group Discussions (FGDs) (one per county), direct observation and photography were the key primary data collection methods used. The survey was conducted between 16th and 31st January 2017. Both qualitative and quantitative data were collected using both primary and secondary data sources. At the farm (or household) level, the quantitative approach extracted quantifiable and numerical data based on the four study objectives from farmers living in the three target counties of Bungoma, Nakuru and Kirinyaga. The three counties were purposively selected as they fall within Kenya's agro-ecological zones (AEZs) II (Kirinyaga), III (Bungoma), and IV (Nakuru) which are key agricultural areas (See Infonet-Biovision 2017).

2.2 Target Population and Sample Design

The survey was conducted primarily with farmers – defined by the survey as a consenting household head or representative engaged in farming, regardless of gender but aged at least 18 years. Using the sample size calculation for prevalence studies formula with finite population (Daniel 1999), the sample size (n´) was computed as follows;

$$n' = \frac{NZ^2 P(1-P)}{d^2(N-1) + Z^2 P(1-P)}$$

Where:

n´= Sample size with finite population correction,
N = Population size
Z = Z statistics for a level of confidence (The standard normal deviation at the required confidence level = 1.96)
P = Expected prevalence (The proportion in the target population estimated to have the characteristics being measured. Since the proportion is unknown 50% will be used. Thus P= 0.5)
d= Level of Precision (error reduction) set at 10%. (Thus d= 0.1)

Since a larger sample size is required to achieve the same precision in cluster or multistage sampling methods, the sample size calculated above needs to be multiplied by the design effect (deff). For this study, a design effect of approximately 1.5 was applied. There being no official county farmer population data, farmer population was estimated based on the following assumptions:

1. **Bungoma County:** According to Kenya's latest (2009) population census, there are 270,824 households in Bungoma County (KNBS 2013). Agriculture employs or is the key livelihood source for 70% of the residents (County Government of Bungoma 2013; Shames et al. 2015). Based on this, it was assumed that 70% of the households are farmers. This translates to a total farmer population of **189,577**. Since not all who depend on agriculture are actually farmers, the estimate means that a higher population is used which is statistically better than if a lower population size was used.
2. **Nakuru County:** Based on the 2009 population census, the county has 409,836 households, 71% of which are involved in farming, i.e. crop and livestock production

(GoK 2014a). This gives an estimated **290,984** farmers.

3. **Kirinyaga County:** Based on the 2009 population census, the County has a household population of 154,220, 46.4% of which are engaged in farming (GoK 2014b). The estimated number of farmers in Kirinyaga county was **71,559**.

Using a proportionate to population size (PPS) sampling method, the sample size per county was determined as illustrated in **Table 1** below:

Table 1: Distribution of Sample Size per County

County	**Estimated number of farmers** (Pi; i=1,2,3)	**Estimated Population Proportion** (=Pi/∑Pi)	**Sample size** (=Estimated population proportion * total sample size)
Bungoma	**189,577**	**0.343**	**51**
Nakuru	**290,984**	**0.527**	**79**
Kirinyaga	**71,559**	**0.130**	**20**
Total	**552,120**	**1**	**150**

Therefore;

$$n' = \frac{552{,}120 \times 1.96^2 \times 0.5 \times 0.5}{(0.1^2 \times 552{,}119) + (1.96^2 \times 0.5 \times 0.5)}$$

$$n' = 100 * 1.5$$

$$= \textbf{150 households}$$

Stratified sampling was applied. Based on literature review, initial contact with county agricultural personnel, and personal knowledge of the counties, the target farmers per county were first categorized into groups (strata) based on the county's major agro-ecological zones (AEZs) and related agricultural systems. Simple random sampling was then applied per stratum. Snowball sampling was used to identify the FGD participants. Each FGD group consisted of between 9 - 12 participants, with at least a third of either gender represented.

2.3 Data Management

Preparatory activities in readiness for the survey included an inception meeting with the client; review of project and other relevant literature; preparation of data collection instruments (DCIs), pre-testing of the DCIs; and recruitment and training of Research Assistants (RAs). Data collection was done using Open Data Kit (ODK)[1] through a digitized questionnaire. Once uploaded to the server, the data was checked and retrieved by a system administrator before cleaning and analysis using Statistical Package for Social Sciences (SPSS) program. The FGD sessions which were recorded using digital voice recorders, transcribed and the data analyzed.

[1] ODK is a mobile data collection tool - a remote web-based server solution (cloud computing) connecting to a mobile phone through internet. See https://opendatakit.org/

3.0 SURVEY RESULTS

3.1 Response Rates and Household Characteristics

A total of 154 respondents were interviewed, 51 in Bungoma, 83 in Nakuru, and 20 in Kirinyaga. Out of this, 94% of the households were rural dwellers, 84% indicated that they are household heads, with 73% being from female headed households. Eighty five percent (85%) of Kirinyaga county respondents were female headed households, Nakuru 77% and Bungoma 63%. Table 2 highlights the characteristics of the FGD participants.

Table 2: Characteristics of FGD participants

County/FGD Location	Date	Actual Participants		
		Male (M)	Female (F)	Total
Bungoma (Kanduyi town)	19/1/2017	7 (58%)	5 (42%)	12 (100%)
Kirinyaga (Kutus town)	21/1/2017	8 (73%)	3 (27%)	11 (100%)
Nakuru (Naivasha town)	27/1/2017	3 (33%)	6 (67%)	9 (100%)

In terms of education, 41% of the respondents have primary-level education, 38% secondary education, and those with tertiary education (11.04%) almost equal to those without any formal education (10.39%). Kirinyaga county has the highest number of household heads with primary education (50%) and secondary education (45%), while Bungoma county has the highest number of household heads with tertiary education (20%). With regard to land tenure, 53% own land that they inherited. This is more pronounced in Kirinyaga (71%) and lowest in Nakuru County where 44% of the respondents have leased or purchased the land. About 7% own land communally in Nakuru and Kirinyaga counties. No communal land ownership is reported by Bungoma county respondents.

Over 80% of all the households report that agriculture is their main source of livelihood, the highest being Kirinyaga county (95%) and the lowest (84%) Bungoma county. According to results in Table 3, crop farming is the dominant agricultural activity undertaken by over 59% of households surveyed. Mixed farming (cultivation of crops and livestock keeping) is practised by an average 33% of the respondents, with Nakuru county having the highest percentage at 37% and Bungoma the lowest at 25%. Fourteen percent of Bungoma county respondents keep livestock only, the highest among the three counties. Growing of both subsistence and cash crops is practiced by 45% of the respondents, with Kirinyaga leading at 75% and Bungoma lowest at 24%. At 65%, Bungoma county has the highest number of respondents growing crops only for subsistence, much higher than Kirinyaga's 15%. Nakuru county has 20% of respondents practising only cash crop farming, the highest of the three counties. Livestock keeping for subsistence alone is highest in Bungoma county (45%) and lowest in Kirinyaga (17%). Less than 4% of Bungoma and Nakuru respondents keep livestock strictly for commercial purposes, a practice that is not reported by Kirinyaga county respondents.

The main types of livestock kept are cattle (46%) and poultry (36%). Maize (37%), legumes (28%), and vegetables (11%) are the major crops grown in the three counties (Table 3). Maize is grown across all the countries but is more common in Bungoma county (45%) and lowest in Nakuru (32%). Growing of legumes is quite high in Bungoma (37%) and Nakuru (25%) but comparatively low in Kirinyaga (9%). High value crops such as tomatoes and French beans are reportedly grown by Kirinyaga and Nakuru respondents but not Bungoma, while drought-resistant crops such as sorghum, millet and cassava are grown in Bungoma. Ninety five percent of respondents report that they earn an income from their agricultural activities,

the highest response being in Kirinyaga (100%) followed by Nakuru (99%) and Bungoma (88%).

Table 3: Household Farming Characteristics

Characteristic	County			Total
	Bungoma	Nakuru	Kirinyaga	
HH Type of Farming (Agriculture)				
Crop farming	60.78	57.83	60	59.09
Livestock	13.73	4.82	5	7.79
Mixed farming	25.49	37.35	35	33.12
HH Type of Crop Farming				
Both Subsistence and Cash Crop	23.53	51.81	75	45.45
Subsistence	64.71	27.71	15	38.31
Cash crop	11.76	20.48	10	16.23
HH Type of Livestock Keeping				
Both Subsistence and Commercial	50.98	64.94	83.33	61.43
Subsistence	45.1	31.17	16.67	35
Commercial	3.92	3.9	0	3.57
Total	**100(51)**	**100(83)**	**100(20)**	**100(154)**

3.2 Farmers' Understanding and Perceptions of Climate Change

3.2.1 Understanding of climate change

A majority (94%) of respondents believe that climate change exists and has occurred or is occurring in their locality, a belief that is highest in Kirinyaga county (100%) and lowest in Nakuru (92%). Level of education appears to have little influence on this perception as a high percentage of the respondents (greater than 89%) across all levels of education believe that climate change has/is occurring (Table 4). The strong belief that climate change exists was confirmed in the FGD sessions where different communities in the target counties reportedly had a local name for climate change, mostly translating or referring to drought. For example, in Bungoma county, climate change is referred to as *simiyu*. One reason for this could be that drought is the hazard most strongly associated with climate change in these areas and Kenya as a whole (cf. GoK 2010).

Table 4: Perception on occurrence of climate change per education levels

Characteristic	Household Head Level of Education				Total
	No formal schooling	Primary School	Secondary	Tertiary	
Climate Change has occurred in area					
Yes	100.0%	94.8%	89.8%	100.0%	94.3%
No	0.0%	3.4%	2.0%	0.0%	2.1%
Don't know	0.0%	1.7%	8.2%	0.0%	3.6%
Causes of Climate Change					
Natural	43.8%	56.9%	53.1%	35.3%	51.4%
Man-made	56.3%	43.1%	46.9%	64.7%	48.6%
Total (n)	**100%(16)**	**100%(58)**	**100%(49)**	**100%(17)**	**100%(140)**

The respondents were almost equally split on whether the cause of climate change is natural (51%) or man-made (49%). Sixty seven percent (67%) of Bungoma county respondents believe climate change is man-made while only 17% of Kirinyaga farmers believe so. More (65%) tertiary-educated respondents believe that climate change is man-made compared to primary- (43%) and secondary- (47%) level educated respondents. A higher number (56%) of respondents without any formal education believe that climate change is man-made rather than natural compared to those with primary and secondary-level education. Most FGD participants across the three counties identified deforestation, pollution, land degradation, cultivation along riverine ecosystems, and charcoal burning as some of the man-made causes of climate change. Natural causes of climate change were linked to God – in particular a belief that God is punishing us for disobeying His commands and teachings. As one FGD participant in Bungoma county noted;

> *"Me I think it's God's anger because human beings have disobeyed God's plans. God had planned His things such as agriculture but human beings think they're smarter than God hence they must be punished. Human beings have destroyed the planning of Mother Nature or God's natural plan hence changing the natural order of things. "*

An FGD participant from Kirinyaga County stated:

> *"What can we do? God is everything! Even if we plant trees and God says there will be no rain, will they grow? Of course not. We have to kneel down to God first."*

As results in Table 5 show, changes in rainfall patterns (28%), changes in heat conditions (25%), changes in humidity (17%), degradation of vegetation (14%), and degradation of soil fertility (10%) were reported as proof of the existence of climate change phenomenon. A relatively high percentage of Bungoma respondents (30%) identified change in rainfall and change in humidity (22%) as evidence of climate change compared to the other counties.

Table 5: Farmers' evidence of the existence of climate change

	Name of County			
Characteristic	**Bungoma**	**Nakuru**	**Kirinyaga**	**Total**
Understanding of Climate Change				
Change in rainfall	30.43	28.45	22.64	28.48
Change in heat conditions	21.74	27.16	22.64	24.66
Change in humidity conditions	21.74	14.22	15.09	17.04
Degradation of vegetation	9.32	15.52	18.87	13.68
Degradation of soil fertility	4.97	12.5	16.98	10.31
Prolonged rain season	7.45	1.72	1.89	3.81
Prolonged drought	4.35	0.43	1.89	2.02
Total	**100(51)**	**100(77)**	**100(12)**	**100(140)**

About 40% of respondents across the three counties reported drought as a key climatic hazard on their farms followed by pests and diseases (21%) (Table 6). Only 6% of the respondents reported floods as a climatic hazard, the highest being in Nakuru county (8%). Twenty five percent (25%) of Kirinyaga county respondents identified riverbank erosion as a major hazard by farmers while salinization is almost equally (13%) perceived by all the counties as a climatic hazard on their farms. Asked whether they have noted any long-term changes in key climate

change parameters, a majority responded in the positive. Specifically, 94% of the respondents noted a *decrease* in average rainfall over the last twenty years, 99% reported an *increase* in average temperatures over a similar period, while 90% noted *increased* frequency of drought, results which are consistent across all the counties. However, 53% reported no change in the frequency of floods, suggesting that floods are not a significant occurrence in the three counties.

Table 6: Key On-farm Climatic Hazards

Characteristic	County			Total
	Bungoma	Nakuru	Kirinyaga	
Key climatic hazards				
Drought	49.5	37.88	30	40.41
Pests and diseases	15.84	21.72	30	20.94
River bank erosion	12.87	16.67	25	16.52
Salinization	12.87	12.63	12.5	12.68
Floods	4.95	7.58	2.5	6.19
Landslides	2.97	3.03	0	2.65
Others	0.99	0.51	0	0.59
Total	**100(51)**	**100(77)**	**100(20)**	**100(140)**

A majority (98%) perceive climate change as bad (Table 7). Asked whether climate change is good, those who responded in the negative dropped slightly to about 94%. Those with a secondary and tertiary levels of education have a slightly more positive view of climate change at 10% and 12% respectively compared to 3% and 0% respectively for those with primary and without any formal education. This nuanced view of climate change was more evident in the FGD sessions where participants generally agreed that climate change can be both good and bad depending on the individual farmer, locality, time, and type of economic activity one is involved in. Some of the reported disadvantages included reduced/poor yields, high food prices, increased pests and disease incidences, lack of food and inadequate water supply. Those able to irrigate their farms, e.g. those close to permanent rivers or with boreholes generally perceive climate change positively as they are able to grow crops and sell their products at a higher price when there is drought.

Table 7: Influence of education on climate change perceptions

Characteristic	Household Level of Education				Total
	No formal schooling	Primary School	Secondary	Tertiary	
Is Climate Change a Good Thing					
No	100.0%	96.6%	89.8%	88.2%	93.6%
Yes	0.0%	3.4%	10.2%	11.8%	6.4%
Is Climate Change a Bad Thing					
No	2.6%	0.0%	6.3%	1.9%	2.0%
Yes	97.4%	100.0%	93.8%	98.1%	98.0%
Total	**100%**	**100%**	**100%**	**100%**	100%

3.2.2 Knowledge of and perceptions on climate change governance

Nearly a third (27%) of the respondents believe that farmers are the key stakeholders best placed to address climate change, a perception that is shared across the three counties. The

perception is slightly higher in Nakuru (29%) and lowest in Bungoma (24%) (Table 8). Moreover, when asked about the best governance level at which climate change should be addressed, about a third (32%) of the respondents ranked the farm/household level first. After the farm/household, the local/county level, the national/Kenya, regional/Africa, and global follow at 29%, 27%, 7% and 5% respectively. This trend is in tandem with the sustainable development mantra of '*think global, act local*'. Other key stakeholders to address climate change include national Government authorities, County governments, and scientists/experts.

Table 8: Perception on key stakeholders to address climate change

Characteristic	County			Total
	Bungoma	Nakuru	Kirinyaga	
Key stakeholders to address climate change				
Farmers	23.66	29.22	28.95	27.32
National government authorities	19.85	20.55	23.68	20.62
County government authorities	16.79	17.81	21.05	17.78
Scientists/experts	19.o8	18.26	10.53	17.78
Community	18.32	14.16	15.79	15.72
Others	2.29	0	0	0.77
Total	**100(51)**	**100(77)**	**100(12)**	**100(140)**

More than three quarters (77%) of respondents are not conversant with existing national climate change-related policies and legislations (Table 9). An even higher percentage (over 87%) were not aware of county climate change-related policies, although this could be linked to the fact that not many counties had developed such policies at the time of conducting the survey. These findings are consistent across the three counties. Less than half of the respondents were knowledgeable about specific national climate change policies (e.g. the NCCRS, NCCAP), regulations (e.g. Climate Change Act 2016) and institutions (e.g. NCCC and CCD). None of the FGD participants across the three counties knew any of the above policies, regulations and institutions. Many felt that those responsible for developing such policies and laws neither consult them during preparation nor educate them on their contents once they have been developed. Most FGD participants felt the situation is made worse by a general lack of agricultural extension officers on the ground. Nevertheless, most FGD participants were aware of other laws which have an impact on agriculture and climate change. Most notable was their knowledge of the Forestry Act. (2006) and related regulations (not the Act itself but rather some of its contents) which, among others, requires farmers and other stakeholders to plant trees with the aim of achieving the constitutional 10% tree cover requirement. Many were aware of the legal requirement of not cultivating on river banks and believed that planting of blue gum trees (*Eucalyptus spp*.) along river banks was contributing to the drying up of local rivers. A few FGD participants in Kirinyaga county were aware of the Kenya Forest Service (KFS) guidelines on planting of Eucalyptus trees (See KFS 2009) and one participant identified the Water Act. which regulates access to and management of water resources.

Table 9: Knowledge of policies at different governance levels

Characteristic		Name of County			Total
		Bungoma	Nakuru	Kirinyaga	
Knowledge of policies at different governance levels					
National Level	*Yes*	23.5%	23.4%	16.7%	22.9%
	No	76.5%	76.6%	83.3%	77.1%
County Level	*Yes*	27.5%	3.9%	0.0%	12.1%
	No	72.5%	96.1%	100.0%	87.9%
Subcounty Level	*Yes*	27.5%	6.5%	0.0%	13.6%
	No	72.5%	93.5%	100.0%	86.4%
Total		**100(51)**	**100(84)**	**100(20)**	**100(155)**

Only about 6% of respondents report having benefited from any climate change programme in the last ten years. The feeling of having not benefited was strongest in Kirinyaga county (100%) and lowest in Bungoma county (88%). Many FGD participants felt that such programmes were few and most were being implemented by non-governmental organisations (NGOs) rather than by Governmental authorities. An FGD participant in Bungoma lamented that…

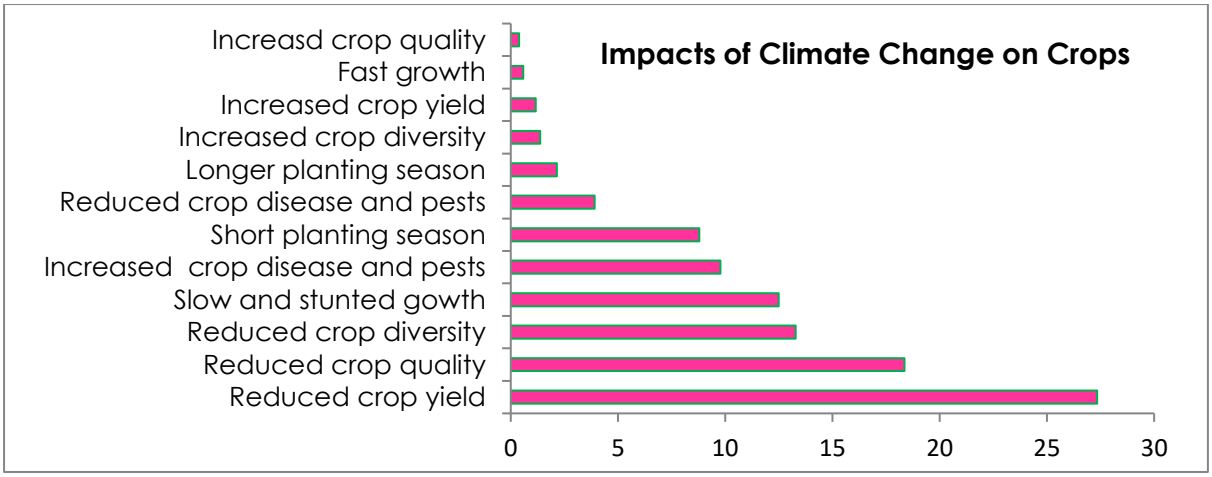
> *"We are very sad. How is it that it is the outside world (*meaning international NGOs and donor community*) that is opening our farmers' eyes? Our own Government is not opening our farmers' eyes."*

The FGD sessions revealed that the farmers feel that the existing agricultural programs, few as they are in their opinion, target largescale or commercial farmers (e.g. flower farms) rather than small scale farmers like themselves. Moreover, they strongly believe that some of the agricultural practices practised by the largescale farmers were negatively affecting small-scale farmers and compromising their ability to adapt to climate change. Participants from Nakuru county gave the example of *cloud seeding* reportedly practised by commercial flower farms around Lake Naivasha which they say disperses the rain clouds and prevents rain from falling, thus affecting their agricultural activities. They suggested that the Government should outlaw such harmful activities, set aside land and areas of the country for subsistence farming through national and county-level land-use planning, and consider putting a mandatory quota for commercial farms to dedicate a section of their land or production to subsistence farming if the country is to achieve food and nutrition security.

3.3 Impacts of Climate Change on the Farm and Decisions

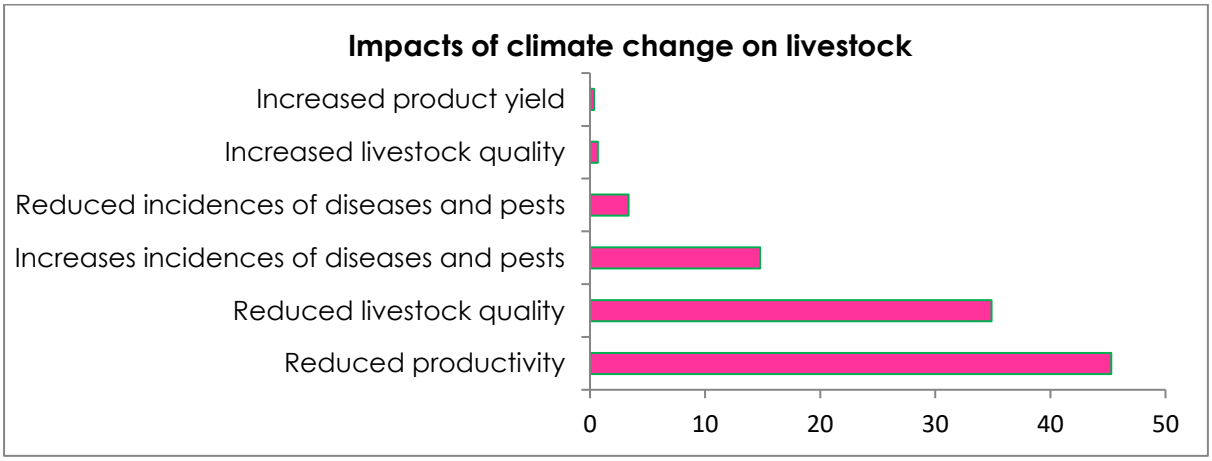
Reduced crop yield was the most reported impact of climate change on crops by 27% of the respondents. Reduced crop quality (18%), reduced crop diversity (13%), slow and stunted growth (13%), and increased crop disease and pests (10%) are other impacts noted by the respondents (Fig. 1). *Increased crop yield* is reported by 2% of respondents in Nakuru county but not the other Counties.

Fig. 1: Reported Impacts of Climate Change on Crops (N=140)



Reduced livestock productivity is reported by 45% as one of the impacts of climate change on their livestock (Fig. 2). This is highest in Kirinyaga county (63%) and lowest in Bungoma county (43%). Other significant impacts are reduced livestock quality (35%) and increased incidences of disease and pests (15%). Changes in soil fertility, particularly a *reduction* in fertility is reported by 91% of the respondents. Reduced incidences of diseases and pests is reported by 3% of the respondents, a response which is largest in Bungoma county at approximately 7%. The particular instances and conditions under which climate change leads to *reduced* instances of diseases and pests and *increased* crop and livestock quality is worth further scrutiny.

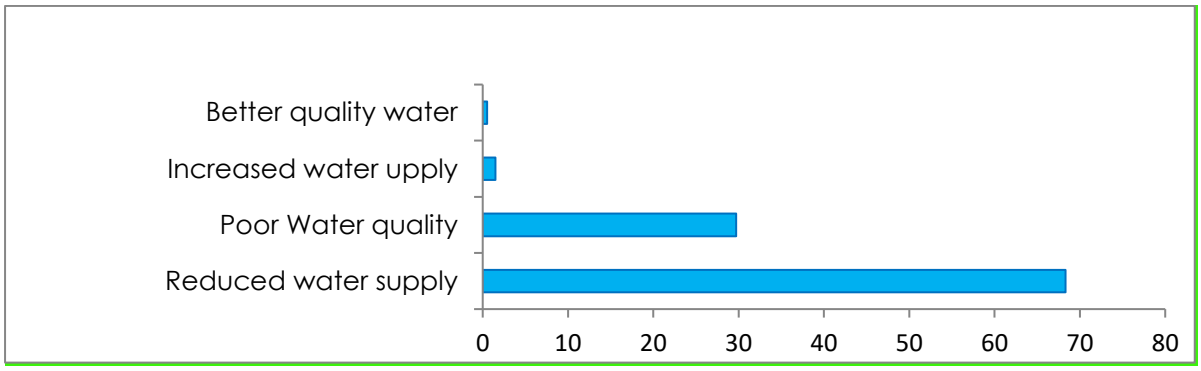
Fig. 2: Impact of climate change on livestock (N=140)



Sixty eight percent (68%) of the respondents consider reduced water supply for both agricultural and domestic use an impact of climate change on their farms (Fig. 3). More (92%) Kirinyaga county respondents reported this impact of climate change compared to 63% in Bungoma county. The reduced water supply is coupled with poor water quality reported by an average 30% of the respondents. Destruction of roads is the most reported impact on infrastructure by approximately 48%, followed by destruction of storage facilities such as granaries and silos by 21% of the respondents. Faster wear and tear of farm equipment is considered an impact by about 18% of the respondents. FGD respondents in Kirinyaga county reported increased breakage of plastic rain water harvesting tanks, a situation they attributed

to climate change induced higher temperatures. One of their suggested solutions was the manufacture of white water tanks or the coating of the water tanks white to reduce their heat absorbing capacity.

Fig. 3: Impact of climate change on water supply (N=140)



As shown in Table 10, dwindling markets is reported by about 40% of the respondents as other climatic impacts noted within the locality. Interestingly, 13% of the Kirinyaga county respondents identified *improved* markets as an impact. Nevertheless, difficulties in accessing farm supplies (as reported by 43% of respondents), challenges of accessing farm laborers and other support staff (72%), poor extension services (60%), and poor weather forecasts (15.9%) are other perceived impacts reported by 43%, 72%, 60% and 16% of respondents respectively.

Table 10: Impact of climate change on locality and surrounding farms

Characteristic	Name of County			Total
	Bungoma	Nakuru	Kirinyaga	
Impact on other farms in area				
Dwindled markets	42.11	41.22	26.67	39.93
Reduced water supply	31.58	31.76	33.33	31.87
Inaccessible roads	25.26	26.35	23.33	25.64
Improved markets	0	0.68	13.33	1.83
Improved water supply	0	0	3.33	0.37
Others	1.05	0	0	0.37
Total	**100(51)**	**100(77)**	**100(12)**	**100(140)**

Overall, a majority (96%) of the respondents are influenced by climate change in making decisions related to their farms (Table 11). Kirinyaga county reported the highest percentage (17%) of those who reported *not* being influenced by climate change in their decision-making. In line with the above findings, most FGD participants also reported that climate change phenomenon influenced their decision-making, with such decisions including whether to plant short season crops, reduce or increase the size of commercial farm land vis-à-vis subsistence farming, practise crop rotation, etc. However, lack of adequate and reliable information is a challenge they identified as negatively affecting their decision-making as it sometimes necessitates a wait-and-see attitude. This was reported in cases such as where farmers don't trust the meteorological department's weather forecasts. In some cases, FGD participants noted that they base their actions on the prevailing decisions taken by other local farmers.

Table 11: Influence of climate change on farm decisions

Characteristic	Name of County			Total
	Bungoma	Nakuru	Kirinyaga	
Influence of climate change on farm decisions				
Yes	100.0	96.1	83.3	96.4
No	0.0	3.9	16.7	3.6
Total	**100(51)**	**100(77)**	**100(20)**	**100(140)**

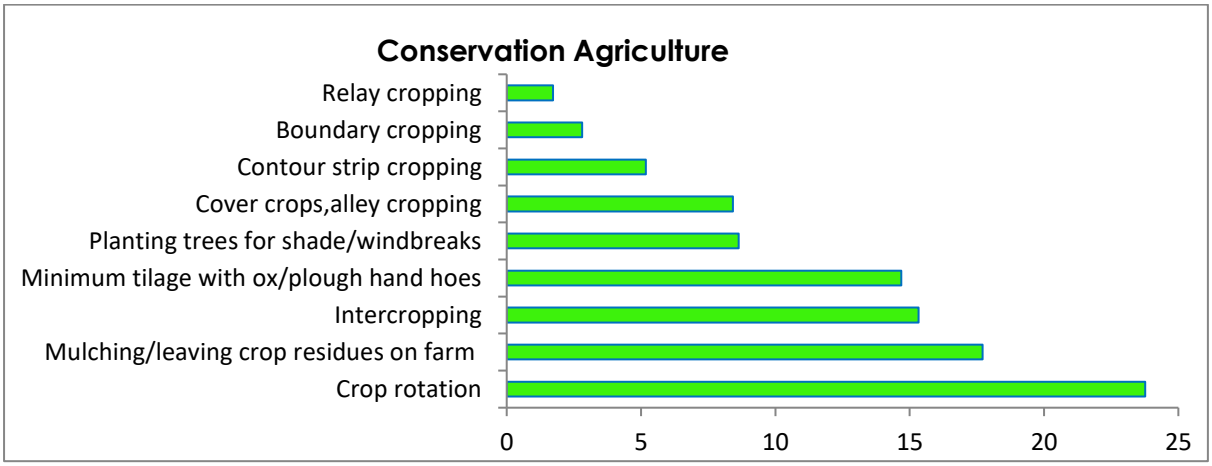
3.4 Farmers' Response and Coping Strategies

The respondents have adopted several response and coping strategies to the impacts of climate change they witness on their farms. They include conservation agriculture (CA), crop-livestock integration, integrated soil and water resource management (IRM), social safety nets, and payment for ecosystem services (PES) such as for water abstraction.

3.4.1 Conservation agriculture

Of the various conservation agriculture (CA)[2] practices, crop rotation is the most practised (23%) by the respondents across the three counties (Fig 4). The practise is highest in Kirinyaga county (48%) compared to Nakuru (23%) and Bungoma (21%) counties. Mulching is the next most practised strategy by approximately 18% of the respondents. Kirinyaga county reported the least adoption of mulching (4%), a trend explained in the FGD sessions as linked to the difficulty of getting mulch in the county due to the crops grown, small size of farms, and competition for other uses such as livestock feed. Other CA practices adopted include intercropping, minimum tillage through use of ox plough and hand hoes, cover crops, contour (grass) strips, and agroforestry. Growing of fruit trees is the most common agroforestry practice as reported by 24% of the respondents (Table 12).

Fig. 4: Conservation agriculture practices implemented (N=139)



[2] See Cornell University (http://conservationagriculture.mannlib.cornell.edu/pages/aboutca/whatisca.html) and FAO (http://www.fao.org/ag/ca/).

Table 12: Agroforestry

Characteristic	Name of County			Total
	Bungoma	Nakuru	Kirinyaga	
Agroforestry/Silviculture				
Fruit trees	20.3	14.44	61.54	24.26
Fodder trees	16.67	21.11	23.08	19.53
Woodlots	16.67	12.22	0	13.02
Other	36.36	52.22	15.38	43.2
Total	**100(51)**	**100(76)**	**100(12)**	**100(139)**

3.4.2 Integrated soil and water management

Composting is the most widely used integrated soil and water resource management (IWRM) practice reported by an average of 18% of the respondents (Table 13). Rainwater harvesting is practised by 17% of the respondents, with Bungoma county having the highest percentage at 21%. Only 3% of Kirinyaga respondents reported practising harvesting rainwater as an adaptation/coping strategy. Irrigation is practised by 12% of the respondents, with Kirinyaga county reporting the highest (39%) percentage of the practice followed by Nakuru county (12%) and to a lesser extent Bungoma county (4%). Terracing on farms to control soil erosion is more prevalent in Kirinyaga county (23%), while harvesting of surface water runoff is reported by more farmers in Bungoma county (10%) than in Nakuru (8%) and Kirinyaga (0%) counties. Use of *zai*/planting pits is reported in Bungoma (7%) while their usage is insignificant in Nakuru and Kirinyaga counties. The researchers did observe the use of pits in banana plantations in Kirinyaga county.

Table 13: Integrated soil and water resource management practices

Characteristic	Name of County			Total
	Bungoma	Nakuru	Kirinyaga	
Integrated soil &water resource mgt. (IWRM)				
Compositing	15.38	19.25	19.35	18.01
Mulching	15.38	20.66	0	17.17
Rain water harvesting/roof water-harvesting	20.51	16.9	3.23	16.9
Irrigation(crop)	4.21	11.74	38.71	11.63
Terracing on farms to control erosion	11.97	9.39	22.58	11.36
Harvesting and storage of surface water runoff (e.g. in ponds, sand dams, etc.)	10.26	8.45	0	8.31
Efficient use of fertilizers	10.26	5.16	6.45	6.93
Diversion ditches	3.42	6.57	6.45	5.54
Zai/planting pits	6.84	0.94	0	2.77
Fish farming	0	0.94	3.23	0.83
Other	1.71	0	0	0.55
Total	**100(51)**	**100(76)**	**100(120**	**100(139)**

3.4.3 Crop-livestock integration and insurance

Approximately 52% of the respondents reported using plant residues and livestock manure for crop production. The practice is however less prevalent in Kirinyaga county (8%) compared to Nakuru (62%) and Bungoma (47%). Zero grazing with improved feeds is

practised by 23% of respondents while keeping of dairy goats and improved cow breeds was reported by approximately 16% of the respondents. Use of improved breeds is prevalent in Kirinyaga county (83%) but comparatively less in Nakuru (19%) and Bungoma county (3%). Although a majority (96%) had traditional insurance, those targeting climate change impacts were insignificant. Livestock insurance was more prevalent (approx. 4%) than crop or area/yield-based insurance cover (less than 1%). Kirinyaga county leads in usage of livestock insurance at approximately 17%, a situation confirmed by Kirinyaga FGD participants who reported its availability and wide adoption. Most FGD participants seemed to agree that the major challenge with insurance uptake is not the lack of insurance products per se but rather the monthly premium which many consider to be high compared to the risk insured against.

Fig. 5: Crop-livestock integration response strategies implemented (N=139)

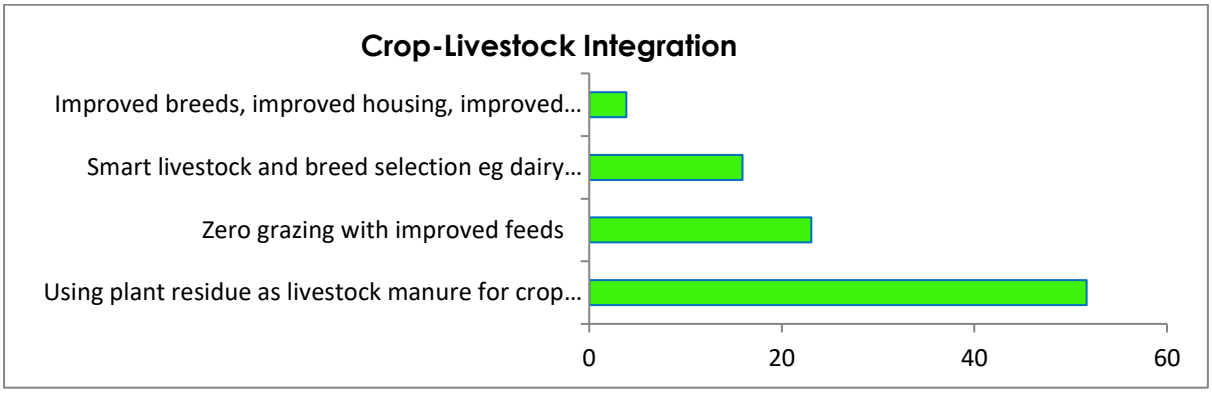


Table 14: Insurance uptake

Characteristic	Name of County			Total
	Bungoma	Nakuru	Kirinyaga	
Index Weather Based Crop and Livestock Insurance				
Area/yield-based insurance	0.0	1.3	0.0	0.7
Livestock insurance	0.0	3.9	16.7	3.6
Others	100.0	94.7	83.3	95.7
Total	**100(51)**	**100(76)**	**100(12)**	**100(139)**

3.4.4 Social safety nets, access to credit, renewable energy, and other response strategies

A majority (83%) of the respondents across the three counties reported being members of a self-help group, 10% with membership to an agricultural Cooperative Society, and 8% with membership to a women group (Table 15). Subsidized inputs, particularly fertilizer and seeds, is a safety-net programme that has been accessed by 36% of the respondents, with Kirinyaga county reporting the highest (75%) percentage (Table 16). However, some FGD participants from Bungoma claimed that the subsidized fertilizers do not improve their yields and would rather buy other types of fertilizers from the market. A few contend it's a "political gimmick." Reports that National Cereals and Produce Board (NCPB) officials sold fertilizers adulterated with glass and rocks to farmers[3] seems to buttress the FGD participants' claims. None of the Bungoma respondents reported having benefited from food aid compared to 8% and 4% from

[3] See Daily Nation Monday June 11, 2018. How rouge traders made billions from fake fertilizers. https://www.nation.co.ke/news/Billions-made-from-tainted-fertiliser-says-PS/1056-4605556-eypdey/index.html

Kirinyaga and Nakuru counties respectively. Only 2% of respondents across the 3 counties reported having accessed credit facilities.

Table 15: Membership of collective/self-help groups

Characteristic	Name of County			Total
	Bungoma	Nakuru	Kirinyaga	
Collective Action focusing on local conventions				
Women group	11.76	5.13	7.14	7.69
Cooperatives	0	14.1	21.43	9.79
Other	88.24	80.77	71.43	82.52
Total	**100(51)**	**100(76)**	**100(12)**	**100(1390**

Table 16: Access to social safety nets

Characteristic	Name of County			Total
	Bungoma	Nakuru	Kirinyaga	
Safety net programs in use				
Food aid	0	3.85	8.33	2.76
Subsidized inputs (fertilizer & seeds)	34.55	30.77	75	35.86
Storage facilities	7.27	5.13	0	5.52
Credit facilities	1.82	2.56	0	2.07
Others	56.36	57.69	16.67	53.79
Total	**100(51)**	**100(76)**	**100(12)**	**100(139)**

Other response strategies such as pilot agricultural carbon projects have been undertaken in some of the study areas, e.g. the World Bank Kenya Agricultural Carbon Project in Bungoma. Some FGD participants had knowledge about them but none had personally participated in or benefited from them. Payment for water abstraction by farmers to the Water Resources Authority (WARA) and the National Irrigation Board (NID) is a form of payment for ecosystem services (PES) which is known by all respondents in Kirinyaga county (100%), a few in Nakuru (21%) but not so many in Bungoma county (2%). FGD participants in Kirinyaga complained that they pay for the water even when they are not using it, or when there is drought and no water is being supplied. Improved cook stoves are the most widely used energy technology (cited by 33% of the respondents) followed by solar energy (26%) and biogas (approx. 2%) (Table 17). No use of biogas is reported in Kirinyaga County. However, FGD participants in the County knew of some farms that had installed biogas.

Table 17: Other adaptation strategies

Characteristic	Name of County			Total
	Bungoma	Nakuru	Kirinyaga	
Other Adaptive Strategies to Climate Change				
Effective cooking stoves	23.73	40.45	28.57	33.33
Solar energy	20.34	22.47	71.43	25.93
Biogas	3.39	1.12	0	1.85
Others	52.54	35.96	0	38.89
Total	**100(51)**	**100(76)**	**100(120**	**100(139)**

3.4.5 Barriers and challenges to adoption and upscaling of the response strategies

Over 89% of the respondents reported that there are indeed barriers to the adoption or upscaling of the adaptation and response strategies they practise on their farms. Some of the barriers or challenges identified include insecurity (emphasised by Bungoma FGD participants), lack of insurance facilities to cushion farmers against climate change (main reason being the considered high premiums), difficulty in accessing credit, distrust amongst farmers (hence little impetus to join Cooperative Societies), and corruption and nepotism - especially by Government officials. Inadequate access to reliable information was another reported challenge. Many FGD respondents felt that scientists should conduct farmer-relevant research and present their findings and recommendations to farmers using innovative yet appropriate approaches and media. *Shamba Shape Up*, a TV and radio programme targeting farmers was identified as one such innovative approach. The reliability of some scientific outputs was also considered a challenge, e.g. the reliability of the weather forecasts from the Meteorological Department.

Another reported barrier was that few youth are engaging in farming. This means that the aging/senior farmers cannot implement some of the response strategies that require youthful stamina, while transmission of farming skills to the next generation is curtailed. FGD participants suggested that one way to tackle this challenge is for the national and county Governments to train and employ more youth in agriculture by putting in place incentives such as more educational scholarships for agricultural courses. Lack of trust by farmers of 'certified seeds' found in the market due to counterfeits and unscrupulous traders was another reported challenge, particularly for those intent on using improved seed varieties as an adaptation strategy. High cost of installation, lack of qualified artisans, and availability of other alternative energy options were noted as some of the challenges to biogas adoption.

3.5 Motivations Behind and Effectiveness of the Response Strategies

One of the objectives of the study was to characterize the motivations behind the various response and coping strategies adopted by farmers into *intrinsic* and *extrinsic* motivations. Intrinsic motivations were understood as those practices which are done by the farmer because they enjoy doing them, find them interesting, or have been passed down to them culturally or through family tradition hence have become 'normal' practice. On the other hand, extrinsic motivations were understood as practices done because of an external influence, reward, authority, or 'expert'. In other words, they have been recommended by a third party, are adopted to get external rewards (e.g. recognition), or to avoid negative consequences or punishment (e.g. a legal requirement). Economic considerations were thus grouped under extrinsic motivations.

3.5.1 Intrinsic and extrinsic motivations

Due to the many potential coping and response strategies under probe and the average time required to fill the questionnaire by the respondents, it was decided that the best approach to elicit and expound on the motivations behind the adaptation strategies would be through focus group discussions. Most FGD participants across the three counties indicated that they undertake many of the on-farm response and coping strategies out of intrinsic motivations. For example, some of the participants said that they plant trees on their farms or have grain storage facilities (granaries) as part of tradition rather than due to the existence of any law or Government policy requiring such actions. However, this does not mean that extrinsic motivations play no part in influencing their decisions. Rather, the two types of motivations interact in a recursive manner to influence the final decisions and choices made. For example, participants in Kirinyaga reported that it is much cheaper to practise minimum tillage (e.g. spraying of crops) rather than employ labourers to weed. This is an example of an economic

(extrinsic) motivation. Understanding the two motivations and how they interact with each other can assist in designing better ecological and climate-resilient agricultural policies and programmes. The following quotes from FGD participants highlight this duality:

"To me agriculture is my hobby"

FGD participant from Nakuru county

"Education. We have studied these things. You know some of us have studied agriculture. Also practice. You know some of us have been brought up with farming. So we see what our parents are doing and we follow"

FGD participant from Nakuru county

"We use both traditional and contemporary knowledge"

Bungoma FGD participant

"Some of the things we learn from one another. For example, If I go to my neighbour and see something new that is working, I'll ask him how did you do it? Then someone else comes to my farm and asks, and that way we learn from each other"

FGD participant from Nakuru county

"I think its tradition. Like in this area there are only two types of maize varieties people are planting"

Kirinyaga FGD participant

"Me I think it comes from the climate change itself. It's the situation you find yourself that forces you to go and get that information, what you are supposed to do. If this type of maize is not doing well on your farm, you'll go out to find solutions"

Kirinyaga FGD participant

"Government not so much but experts I will say influence us a lot. For example, for those with or without experience, if you go to the agrovet they will tell you to use this or that, and you follow"

Kirinyaga FGD participant

3.5.2 Effectiveness and benefits of the adopted response strategies

Responses were solicited on the farmers' opinions on the effectiveness of their adopted response strategies. The indicators of 'effectiveness' were understood to be whether the strategies solved or reduced the severity of the perceived problem or climatic impact, and/or whether there were increased yields as a result of the adopted responses. Most FGD participants across the three counties noted that it is difficult to pinpoint which of the various adopted measures were effective and which ones were not. This is because, they opined, many of the response strategies are used in combination on the farm hence isolating the effectiveness of one practice over the other becomes difficult. Nevertheless, many were generally of the view that if done well, their adopted climate change response strategies were indeed effective. The benefits of the adopted adaptation strategies include provision of food and medicines, diversification of livelihoods, generation of income, demarcation of boundaries, provision of shade, protection of soil and land from degradation, etc. These benefits demonstrate the nexus between adaptation and mitigation in which some mitigation actions (e.g. tree planting) have adaptation benefits (e.g. food provision) and vice versa.

4.0 DISCUSSION

This section interprets and discusses the key results following the four specific objectives. The results confirm that agriculture is the key livelihood activity for the three counties. The respondents have all levels of education – from no formal education to degree-level education. Women form a significant part of the farming community while a significant portion of the respondents earn an income from their agricultural activities.

4.1 A local name, visible signs, and farmer is key; but is it natural or man-made?

The knowledge and perception of farmers that climate change is existing or happening is most readily reflected in having a local name for it. The local name for drought is what in most cases is also given to climate change, suggesting drought is the hazard most associated with climate change in these counties. It could also mean that drought is the farmers' worst fear. Changes in rainfall patterns, degradation of vegetation, reduced rainfall, increased pest and diseases, and reduced soil fertility are some of the signs the farmers have observed, and which confirm to them the existence of climate change. Though generally perceived negatively, a nuanced picture in which climate change is seen as having both advantages and disadvantages emerge. More importantly, the respondents consider farmers and the farm/household as the single most important stakeholder and level respectively to address climate change. In essence, farmers believe that, with the support of government authorities, scientists and other experts, they are the ones who should be at the centre in efforts aimed at addressing climate change. Such a farmer-centred approach aligns with emerging bottom-up approaches to environmental and climate change governance approaches such as community-based adaptation (CBA) and ecosystem-based adaptation (EBA) approaches.

Analysis of the responses to whether climate change is natural and/or man-made reveals that the scientific distinction between natural and man-made causes of climate change is not as clear cut to farmers as it is to scientists and, perhaps, policymakers. Scientifically, climate change has both natural and man-made causes, even though evidence overwhelmingly point to human activities as the major cause of current climate change (IPCC 2007). According to the scientific community, the natural causes include orbital changes, volcanic eruptions, variation in solar radiation, movement of crustal plates, and El Niño-Southern Oscillation (ENSO) (IPCC 2007). Many farmers however interpret natural causes of climate change as God's will or the result of God's intervention. Based on this understanding, the respondents have an almost seamless connection between the natural and man-made causes of climate change. That is, it is due to man's 'bad' or 'sinful' actions that has made God angry and out of this anger, God is punishing us (through climate change). Such a belief connection is however lacking in the scientific differentiation between natural and man-made causes of climate change. This difference in understanding and resultant application can be put to good use. It offers a window of opportunity for faith-based organisations (FBOs) and other interested groups to use the environmental teachings of various religions to advocate and influence farmers to practice environmentally conscious agriculture, including systemic ecological organic agriculture, that enhances adaptation and resilience.

4.2 Some impacts are positive, on-farm decisions strongly influenced by climate change

Climatic impacts such as reduced soil fertility, reduced yields, and increased pest and disease incidences were reported by the respondents. These are to be expected. However, unexpected impacts such as increased crop yields and reduced incidences of diseases and pests were also reported, though by a smaller percentage. Such responses represent opportunities which need further scrutiny and, where possible, be upscaled. One example is the upscaling of small-scale irrigation for enhanced food security and resilience.

Climate change strongly influences farmers' on-farm decisions. Such decisions include the type and varieties of crops to grow, the size of land to till either for subsistence or commercial purposes, and what adaptation and coping strategies to employ. But in order to make more informed decisions, the farmers need adequate and reliable informational and technical support, e.g. weather forecasts, access to quality certified seeds, etc.

4.3 Farmers believe response strategies are effective, but challenges remain

Various response and coping strategies are adopted by the respondents, both on-farm (e.g. soil and water conservation practices, conservation agriculture, agricultural intensification through mixed farming) and off-farm (e.g. agro-weather forecasts, insurance, and membership of self-help groups). Most respondents perceive their adopted strategies as being effective if properly implemented. This points to a high degree of faith in their adopted strategies but could also be a call for external support to ensure they are properly implemented. The preference for particular response strategies is possibly influenced by many factors, including the specific impact targeted, type of agricultural system, geography and topography of the area, prevailing agricultural practices, costs involved, as well as expected benefits or outcomes. Inadequate access to reliable information, distrust for certain scientific outputs such as agro-weather forecasts, and few youths interested or engaging in farming are some of the challenges and barriers encountered by the farmers. Many of these challenges can be addressed if farmers are actively involved in and their perspectives genuinely mainstreamed into the design and implementation of potential solutions. For example, the integration of traditional/indigenous weather knowledge systems into early warning system (EWS) that involves the farmers in data provision and analysis is one way of building trust in the weather forecasts.

4.4 Both intrinsic and extrinsic motivations influence adopted response strategies

Being a livelihoods activity, agriculture is deeply embedded in local culture and traditions. As such, farmers understand and practise farming through their own formal and informal systems and norms that govern factors such as labor, gender, identity and beliefs (Quinn 2017). Adaptation and other climate change response strategies can be *reactive* – triggered by past and present events, or *anticipatory* – based on some assessments of conditions in the future (Wreford 2010). The survey results reveal that tradition, formal education, peer learning, personal experience, and 'experts' are some of the sources of information, knowledge and motivation behind the response strategies adopted by the farmers. In essence, both intrinsic and extrinsic motivations play a part in influencing farmers' choice of response strategies. However, which motivation trumps over the other in any particular decision is not easy to tell even for the farmers themselves. Nevertheless, understanding these motivations and how they interact with each other can assist in designing better ecological and climate-resilient agricultural policies and programmes. An analytical framework that incorporates the psycho-analytic split between *unconscious beliefs* and *conscious awareness* which all human beings possess (Zizek 1989) is a useful approach to understanding this duality. Moreover, the understanding of who constitutes an 'expert' from a farmer's perspective appears much broader than the conventional understanding. For example, as highlighted in the Results section, agrovet shop attendants are considered experts by farmers.

5.0 CONCLUSION AND RECOMMENDATIONS

This survey investigated farmers' understanding of climate change and its impact on their livelihoods. It has revealed farmers' adaptation and response strategies and the motivations behind them. The results show that a majority (94%) believe that climate change exists and is occurring as evidenced by the local names given to the climate change phenomenon and the various impacts they witness or perceive. Although generally perceived as negative, a more nuanced view of climate change as both positive and negative also emerge. Some surprising positive impacts are identified by the farmers and should be investigated further for possible upscaling. Reduced yields and quality, increased incidences of disease and pests, reduced soil fertility, and reduced water supply are some of the impacts reported by farmers. A majority (96%) of respondents are influenced by climate change in making farm-level decisions such as what crops to plant and what husbandry practices to adopt. A combination of adaptation and/or coping strategies are employed by farmers depending on the prevailing agricultural systems and perceived climatic impacts. Regrettably, only 2% of respondents across the 3 counties reported having accessed credit facilities in the past. Nevertheless, both intrinsic (e.g. tradition, agriculture being a hobby, etc.) and extrinsic (e.g. influence of experts and economic considerations) motivations influence the choice of response strategies adopted. The adopted coping strategies are generally considered effective by the respondents but could be enhanced if certain barriers they face are addressed.

A significant finding is that farmers consider themselves as the single most important stakeholder in addressing climate change, albeit with support from government authorities, scientists, and other experts. However, they are rarely involved in formulation and implementation of relevant policies, regulations and plans as illustrated by their own sentiments and very limited knowledge of such policies and plans. Being a livelihood activity, agriculture is deeply socially embedded. Farmers therefore understand and practice farming through their own cultural and traditional lens. For example, farmers' understanding of who constitutes an 'expert' does not always tally with that of scientists and/or policy-makers. Such differences in understanding should be appreciated and used to inform policy and practice.

The following recommendations emanate from the results of the survey:

1. More effort should be put in strengthening the capacity of farmers to develop their own knowledge base and to find ways of promoting innovative activities at the interface of science and indigenous knowledge.
2. Farmers' indigenous knowledge, experiences, perceptions and opinions should form a significant part of agricultural policies and programs. This can be achieved by being mainstreamed into the planning and policies of governments, the private sector, and academia through participatory development, implementation, monitoring and evaluation (M&E).
3. Responses to climate change in the agriculture sector, both policy and practice, need to align with local cultural traditions, values and norms. Such traditions create opportunities and risks for farmers, and influence their adoption of various response strategies, but are rarely given due attention.
4. Differences in perception and understanding of (aspects) of climate change between farmers on the one hand and scientists and policy-makers on the other hand should be appreciated as a window for continued learning and engagement. Faith-based organisations (FBOs) can utilise such opportunities to promote ecologically conscious and resilient agriculture through the environmental teachings of various faiths.

5. More research on farmers' decision-making pathways is needed, especially on how intrinsic and extrinsic motivations interact under different circumstances to influence the final decisions. Design and conduct of a follow-up survey focusing specifically on this element is recommended.

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ANNEXES

Annex 1: Farmers' Questionnaire

Farmer Questionnaire for the A Study on Farmers' Understanding of Climate Change and their Response Strategies to the Effects of Climate Change in their Farm Lands.

Introduction

Good morning/afternoon/evening. My name is _____. I am conducting a study on behalf of/for Biovision Africa Trust (BvAT) who; together with PELUM Kenya and World Agroforestry (formerly ICRAF) under the continental Ecological Organic Agriculture Initiative (EOA), are undertaking a study on farmers' understanding of climate change and how they respond to the effects on their farm lands.

Reason for the Research

You are being asked to take part in the research to solicit your opinion as a farmer. The study will support the achievement of the objectives of the EOA which is to mainstream ecological organic agriculture into national agricultural production and promote ecologically sound strategies and practices for sustainable development in Africa. This study is simultaneously being conducted in Bungoma, Nakuru, and Kirinyaga counties during the month of January 2017. Kindly answer all questions that will be asked as genuinely as possible based on your own understanding and experiences on your farm. It will take between 30 to 45 minutes.

Confidentiality

If you agree to participate, I will ask you some questions. We will protect the information about you and your part in this research to the best of our ability. You will not be named in any reports. The information you are giving Biovision Africa Trust (BvAT) together with PELUM Kenya and World Agroforestry (formerly ICRAF) and its partners will only be used for the purposes pf this study

Leaving the Research

You may leave the research at any time. If you choose to take part, you can change your mind at any time and withdraw.

Questions

Should you have any questions during or after the interview, please feel free to ask the interviewer or email the Principal Investigator, Dr. Martin Oulu (ochiengmoulu@gmail.com), or BvAT (C/O ICIPE), P.O. Box 30772-00100, Duduville Kasarani, Off Thika Road, Nairobi, Kenya. Thank you for your co-operation.

PART 1: IDENTIFICATION CHARACTERISTICS

Village Data

#	Question	Code	Skip Pattern
1	Name of County	1. Bungoma 2. Nakuru 3. Kirinyaga	
2	Name of -County		
3	Name of Location		
4	Name of Sub-Location		
5	Name of Village		
6	Is locality an urban, rural or a mixed one?	1. Urban 2. Rural 3. Mixed (Peri-urban)	
7	GPS coordinates	Longitude…. Latitude…. Altitude….	
Farmer/Household Data			
1	Respondent is household head	1. Yes	

		2. No.	
2	What is your key livelihood source?	1. Farming 2. Employment 3. Business 4. Other	If Not farming, end interview
3	Gender	1. Female 2. Male	
4	Age	1. 15-19 years old. 2. 20-29 years old 3. 30-39 years old 4. 40-49 years old 5. 50-59. years old 6. 60 years and above	
5	Marital Status	1. Married 2. Single 3. Widow/Widower 4. Other	
6	Highest level of education	1. No formal education... 2. Primary 3. Secondary 4. College /University	
7	What is your monthly family budget? (probe for estimation if unsure about exact budget)	1. Below 5,000 2. 5,000- 10,000 3. 10,000-15,000 4. 16,000-20,000 5. 21,000-25,000 6. 26,000-30,000 7. 31,000-35,000 8. 36,000-40,000 9. OVER 40,000	
8	What is the major area of household expenditure	1. Rent 2. Farm lease 3. Food 4. Fees 5. Hospital Bills 6. Other (Specify)	
9a	Do you have any family members who are financially dependent on you?	1. Yes 2. No.	
9b	If yes, how many?	1. 1 2. 2 3. 3 4. 4 5. 5 6. 6 7. Over 6	
10	How long have you lived in the area?	_____ number of years)	
Farming Activities			
11	What is your **main** farming activity?	1. Crop farming 2. Livestock farming 3. Mixed farming	

		4. Others (Specify)	
12a	What type of crop farming do you undertake?	1. Cash Crop farming 2. Subsistence farming 3. Both cash crop and subsistence farming	
12b	Which of the following crops do you grow?	1. Maize 2. Millet 3. Sorghum 4. Legumes (Beans, Groundnuts etc) 5. Fruits 6. Cassavas 7. Potatoes 8. Yams 9. Sugarcane 10. Coffee 11. Tea 12. Fodder 13. Vegetables 14. Others (Specify)	
12c	What are the TWO major Crops planted?	1. Maize 2. Millet 3. Sorghum 4. Legumes (Beans, Groundnuts etc.) 5. Fruits 6. Cassavas 7. Potatoes 8. Yams 9. Sugarcane 10. Coffee 11. Tea 12. Fodder 13. Vegetables 14. Others (Specify)	
13a	What type of livestock farming do you undertake?	1. Commercialized farming 2. Subsistence livestock keeping	
13b	Which of the following livestock do you keep?	1. Draught Cattle 2. Cattle 3. Sheep 4. Goats 5. Poultry 6. Others (Specify)	
13c	What is the main livestock kept?	1. Draught Cattle 2. Cattle 3. Sheep 4. Goats 5. Poultry 6. Others (Specify)	
14	Does the farming activity undertaken yield any income?	1. Yes 2. No	
15a	How did you acquire the land you currently use for farming?	1. Inherited 2. Lease/Purchased 3. Communal 4. No Response 5. Others (specify)	

15b	Do you have legal title document(s) to the land you currently occupy/use?	1. Yes 2. No 3. I don't know	
	Ask for permission to take photo of the farm and livestock		
Part 11: Farmers Understanding and Perception of Climate Change			
16	What do you understand by climate change? (description and name in local language if available. Probe distinction between climate change and weather).	1. Change in rainfall patterns 2. Change in heat conditions 3. Change in humidity conditions 4. Prolonged rain seasons 5. Floods 6. Degradation of soil fertility 7. Degradation of vegetation 8. Don't know 9. Others (Specify)	
17	Over the last twenty (20) years, have you noticed any long-term changes in: **a) Mean Rainfall?** b) **Mean Temperature**? c) **Frequency of drought**? **d) Frequency of floods?**	**1.**Decrease **2.**Increase **3.**No change **4.**Don't know **1.**Decrease **2.**Increase **3.**No change **4.**Don't know **1.**Decrease **2.**Increase **3.**No change **4.**Don't know **1.**Decrease **2.**Increase **3.**No change **4.**Don't know	
18	Do you believe climate change has occurred in this locality?	1. Yes 2. No 3. Don't know	
19	What or who do you think is the cause of climate change?	1. Natural (kindly list the natural) 2. Man-made (kindly list the man-made) 3. Others (Specify)	
20	What are the key climatic hazards on your farm and locality?	1. Drought/irregular rains 2. Floods 3. Landslides 4. Salinization 5. River bank erosion 6. Pests and diseases 7. Others (Specify)	
21	Do you think climate change is good or bad? (multiple answers possible)	1. Bad (why?) 2. Good (why?) 3. Don't know	
22a	Who, in your opinion, are the Key Stakeholders that should address climate change?	1. Farmers 2. National government authorities 3. County government authorities 4. Scientists/experts 5. Community 6. Others (Specify)	
22b	At what governance levels, in your opinion, should climate change be addressed? (multiple answers possible)	1. Farm/Households 2. Local/county 3. National/Kenya 4. Regional/Africa 5. Global	
22c	Which climate change policies, legislations, and institutions are you conversant with?	1. National: NCCRS, NCCAP, CC Act 2016, NCCC, CCD, Others (specify) 2. County:	

		3. Sub-county/local:	
22d	Have you benefitted from any climate change programmes?	1. Yes (specify programme and benefit) 2. No 3. Don't Know	
Part III: Impacts of Climate Change on the farm (according to the farmer)			
23	What do you think are the impacts of climate change on your farm? (probe negative and positive impacts on the following aspects of the farm. Take photos where the impacts are visible)		
	a) Crops?	1. Reduced crop yield 2. Increased crop yield 3. Reduced crop diseases and pests 4. Increased crop diseases and pests 5. Reduced crop quality 6. Increased crop quality 7. Reduced crop diversity 8. Increased crop diversity 9. Slow or stunted growth 10. Fast growth 11. Short planting season 12. Longer planting season 13. Others (specify)	**(Multiple Responses possible)**
	b) Livestock?	1. Reduced productivity 2. Increased product yield 3. Reduced incidences of diseases and pests 4. Increased incidences of diseases and pests 5. Increased livestock quality 6. Reduced livestock quality 7. Others (Specify)	**(Multiple Responses possible)**
	8. Soil and topography?	1. Changes in soil fertility 2. Floods 3. Other	**(Multiple Responses possible)**
	9. Water supply?	1. Increased water supply 2. Reduced water supply 3. Better quality water 4. Poor quality water 5. Other	**(Multiple Responses possible)**
	10. Infrastructure	1. Corrosion of buildings 2. Faster wear and tear of farm equipments 3. Destruction of storage facilities 4. Destruction of roads 5. Others (specify)	**(Multiple Responses possible)**
	11. Access to or supply of farms inputs	1. Easy access to farm supplies 2. Difficult to access farm supplies 3. Affordable farm supplies 4. Expensive farm supplies 5. Others (specify)	**(Multiple Responses possible)**
	12. Human resource (labourers and other support staff)	1. More labourers and other support staff 2. Less labourers and other support staff 3. More days spent on sick leave 4. Less days spent on sick leave 5. Others (specify)	**(Multiple Responses possible)**
	6. Technical support and extension services	1. Better extension services 2. Poor extension services 3. Better weather forecasts 4. Poor weather forecasts	**(Multiple Responses possible)**
24	Does climate change influence the decisions or activities you undertake on your farm? Explain your answer	1. Yes (How?) 2. No 3. Don't know	

25	What do you think are the impacts of climate change in your locality/ areas surrounding the farm? (probe negative and positive impacts on the following aspects of the local area surrounding the farm)		
	a) Infrastructure	1. Inaccessible Roads 2. Improved Water supply 3. Reduced Water Supply 4. Access to Electricity supply, 5. Improved Markets 6. Dwindled Markets 7. Others	
	b) Other farms around you?	(Specify)	
	c) Others	(Specify)	
SECTION V: Adaptation, coping and other climate change response strategies applied by the farmer			
26	How do you respond to the above climatic impacts on your farm?		
	a) Conservation agriculture (CA)/improved agronomic practices	1. Crop rotation 2. Mulching/leaving crop residues on farm 3. Minimum tillage with ox plough/hand hoes 4. Contour strip cropping 5. Use of improved germplasm 6. Intercropping 7. Relay cropping 8. Cover crops, alley cropping, 9. Boundary planting 10. Riparian tree planting 11. Apiculture/bee keeping 12. Planting trees for shade/ windbreaks, 13. Other (specify)……	
	b) Crop-livestock integration (CLI)	1. Zero grazing with improved feeds 2. Smart livestock and breed selection e.g. dairy goats, improved cow breeds 3. Using plant residues as livestock feed, and livestock manure for crop production 4. improved breeds, improved housing, improved feed, investing in health control programs, feed conservation 5. Others (specify)……	
	c) Integrated soil and water resource management (IWRM)	1. Zai/planting pits 2. Rain water harvesting/roof top water harvesting 3. Surface runoff water harvesting and storage (in sand dams, etc.) 4. Irrigation (crops), 5. Fish farming 6. Terracing on farms to control erosion 7. Diversion ditches 8. Mulching 9. Composting 10. Efficient use of fertilizers 11. Other (specify)……	
	d) Index (weather) based crop and livestock insurance	1. Area-yield-based insurance 2. Livestock insurance 3. Others (specify)…….	
	e) Do you use any of the following safety net programs?	1. Food aid 2. Subsidized inputs (fertilizers/seeds) (by who?) 3. Storage facilities (by who?) 4. Credit facilities (by who?) 5. Other (specify)……..	
	f) Collective action focusing on local conventions	1. Women groups (what do they do?) 2. Cooperatives (what do they do?) 3. Other (specify)…….	

	g) Agriculture services focusing on Farmer Field Schools	1. Farmer learning centers 2. On-farm demonstrations 3. Others (specify)……	
	h) Agroforestry/silviculture	1. Fruit trees 2. Fodder trees 3. Woodlots 4. Other (specify)…….	
	i) Climate smart villages; climate smart landscapes (CSV/CSL)	1. Weather advisories (how) 2. Extension services (on what?) 3. Other (specify)…….	
	j) Payment for environmental services (PES)	1. Earning carbon credits from soil carbon sequestration/ sustainable agricultural land management (SALM) 2. Paying for irrigation water 3. Others	
	k) Others (List)	1. Efficient cooking stoves 2. Solar energy 3. Biogas 4. Others (specify)	
27	What barriers or challenges do you encounter in carrying out or adopting these response strategies? Rate the barriers to implementation/adoption (High, Moderate, Low)		

No.	Barrier to Adoption and Response strategy	High barrier	Medium barrier	Low barrier
1.				
2.				
3.				
4.				
5.				

SECTION VI: Effectiveness and benefits of the adopted climate change response strategies

28	In your opinion, how effective are the adaptation or response strategies you are employing?	1. Very Effective 2. Moderately effective 3. Effective 4. Not Effective 5. Don't Know	
29	In your opinion, what are the benefits associated with the above listed adaptation practices and response strategies? (probe deeper for evidence of the benefits, e.g. increased yield, reduced disease instances, improved incomes, expanded markets, etc.)		
30	Any benefits of the adopted response strategies to local community, other farmers, and to the county as a whole? (List)	_____ _____ _____	

No.	Benefits to farmer	Rating		
		High	Medium	Low
1.				
2.				
3.				
4.				

SECTION VII: Any other information			
32	Please share any other information or suggestion that you feel might assist this study.	_____ _____ _____	
33	Would you suggest any other farmer you strongly feel should also be interviewed? (give name, location, and reason why)		
Thank you for your time			

Annex 2: FGD Guide

FGD GUIDE

A Study on Farmers' Understanding of Climate Change and their Response Strategies to the Effects of Climate Change in their Farm Lands.

Introduction

Biovision Africa Trust (BvAT) together with PELUM Kenya and World Agroforestry (formerly ICRAF) under the continental Ecological Organic Agriculture Initiative (EOA) are undertaking a study on farmers' understanding of climate change and how they respond to the effects on their fam lands. The objective of this Focus Group Discussion (FGD) is to solicit the opinions of and discuss in a collective forum involving farmers the issues relevant to the objectives of the study. The study will support the achievement of the objectives of the EOA which is to mainstream ecological organic agriculture into national agricultural production and promote ecologically sound strategies and practices for sustainable development in Africa. Your participation in this FGD is voluntary and you can withdraw anytime should you feel the need to. Everyone is free to air their views without intimidation from anyone and the information provided is confidential, i.e. will only be used for the purposes of this study. The FGD Session should take about 90 to 120 minutes. This study is simultaneously being conducted in Bungoma, Nakuru, and Kirinyaga counties during the month of January 2017. Should you have any questions during or after the interview, please feel free to ask the interviewer or email the Principal Investigator, Dr. Martin Oulu (ochiengmoulu@gmail.com), or BvAT (C/O ICIPE), P.O. Box 30772-00100, Duduville Kasarani, Off Thika Road, Nairobi, Kenya. Thank you for your co-operation.

SECTION I: Respondent Information

FGD Date: ……Time: ……..
FGD Location
County:…… Sub-County…… Divison……..

Location…….. Sub-Location…….. Village/Town……

Participants
Respondents' names……..Respondents identity/Role in the community……
1.
2.
3.
4.
5.

SECTION II: Farmers understanding and perception of Climate change

1. What do you understand by climate change? (description and name in local language if available. Probe distinction between climate change and weather).
……

2. Over the last twenty (20) years, have you noticed any long-term changes in:

- **Mean Rainfall?**
  A) Decrease B) Increase C) No change D) Don't know

- **Mean Temperature**?
  A) Decrease B) Increase C) No change D) Don't know

- **Frequency of drought**?
  A) Decrease B) Increase C) No change D) Don't know

- **Frequency of floods?**
  A) Decrease B) Increase C) No change D) Don't know

3. Do you believe climate change occurs?
   - Yes
   - No
   - Don't know

4. What or who do you think is the cause of climate change? (probe distinction of natural and man-made causes. Note any North/South distinction if any) .....

……

5. What are the key climatic hazards on your farm and locality?

   - Drought/irregular rains
   - Floods
   - Landslides
   - Salinization
   - River bank erosion
   - Pests and diseases
   - Others

6. Do you think climate change is good or bad (multiple answers possible):

   4. Bad (Give reasons) ……
   5. Good (Give reasons) ……
   6. Don't know ……

7. Who, in your opinion, should address climate change?

   - Key stakeholders identified (farmers, government authorities - national and/or county, scientists/experts ……..
   - Governance levels involved (households, local/county, national, regional, global)……..

8. Which climate change policies, legislations, institutions, and programmes are you conversant with?

   - National:
   - County:
   - Sub-county/Local:

9. Which particular climate change programmes have you benefited from in the past 10 years and how?

SECTION III: Impacts of Climate Change on the farm (according to the farmer)

10. What do you think are the impacts of climate change on your farm? (probe negative and positive impacts on the following aspects of the farm. Take photos where the impacts are visible)

- Crops? (list potential impacts on crops e.g. yield, disease and pests, quality, varieties etc)
  .....
- Livestock?
  .....
- Soil and topography?
- Water supply?
- Infrastructure (buildings, equipments, etc.)
- Access to or supply of farms inputs
- Human resource (labourers and other support staff)
- Technical support and extension services

11. How does climate change influence the decisions or activities you undertake on your farms?
……
……

12. What do you think are the impacts of climate change in your locality/ areas surrounding the farm? (probe negative and positive impacts on the following aspects of the local area surrounding the farm)

- Infrastructure (roads, water and electricity supply, markets, etc)
  ……..
- Other farms around you?
  ……
- Others

SECTION V: Adaptation, coping and other climate change response strategies applied by the farmer

13. How do you respond to the above climatic impacts on your farm?
(List and rate the importance to the farmer any climate smart agriculture (CSA) practices applied on a scale of 1-3: 1 = Very Important, 2 = Important 3 = Least Important). Also identify which of the response strategies are intrinsic and which ones are extrinsic.[4]

	CSA Practice (Check all that apply)	**1**	**2**	**3**	**Intrinsic** (specify)	**Extrinsic** (specify)

[4] Intrinsic motivations are here understood as those practices which are done by the farmer because they enjoy doing them, find them interesting, or have been passed down to them culturally or through family tradition hence have become 'normal' practice done without much thinking. Extrinsic motivations are practices done because an external 'authority' or 'expert' has recommended so, and are thus consequently done to get external rewards (e.g. recognition), or to avoid negative consequences (e.g. if its required by law)

	Conservation agriculture (CA)/improved agronomic practices a. Crop rotation b. Mulching/leaving crop residues on farm c. Minimum tillage with ox plough/hand hoes d. Contour strip cropping, e. use of improved germplasm, intercropping, f. relay cropping, g. cover crops, alley cropping, h. boundary planting, i. riparian tree planting, j. apiculture, planting trees for shade/ windbreaks, soil conservation, fruit orchards k. Other (specify)……					
	Crop-livestock integration (CLI) a. Zero grazing with improved feeds b. Smart livestock and breed selection e.g. dairy goats, improved cow breeds c. Using plant residues as livestock feed, and livestock manure for crop production d. improved breeds, improved housing, improved feed, investing in health control programs, feed conservation e. Other (specify)…….					
	Integrated soil and water resource management (IWRM) a. Zai pits b. Rain water harvesting/roof top water harvesting c. Surface runoff water harvesting and storage (in sand dams, etc) d. Irrigation (crops), fish farming e. Terracing on farms to control erosion f. Building terraces, road catchments, diversion ditches, infiltration ditches, planting pits, micro catchments g. Mulching, composting, using improved fallows, more efficient use of fertilizers h. Other (specify)…….					
	Index (weather) based crop insurance a. Area-yield-based insurance b. Livestock insurance c. Other (specify)…….					
	Safety net programs a. Food aid b. Subsidized inputs (fertilizers/seeds) (by who?) c. Storage facilities (by who?) d. Credit facilities (by who?) e. Other (specify)…….					
	Collective action focusing on local conventions a. Women groups (what do they do?) b. Cooperatives (what do they do? c. Other (specify)…….					
	Agriculture services focusing on Farmer Field Schools a. Farmer learning centres b. On-farm demonstrations c. Others (specify)……					
	Agroforestry/silviculture a. fruit trees b. fodder trees c. woodlots d. Other (specify)…….					
	Climate smart villages; climate smart landscapes (CSV/CSL) a. Weather advisories (how) b. Extension services (on what?) c. Other (specify)…….					
	Farmer managed natural regeneration (FMNR)					
	Payment for environmental services (PES)					
	Others (List): E.g. efficient cooking stoves, solar energy, biogas					
	None					

14. What barriers or challenges do you encounter in carrying out or adopting these response strategies? Rate the barriers to implementation/adoption (High, Moderate, Low)

No.	Barrier to Adoption and Response strategy	High barrier	Medium barrier	Low barrier
1.				
2.				
3.				
4.				
5.				

SECTION VI: Effectiveness and benefits of the adopted climate change response strategies

15. In your opinion, how effective are the above response strategies?

No.	Response strategy	Effectiveness (i.e. achievement of intended goal/objective)	Rating		
			High	Medium	Low
1.					
2.					
3.					
4.					

16. In your opinion, what are the benefits associated with the above listed adaptation practices and response strategies? (probe deeper for evidence of the benefits, e.g. increased yield, reduced disease instances, improved incomes, expanded markets, etc.)

No.	Response strategy	Benefits to farmer	Rating		
			High	Medium	Low
1.					
2.					
3.					
4.					

17. Any benefits of the adopted response strategies to local community, other farmers, and to the county as a whole? (List)

SECTION VII: Any other information

18. Please share any other information or suggestion that you feel will assist this study.

*******Thank you for your time*******