FACTORS INFLUENCING CLIMATE CHANGE ADAPTATION AMONG TEA FARMERS IN CHEBUT CATCHMENT AREA, NANDI CENTRAL DISTRICT, KENYA

BY

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DECLARATION

This research report is my original work and has not been presented for academic purposes in the University of Nairobi or any other university.

Sign …… Date: …….

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This research report has been submitted with my approval as the university supervisor

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DEDICATION

This research work is dedicated to my parents Edward and Sally. Their contribution has been immense.

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ABBREVIATIONS AND ACRONYMS

CIAT International Center for Tropical Agriculture

FAO Food and Agriculture Organization

GDP Gross Domestic Product

GHG Green House Gases

IPCC Intergovernmental Panel on Climate Change

IFAD International Fund for Agricultural Development

TAR Third Assessment Report

UNDP United Nations Development Program

UNFCCC United Nations Framework Convention on Climate Change

ABSTRACT

Climate change will drastically reduce tea production over the next 40 years with suitable lands being pushed up the altitude, denting earnings from one of the Kenya's top hard currency source. The International Centre for Tropical Agriculture has it that, land under tea will reduce by 42percent by 2050, creating excess capacity in the tea factories dependent on the catchment. Of concern were areas west of the Rift valley particularly Nandi, Kericho and Gucha which will be most affected. The region around Nandi shows a slight decrease in suitability by 2020 but by 2050, significant loss of suitability of up to 40 percent is observed, and producers here will therefore need to carefully analyse the implications and implement adaptations and diversifications. The purpose of this study was to assess the factors influencing climate change adaptations among tea farmers in Chebut catchment area in Nandi Central District. The research was based on a descriptive survey design with a target population of 10,000 tea farmers. A sample of 370 was chosen using both simple random and systematic sampling. Questionnaires were distributed to 60 tea buying centres and the data obtained was analysed using Ordinary Logistic Regression Model with SPSS version 17.0. Findings through descriptive analysis reveal that majority of the respondents were aware of warmer temperatures and experienced irregular rainfall patterns which started late and stopped early. The results of the model revealed that the choice of adapting to climate change by the tea farmers was positively and significantly influenced by level of education of the farmer whereas farmers' demographics (age, marital status, gender), size of farm, and access to information (exhibitions, trainings, seminars) appeared to play no significant role in influencing climate change adaptations in Chebut area. The research concluded that education was a major predictor of climate change adaptations and that there was inadequate access to climate change information through training. The research recommended that for farmers to develop more effective climate change adaptation strategies, there is need for the government and tea factories to support farmers by providing necessary resources such as information and extension workers to train farmers on existing climate resilient projects and new infrastructure in climate change monitoring and reporting stations. Effective policies should be put in place such as extension services, consider running programs on television and radios to increase awareness on climate change. These policies should address imperfections such as access to information and linking farmers with extension services and farmers groups in order to reach small-holder farmers. Massive campaigns on the reality of climate change and its serious consequences on food production so as to persuade farmers to adopt adaptations need to be conducted. The social network through farmer to farmer extension should be promoted and strengthened so as to boost awareness level from the current position to a level where all tea farmers are better placed in adaptation practices in addition, regular meetings, seminars and workshops should be put in place to improve adoption of new skills and technology that will boost uptake of climate change adaptations.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Climate trends over the past few decades have been fairly rapid in many agricultural regions around the world, an increase in atmospheric carbon dioxide (Co_2) and Ozone (O_3)levels have increased everywhere (Lobell & Gourdji, 2012). This trend raises many questions relating to food security and the aggregate productivity of global agriculture (Lobell & Gourdji, 2012). Climate change will exacerbate many of these trends with direct effects on agricultural yields, water availability and production risk. (Thornton & Herrero, 2010). Future changes in the climate could have significant impact on agriculture that will challenge farmers to adopt to changes in land use, commodity production and its location. Moreover, agriculture is a major source of global greenhouse emissions representing 10 – 12% of total global anthropogenic emissions of greenhouse gases (Wreford, Moran and Adger, 2010). However, scientific view is that increases in global temperatures must be below 2^oC if governments had to combat climate change in the context of sustainable developments (UNFCCC, 2010).

Prediction of emission growth without constraints could result in rise in temperature of between 4^o and 5^o C on average by 2060 and could mask far higher temperatures rises of between 10^o to 15^o C in many areas including in lower latitudes and the arctic (Met Office: UK climate: December 2009.) The 2010 World Development Report draws on analysis of the intergovernmental panel on climate change (IPCC 2007) to calculate that agriculture directly accounts for 14 per cent of the total The emissions in Co_2 equivalents and indirectly accounts for an additional 17 percent of emissions when land use and conversion for crops and pasture are included in the calculations (World Bank, 2009). Given that agricultures share in global GDP is about 4 percent, those figures suggest that agriculture is highly GHG intensive.

With weakening prospects of prompt mitigation, it is increasingly likely that the world will experience 4^oC and more of global warming (Smith et al, 2011). Far from reducing, GHG emissions are accelerating, their annual rate climbing by nearly 50% since 1990 and by 50% in 2010. This global surge record level of 2010 seems to diminish the prospects of meeting the internationally agreed target of emitting global mean warming to below 2^o C as was observed at

the conference on climate change adaptation in Helsinki (2012).Whereas the stern report (Stern, 2007) projected that a $2^{o}C$ increase in average temperature would reduce world GDP by roughly 1%, the 2014 world development report of the world bank (2009) focus on developing countries and estimates that without offsetting innovations, climate change will ultimately cause a decrease in annual GDP of 4% in Africa and 5% in India. Moreover within those already poor regions, the largest effects will be on the poor who tend to earn their livelihoods in farming.

In developing countries, agricultural productivity remain low, poverty, vulnerability and food insecurity remain high and direct effects of climate change expected to rise. Climate change is expected to have a significant impact on global tea production. Because tea relies on well distributed rainfall, increased temperatures and changes to rainfall patterns will influence both the quantity and quality of tea production posing a threat to vulnerable smallholder tea farmers (UNFCCC, 2010). Changing water patterns are undermining the ability of smallholder producers in Malawi's southern region to grow tea, a crop that usually brings in 70% of their income. Using statistics from the UNDP, the University of Greenwich deduced in 2010 that the mean temperature in Malawi could be expected to rise by between 0.5 and 1.8 degrees Celsius by the 2030's. This would reduce the viability of tea at the lower levels of its current altitudinal range within the next few decades (Wreford et alr,2010).

In Uganda CIAT observed a slight increase in maximum temperature from $27.5^{o}C$ to $30.1^{o}C$ and the minimum temperature increase from $13.6^{o}C$ to $15.8^{o}C$. By 2020 suitable tea growing areas start to decrease quite significantly across Uganda, with even more significant implications by 2050 (Anton, 2011).

In Kenya, climate change will drastically reduce tea production over the next 40 years with suitable lands being pushed further up the altitude, denting earnings from one of the country's top hard currency source. A study done over 30 years (1^{st} January 1979 to 31^{st} December 2009) sited in a tea growing area at a meteorological station in Kericho, presents evidence of an upward warming trend of $0.2^{o}C$/decade in the observed maximum, minimum and mean temperatures during the period (Omumbo et al, 2011).

Drought is a major climatic change effect/factor and a challenge facing tea industry in Kenya. Like most other agricultural crops, smallholder tea depends on rain fed agriculture. In times of drought, production drops by very huge margins causing a lot of misery especially to small

holder farmers. For instance droughts in the years of 1997 and 2000 forced production to slip by about 15 percent. The drought of the year 2000 was even worse whereby tea farm were badly scorched. In 2006, Uniliver Tea Company which controls the largest plantations in Kenya, temporarily closed three of its eight factories and run the other at reduced capacity because of reduced output as a result of drought exacerbated by climate change (Tea Board of Kenya, 2012).

Efforts to adapt to the impacts of inevitable climate changes, while at the same time drastically reducing greenhouse gas emission, will require transformations at a rate and scale that is unprecedented in human history (Adger et al, 2009; Orlove, 2009). In addition, it requires that societies adapt to not only new biophysical conditions, but also to new understandings of human environment relationships. Thus from a broader perspective that adaptation is not simply about changes in systems and behaviours required to reduce the negative impacts of climate change, but about the wider capacity of individuals and societies to respond to challenges to existing beliefs, values and worldviews (O'Brien, 2010).

1.2 Statement of the problem

Tea is a key crop for Kenya providing income for 3 million people and their families. Tea is also anticipated to play a significant role in achieving vision 2030 (Kenya's development policy that aspires to achieve a yearly 10% growth in GDP from 2012) as well as the millennium development goals but in 2008 and 2009, the production of tea in the leading countries fell with Kenya reducing from 350 metric tons in 2008 to approximately 318 metric tons in 2009 due to adverse weather conditions (Tanu et al,2012).

As shown in the monthly tea production table, production of tea in 2011 closed with a total production of 377 million Kilograms compared to 399 million Kilograms in 2010 representing a 5% drop due to the dry spell (Tea Board of Kenya, 2012).

Monthly Tea Production

Tea Statistics

THE TEA BOARD OF KENYA

10-YEAR MONTHLY TEA PRODUCTION (Qty in M. Kgs)											
MONTH	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
JANUARY	32.8	31.1	34.1	17.9	41.6	29.7	25.5	37.7	35.9	36.2	45.3
FEBRUARY	23.6	28.1	25.8	11.7	34.8	24.1	21.5	34.8	26.7	18.4	38.5
MARCH	15.0	28.9	24.8	19.9	32.2	16.9	18.8	39.2	22.4	17.8	
APRIL	19.3	29.4	29.1	30.4	30.7	27.4	18.3	35.9	31.4	18.1	
MAY	26.0	28.4	28.8	26.4	32.1	36.4	29.8	35.6	32.8	37.3	
JUNE	19.5	23.9	24.0	27.7	27.3	22.8	25.3	29.8	28.9	30.2	
JULY	18.9	18.6	20.8	23.8	22.7	24.2	21.5	24.4	26.3	24.3	
AUGUST	19.9	18.9	21.8	23.2	22.7	24.5	21.2	23.1	24.4	31.9	
SEPTEMBER	26.4	23.0	26.9	28.6	28.9	32.0	27.4	28.8	30.5	33.5	
OCTOBER	31.6	27.4	32.3	34.8	35.2	35.3	32.8	34.1	39.9	40.2	
NOVEMBER	27.0	32.0	30.0	31.6	32.3	34.4	35.9	37.0	36.8	39.9	
DECEMBER	32.9	34.6	29.8	34.4	28.8	37.9	36.1	38.3	41.3	41.4	
TOTAL	**292.9**	**324.3**	**328.2**	**310.4**	**369.3**	**345.6**	**314.1**	**398.5**	**377**	**369.2**	**83.8**

Table 1.1: monthly tea production

Source: Tea Board of Kenya, 2011.

Total export volumes stood at 421 million kilograms which was a 5% decline from 441 million kilograms in 2010 (Tea Board of Kenya, 2012)

Tea industry woke up to anxiety in 2012 to witness early frost attack in the tea growing areas and dry and hot weather conditions .The Tea Board of Kenya forecasts agree that many developing country climates will become less suitable for the agricultural practices they now undertake because places that now tend to be warm and humid will be disadvantaged relative to places that are now cooler (Omumbo et al., 2011)

Findings from the International Centre for Tropical Agriculture (CIAT) have it that, land under tea will reduce by 42 percent by 2050, creating excess capacity in tea factories dependent on the catchments. Of concern were areas west of the Rift Valley particularly Nandi, Kericho and Gucha which will be the most affected. The region around Nandi shows a slight decrease in suitability by 2020 but by 2050 significant loss of suitability (up to 40 %) is observed. Producers here will therefore need to carefully analyze the implications and implement adaptation and diversification strategies (Anton, 2012).

Maximum and minimum temperatures in some places increasing by about 1^{o} Celsius by 2020 and 2.3 degrees by 2050 and its implications are that the distribution suitability within the current tea growing areas in Kenya for tea production will decrease quite seriously by 2050 as the suitable areas will be in increasingly higher altitudes (Anton, 2012)

Areas that retain some suitability will see decreases of between 35% and 55% compared to today's sustainability of 60 and 80%. Currently an optimum tea producing zone is at an altitude of between 1500 and 2100 meters above CIAT predicts this will increase to an altitude of between 2000 and 2300 meters above sea level (Anton, 2012). The altitude of Nandi reaches a maximum of 2116.50 meters at Nandi Hills, which means most of the areas below this height will experience significant loss of suitability to tea farming.

Although a lot of awareness has been done on climate change, all relevant Local Institutions, from government to NGOS have not actively got involved in tackling the problem. Adaptations at the community level are particularly significant yet communities are not able to take control of their responses to climate change (Moncel and Asselt,2012).

It seems that there is a gap between the rate at which climate is changing and the response to reduce its impact through employment of adaptation strategies that ensure sustainable tea production in area. (Tea Board of Kenya, 2011). In addition, factors that influence farmers' decisions, to adapt to climate change in Chebut area are not known. Chebut area has been purposely selected owing to not only its fragility and sensitivity to climate variability but the region that is going to experience decreased suitability for tea by 2020 and significant loss of suitability by 2050 as predicted by the international center for tropical agriculture (Anton,2012).

1.3 Purpose of the study

The purpose of this study was to assess the factors influencing climate change adaptation among tea farmers in Chebut catchment area in Nandi Central District.

1.4 Research Objectives

The study was guided by the following objectives:-

i) To assess the extent to which access to information influences climate change adaptation in Chebut catchment area.
ii) To examine the extent to which demographics influence climate change adaptation in Chebut catchment area.
iii) To establish the extent to which the size of the farm influences climate change adaptation in Chebut catchment area.
iv) To determine the extent to which level of education influences climate change adaptation in Chebut catchment area.

1.5 Research Questions

The study intended to answer the following questions.

i) To what extent does farmers access to information influence climate change adaptation in Chebut catchment area?
ii) To what extent do farmers' demographics influence climate change adaptation in Chebut catchment area?
iii) To what extent does the size of the farm influence climate change adaption in Chebut catchment area?
iv) To what extent does the farmers' level of education influence climate change adaption in Chebut catchment area?

1.6 Significance of the study

The findings of this study could be important in providing insight into the critical aspects of the adaptation towards climate change in Chebut tea catchment area.

The Kenya Tea Development Agency at Chebut could find the study useful as it brings to light the position of tea farmer's level of adaptation to climate change and be aware of the future that lies ahead in the industry as far as tea production is concerned.

The study could also help NGO's which are directly involved in training and awareness to understand the extent to which their efforts have been successful, and will help them make decision on what projects to fund.

This research could also be valuable to the tea research foundation of Kenya to establish whether the new tea varieties resistant to drought have been planted in the area .Finally, this research could be beneficial to other researchers who may want to assess factors influencing adaptation of climate change elsewhere.

1.7 Delimitation of the study

The study was carried out in Chebut tea catchment area in Nandi Central District with a total land area of 2884.2 km^2 and a population density of 261 people per km^2 and will involve 370 respondents from a listed number of 10,000 tea growers from 96 tea buying centers. The study sought information from tea farmers so as to ascertain factors influencing climate change adaptations in Chebut area.

1.8 Limitations of the study

One of the limiting factors of the study was on language barrier where respondents to written questionnaires faced due to illiteracy level in the area. Use of trained research assistant, conversant in the language of their best understanding helped in mitigating such challenges. Uncooperative informants were encountered due to suspicion on the real motives of the researcher. The level of literacy and understanding as to the purpose of the study varied from one respondent to the other thus different levels of suspicion. However, working closely with the community group facilitators, community leaders and the community volunteers' helped explain the sole academic purpose of the study to the informants who may have appear suspicious of the real motive of the study. Since the tea farmers cover a wide geographical area, the researcher and his assistants reached them at tea buying centers when they come to weigh their tea.

1.9 Assumptions of the study

The researcher assumes that farmers in Chebut area not only are aware of climate change but climate change adaptations as well. This assumption will enable the researcher to assess the extent to which access to information, size of the farm, farmers' demographics and farmers' level of education influences their decisions to adapt to climate change.

1.10 Definition of significant terms used in the study

The following are the definitions of the key terminologies used in this research.

Access to information

This refers to the level to which farmers are able to obtain information concerning climate change adaptation.

Adaptation

This refers to the practical steps to protect farms, forests, soil and, water from the likely disruption and damage that will result from effects of climate change

Adaptive capacity

This is the ability of tea farmers in Chebut area to adjust to climate change and to moderate potential damages, so as to cope with the consequences that may come as a result of climate change

Climate change

This is a change of climate which is attributed directly or indirectly to human activity which leads to temperature and rainfall variability in Chebut area.

Climate change adaptation

Refers to the adjustment in natural or human systems to a new or changing environment

Climate change mitigation

Refers to a human intervention to reduce the sources or enhance the sinks to green house gases.

Climate variability

Refers to variations of climate brought about by changes in temperature and precipitation due to natural internal processes within the climate system or to variations in natural or human activities.

Farmers' Demographics

This refers to information relating to farmers' age, gender and experience.

Global warming

This is an increase in the average temperature of the Earth's atmosphere, especially sustained increase enough to cause change in the global climate.

Green house gases

These are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation like carbon dioxide and sulphur dioxide.

Large scale farmers

This refers to those farmers holding more than eight acres of land under tea farming.

Level of Education

This is level of education attained by individual farmers in Chebut catchment area.

Size of the farm

This is the size in acres that individual tea farmers in Chebut catchment area hold.

Small scale farmers

This refers to those farmers holding less than eight acres of land under tea farming.

Vulnerability

This refers to the degree to which farmers are susceptible to adverse effects of climate change.

1.11 Organization of the study

Chapter one is the introduction to the study covering the following areas: background to the study, statement of the problem, purpose of the study, research objectives, research questions, significance of the study, delimitations of the study, assumptions of the study and definition of significant terms.

Chapter two comprises the literature review which addresses what has been done in relation to the topic of study and help identify the knowledge gap that exists locally. It covers the following areas: introduction, overview of climate change adaptation, influence of access to information on climate change, influence of size of farm on adaptation to climate change, influence of farmers

demographics on adaptation to climate change, influence of level of education on adaptation to climate change, conceptual framework and summary of literature review.

Chapter three contains the methodology which comprises: introduction, research design, target population, sample size, sampling technique, research instruments, instrument validity, instrument reliability, data analysis techniques and ethical consideration of the research.

Chapter four consists of data analysis, presentation, and interpretation. Its components are: introduction, questionnaire return rate and findings on access to information, size of farm, farmers' demographics, level of education of the farmer, farmers' perception on climate change and climate change adaptation activities.

Chapter five contains a summary of findings , discussions, conclusions and recommendations which covers introduction, summary of findings, discussions, conclusion of the study, recommendation of the study and suggestions for further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter attempts to review what past researchers have attributed that is relevant on climate change adaptation. This enabled the study to develop new knowledge from the gaps identified in the literature reviewed which if bridged would contribute to successful climate change adaptation strategies. The independent variables of the study were focused on and their contribution to climate change adaptations which is the study's independent variable.

A conceptual framework was used to demonstrate the relationship between variables.

2.2 Overview of climate change adaptation

Responses to counter the climate change effects are mitigation and adaptation. Klein et al (2001) cited in De Jonge (2010) argued that risks of climate change to human and natural systems can be reduced by either mitigation or adaptation strategies. This is also supported by Gbetibouo (2009) who argues that without adaptation, climate change is generally detrimental to the agriculture sector.

Several studies reveal that farmers adapt to climate change in order to counter the negative impacts of climate change on their farming activities. (Apata et al, 2009; De Jong, 2010; Deressa et al, 2009; Deressa et al, 2010; Fosu Mensah et al, 2010; Gbetibouo, 2009; Hassan and Nhemachena, (2007); Hassan and Nhemachena, (2008). Thomas et al (2007) even identifies the adaptation strategies used by farmers in South Africa as changing farming practices (such as plant drought resistant varieties, have more livestock, built cattle shelter) diversifying livelihood (get off farm work, start business) and forming networks (cooperatives, community horticultural projects).

2.3 Influence of access to information on climate change adaptation

This variable measures the farmers' awareness to climate change information. Sources of information include media weather reports from the department of meteorological service, extension officers and social networks such as farm to farm extension, training among others. Access to information on climate change influences the farmers' awareness to changes in climate

and creates opportunities for the farmer to adopt suitable strategies that best suit the changed climatic conditions (Mudzonga, 2012).Using logit regression on a data sample of 77 farm households in Chivi district of Zimbabwe, found out that access to information, access to credit, access to extension services, education level of the farmer, age and farming experience influenced farmers' capacity to adapt to climate change. Although his research informs the research in Chebut area, its sample was small compared to 370 for Chebut. In addition, the study covered farmers in different activities of farming, whereas research in Chebut area will be limited to tea farmers only.

Hassan and Nhemachena (2007), examined farmers' adaptation strategies to climate change in southern Africa based on cross sectional data from South Africa, Zambia and Zimbabwe that was collected as part of global environmental facility/World Bank climate change and African agriculture project. Using Multivariate Probit Model, they found out that, access to credit extension services and awareness of climate change were some of the important determinants of farm level adaptation to climate change. Nhemachena and Hassan (2007) in their study on micro-level analysis of farmers' adaptation to climate change in southern Africa found that access to information about climate change forecasting, adaptation options and other agricultural activities remain important factors determining use of various adaptation strategies. However, the study did not incorporate education and size of the farm which the current study seek to establish their influence on adaptation to climate change among tea farmers in Chebut area.

Hassan and Nhemachena (2008) analyzed the determinants of farm level climate change adaptation in Africa using Multinomial logit Model on a cross sectional survey data collected in 2002 of over 8000 farmers across 11 countries of Africa (Burkina Faso , Cameroon, Egypt, Ethiopia, Ghana, Kenya, Niger, Senegal, South Africa, Zambia and Zimbabwe). Findings from the study revealed that monocropping is the agricultural practice most vulnerable to climate change in Africa. In addition, extension services, technology and farm assets (land, labour and capital) were established as critical for helping African farmers to adapt to climate change .However, they included electricity and heavy machines which will not be covered in Chebut area as tea farmers neither use heavily mechanized nor electrified operations except for tea factories.

Fosu Mensah et al (2010), using a Logit Model analyzed 180 farmer households using survey data set to study the farmers' perception and adaptations to climate in Sekyedumase district located in the northern part of Ghana. The survey was carried out between February and October 2009. Crop diversification and changing crop planting dates were identified as major adaptation strategies to warmer climate. It also established that access to extension services, access to credit, land tenure, and soil fertility, size of the farm, gender and farming experience were significant determinants in adapting to climate change. Although the study in Ghana informs the current study on the independent variables together with the use of logit regression, soil fertility, access to credit and extension services will not be covered in Chebut area.

2.4 Influence of size of farm on climate change adaptation

Farm size is the total land holding of farming household. This variable is measured in acres. Farm size determines the land allocation of the modern crop varieties. The bigger the size of the farm, the greater the proportion of land allocated and hence the adaptation strategies that the farmer is likely to adopt (Gershom et al 1985). Ozor et al (2012), Using probit regression model on a sample of 360 soy beans farmers in south east Nigeria who were selected through multistage sampling technique established that farmers with larger farms adopted adaptations better than those with small farms as they generally entail greater farm investment which should drive greater adaptation practices to endure reasonable returns.

A research paper by Kurukulasuriya and Mendelsohn (2007), using Multinomial Logit Model to analyse a sample of 7000 farmers from 11 countries in Africa, they established whether crop choice is climate sensitive. The study considered temperature, precipitation, size of the farm, slope of the farm, household size, electricity and soil type as variables influencing crop adaptation in Africa. Main findings of the study showed that as temperature warms, farmers will shift towards more heat tolerant crops. Depending on whether precipitation increases or decreases, farmers will also shift towards drought tolerant or water loving crops respectively. The analysis was based on a number of crop choices made by the farmers in 11 African countries namely; Burkina Faso Cameroon, Egypt, Ethiopia, Ghana, Kenya, Niger, Senegal, South Africa and Zambia and Zimbabwe. A cross survey was done in 2002 – 2003 agriculture year except for Cameroon, Ethiopia, Kenya and Zimbabwe where data was collected in 2003 – 2004 production year. The research however, ignored other social and economic factors that influence farmers to

adapt to climate change such as education and age of the farmer which will be researched in Chebut area.

A study by Advancing Capacity to support Climate Change (ACCCA, 2010) among small holder farmers in three drought prone districts in Tigray in northern Ethiopia, reported that large farms positively influenced adoption of soil and water conservation, tree planting and use of improved varieties. Using data from a survey of 160 farm households in three districts of Tigray, North Ethiopia' they analysed the factors influencing their decisions to adapt to climate change.Through a Multivariate Probit model, they found out that livestock ownership, gender, access to climate change information, size of the farm and perceived temperature change had positive and significant impact on climate change adaptation. In Chebut area, however, the number of livestock is not included as independent variable, in addition, the logit model will be used instead of the probit model used in Tigray area.

Deressa et al (2009), using Multinomial Logit Model on a sample of 1000 farmers, researched on determinants of farmers' choice of adaptation methods to climate change in the Nile basin of Ethiopia reported that land size represents wealth and farmers adapted more as the size of the land holding increases. However, the multinomial model used analyzed a dependent variable that takes more than two variables whereas the current research in Chebut catchment will study the dependent variable with only two variables mainly because of time and financial constraints to collect a very large sample that can allow the use of multinomial logit model.

2.5 Influence of farmers demographics on climate change adaptation

Age is the number of years of the farmer. Deressa et al (2010),using the Heckman model to the same data (a sample of 1000) used by Deressa et al (2009),where multinomial model had been used, argue that age of the farmer represents experience in farming. The older the farmer, the more experienced he/she is in farming and the more he/she is exposed to past and present climatic condition over as longer horizon of his/her life span. This model initially assessed farmers' perceptions that climate was changing followed by examination of the responses to this perception in the form of adaptation. The findings revealed that education level, use of extension services, availability of credit positively and significantly affected adaptation to climate change but size of the farm negatively affected adaptation. Although, the Heckman model, with two equations, considers the dependent variable as binary, that is, whether the farmer adapted to

climate change or not, as shall be used in Chebut area, a Logit model to be used here will have only one equation.

Hassan and Nhemachena (2008) in their study of determinants for adapting to climate change in Africa, found age to be insignificant in influencing farmers' adaptation to climate change. However, they argue that it is farming experience that matters more than merely the age of the farmer when it comes to adaptation to climate change. Hassan and Nhemachena (2007) in their study of climate change adaptation strategies in southern Africa noted that more farming experience increases the probability of a farmer adapting to climate change. They found out that farmers experience increases the probability of up-take of all adaptation options.

Apata et al (2009), in their analysis of climate change perception and adaptation among arable food crop farmers in south western Nigeria, administered questionnaires and held focus groups which provided a sample data of 350 arable food crop farmers that was analyzed by Binomial Logit analysis. Findings revealed that, mulching, planting trees, use of manure, terracing, increased temperature, farm size, farm experience, education status of the farmer, access to extension service and credit facility positively influenced adaptation. However, the research modeled adaptation strategies as independent variables which will not be applied in Chebut catchment area as this will determine the dependent variable.

Gbetibouo (2009) applied the Heckman Probit and Multinomial Logit models to the data that was collected using a farm survey on 1870 farmers on perception and adaptations to climate change and variability in the Limpopo basin of South Africa for the farming season 2004 – 2005. Its major findings indicated that household size, farming experience, wealth, access to credit, access to water, tenure rights, off farm activities and access to extension activities were the main factors that enhanced adaptive capacity of farmers to climate change. However, analysis in Chebut area will use Logit Model as the Multinomial logit model requires many observations which cannot be covered due to time and financial constraints.

Mudzonga (2012), using a Logit model, analyzed data collected through household survey of 77 farmers on climate adaptation among crop farmers in Chivi district of Zimbabwe; found out that highly experienced farmers in Zimbabwe tend to have more information about changes in climatic conditions and their relevant response measures to take. He established that education level, farm house hold size, age, nonfarm income, size of farm and farming experience were

determinants of climate change adapt5ations in Chivi district. The study informs the study in Chebut area on the independent variables to be incorporated however, only education, age, access to information and demographics will be researched. In addition, the sample of 370 will be used unlike 77 used by Mudzonga.

Ozor et al (2012) in their framework for agricultural adaptation to climate change in southern Nigeria found that age positively and significantly related with the use of agronomic practices. A total of 360 respondents selected through multi-stage random sampling technique participated. Older farmers generally had more experience and were able to take healthier production decisions than younger ones. They however established that experience did not significantly influence farmers' adaptations as it does not require experience for a farmer to use weather forecast for instance, they only required a radio or friends to get the information.

Idrisa et al (2010) in their study on farmers' socio economic and technological characteristic on soybean technology adoption in southern Borno state in Nigeria, using 360 respondents selected through multistage, purposive and random sampling techniques and analyzing data by logit model established that age influenced use of adaptation measures, the younger respondents used more adaptation measures compared to their older counterparts .Whereas this study uses logit model to analyse, as will be used in Chebut area, purposive sampling will not be used but rather systematic and random sampling will be used to select the respondents .Oyekale (2009) in the study of climate variability and its impacts on agricultural income and households' welfare in southern and northern Nigeria postulated that younger farmers had greater tendencies to improvise and opt new technologies because they are relatively knowledgeable, more open to risk taking and have longer planning horizons than their older counterparts.

Nabikolo et al (2012) in their study of the determinants of climate change adaptation among male and female headed farm household in Sororo district in Eastern Uganda, established that the influence of gender on adaptation vary among cultures and social structures. Using logit regression, they analysed 136 farm households both by pooling and gender disaggregation and established that gender, farm size, and land ownership were significant in influencing farmers' decision to adapt to climate change.

Nhemachena and Hassan (2008) found out that female headed household were more likely to take up climate change methods in the Nile basin of Ethiopia. Generally, agricultural activities of

female headed households are under resourced compared to male headed ones; a gap that reduces efficient investments in agriculture and constraints investments that enhance resilience to climate change and variability (FAO, 2011)

2.6 Influence of level of education on climate change adaptation

This is the number of years spent by the farmer acquiring education. Education has been proven to be related to early adopters and to greater productivity of improved varieties. Maddison (2006) in his study of the perception and adaptation to climate change in Africa argues that education diminishes the probability that no adaptation is taken.

Mudzonga (2012) in his study of farmers' adaptation in Chivi district of Zimbabwe noted that education had a strong influence in adapting to climate change. He noticed that moving from one category of education to the next increased the probability of the farmer adapting to climate change. Deressa et al (2009) studied the determinants of farmers' choice of adaptation strategies by analyzing perception of adaptation by farmers in the Nile basin of Ethiopia for mixed crop and livestock farmers during 2004/2005 production year. From the household survey, the study revealed that most farmers perceived that temperatures had increased and that precipitation had decreased. Findings revealed that education among other factors positively influenced the farmers to adapt to climate change. Deressa et al (2011) in their study of the perception and adaptation to climate change by farmers in the Nile basin of Ethiopia found a positive relationship between education and adaptation to climate change.

De Jonge (2010) analyzed survey data collected in 2009 from irrigators in the river land of Australia where 43 irrigation farmers were interviewed on their perception and ability to adapt to climate change. Using Multiple regression Model to analyze the data, he found out that farmers who had university education were more likely to respond to climate change than those who had primary education only. However, the model only included a dependent variable that takes one value yet adaptation is a decision that can involve more than one choice as shall be applied in a logit model in Chebut catchment area. Ozor et al (2012) in their framework for agricultural adaptation to climate change in southern Nigeria established that education equips one with better understanding of how to process information provided by different sources regarding new farm practices which improve adaptation to climate change.

Ndumbiri et al (2012), researched on adaptation practices in Kyuso district in Kenya. Data was collected from 246 farmers from six locations sampled through a multistage and simple random sampling procedure. The logistic regression analysis was carried out to assess factors influencing farmers' perceptions of climate change. Findings established that majority of farmers who adapted to climate change had attained post primary education in comparison to those up to primary level education.

Oyekale et al (2012), researched on determinants of climate change adaptation among cocoa farmers in southwest Nigeria. Using a multistage sampling procedure, they sampled 515 farmers from cocoa producing states, they analysed the data by probit regression and established that all farmers had noticed climate change. In addition, they established that years of education, age of the farmer and the size of the land under cocoa influenced farmers' adaptation to climate change. They also noted that efforts to address climate change adaptation among cocoa farmers were not gender sensitive. Their findings were that men had higher chance of diversifying their crops and income sources, compared to women. Although the independent variables under study by Oyekale are similar, probit regression will not be used in Chebut area, but logit regression. In addition, data analysis was on cocoa farmers, whereas in Chebut area, analysis will be on data from tea farmers.

Idrisa et al (2012), in their study of adaptation measures at Borno state in Nigeria, examined the awareness and adaptation to climate change among farmers in the Sahel savanna zone of Borno state, Nigeria. Data was collected from 225 respondents selected through multi-stage sampling technique and analysed using Tobit regression model. They established that the level of education of respondents and extension visits were highly significant in influencing the use of adaptation measures among respondents. However, the researcher at Chebut area will use the logit regression but not the Tobit regression as used by Idrisa.

2.7 Conceptual Framework

A conceptual frame work is a hypothetical model identifying the concepts under study and their relationship between the independent and the dependent and also the confounding variables. The section provides a structural description of the relationship between the variable forming the concepts of the study on climate change adaptation.

The independent variables are grouped together on the left side but not in any order of importance. The dependent variable is placed on the right hand connected with an arrow as a sign of direct relationship.

Independent variables

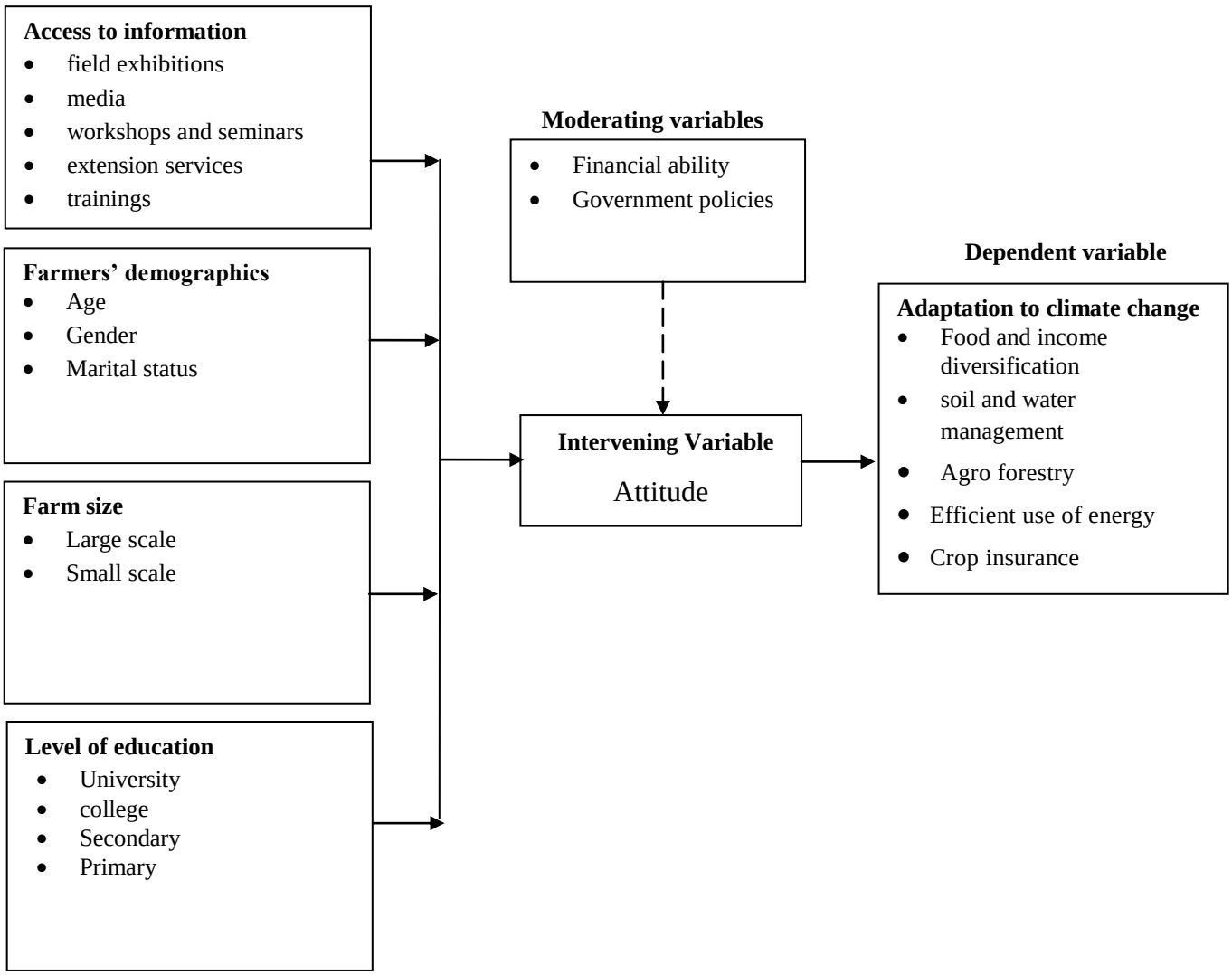

Figure 1: Conceptual framework

From the conceptual framework, adaptation to climate change have been linked to the independent variables of access to information, farmers' demographics, size of the farm, and farmers' level of education . Other factors, even if not directly related to the study for example attitude, government policy and financial ability also have influence on climate change adaptations. From the findings, field exhibitions, media workshops and seminars, extension services and training on climate change were identified as not played significant role in

influencing adaptations. This is partly because majority of the respondents reported not having been exposed to any of them and thus their influence was not significantly felt. Age, gender and marital status too did not play significant influence to adaptations. However, there was a relationship between adoption of adaptation practices varying with age, gender, and marital status. A male farmer was more likely to adapt if married and between 18-30 years. Size if the farm was found to be insignificant, though, a large scale farmer was better placed to adopt adaptation than a small scale farmer. Education was significant in influencing adaptation practices and that adaptations increased relative to the level of education of the farmer. The higher the level of education, the greater the number of adaptations adopted.

2.8 Summary of literature review.

From the literature review, there have been some mixed results on variables such as household size, size of the farm, level of education, temperature, precipitation, access to information, access to credit, age and farming experience. Different methodologies and data sources have been used to analyse factors that influence farmers' adaptation to climate change. The literature reviewed was necessary to compare results of previous studies on the factors that influence the farmers' decision to adapt to climate change with those of the current research on Chebut catchment area. While acknowledging the findings from previous research, this research will use questionnaire to gather data on factors influencing farmers' adaptation to climate change in Chebut catchment area and analyse it through the Logistic regression model.

From the literature, researchers have held same findings on such factors as education and access to information, as positively and significantly influencing adoption of adaptation practices among farmers. However, different arguments were presented in their findings on other factors as age, gender, marital status and size of farm of a farmer. Some of these factors were found significant in influencing adoption of adaptations by some researchers in the literature review, whereas others reported that they were insignificant. This therefore created a knowledge gap that inspired the researcher in attempting to establish whether findings in Chebut catchment area on tea farmers will hold true or contrast on the findings of other researchers cited in the literature review.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

Chapter three presents key methodological issues that were followed to conduct this research. Among the areas included; the nature of research design, the population of the study, the sample size, sampling techniques and methods of data analysis used.

3.2 Research design

This is a research, based on a descriptive survey design. According to Best (2004), a survey is a means of gathering information about the characteristics, actions, or opinions of a group referred to as population. This design was appropriate for the study because it enabled data collection from the sample on the assessment of climate change adaptation strategies.

3.3 Target Population

This is the entire group a researcher is interested in or the group which the researcher wishes to draw conclusion from (Mugenda and Mugenda, 2003). The target population of the research was in Chebut catchment area, Nandi Central District, Nandi county (latitude 0^{o} 12 ' 0" N and longitude 35^{o} 6' 0" E).Chebut catchment has 10, 000 tea farmers supplying their tea to 60 buying centers. Sizes of the farm, gender, level of education are the characteristics to be investigated. This is the region that is expected to experience decreased suitability in tea production. Farmers were selected from geographical areas with buying centers that are registered with Chebut tea factory as listed in Appendix XI and distributed in the geographical areas shown in Appendix XII.

3.4. Sample Size and Sampling Technique

3.4.1 Sample Size

A sample size is a subset of the total population that is used to give the general views of the target population (Kothari 2004). From the total population of 10,000 tea growers in the area, a sample size of 370 individuals was chosen based on Krejcie and Morgan table (Appendix VIII).

3.4.2 Sampling Technique

The sample was drawn using systematic sampling where every k^{th} element in the sampling frame was selected after the first observation had been picked randomly (Schwarz, 2011). To attain a sample of 370, 6 farmers were chosen from each of the 60 buying centers. The remaining 10 was obtained from 6 field assistants and 4 from tea farmers with unique characteristics which systematic sampling could not capture (2 with purple tea and 2 with over 100 acres of tea). Since the process of systematic sampling involves first selecting a fixed point in the larger population and then obtaining subsequent observation by using a constant interval between the samples (Ken, 2004), the first farmer who arrived to weigh tea at the buying centre was chosen, then, using a constant interval, the researcher chose every third farmer who came after.

3.5 Research Instruments

The researcher's research instrument was a questionnaire with five parts. Part I sought to get the personal information of the farmers and had two questions that captured farmers' awareness and practices on climate change adaptations, Part II had four questions on access to information, Part III had two questions on size of the farm, Part IV had four questions on demographics and Part V had three questions on level of education. In all the five parts, both open and closed ended questions were used to capture farmers' views on climate change adaptations.

3.5.1 Instrument validity

Validity is the appropriateness, correctness and meaningfulness of the specific references which are selected on research results (Frankel & Wallen 2004). It is the degree to which results obtained from the data analysis actually represent the phenomenon under study.

To ascertain validity of the instrument, the researcher addressed content and construct validity (extent to which the domain of interest is comprehensively sampled by the items in the questionnaire) by using the exploratory factor analysis and confirmatory factor analysis to ascertain how well the variables were consistent with the researcher's understanding of the nature of the construct. According to Field (2000), the scores in exploratory factor analysis are the Pearson coefficient correlation between observed variables and the factors which results from their sharing common underlying factors. Field recommends an absolute value greater than 0.4, which explain around 16% of variance. Results from inter-item correlation matrix in Appendix

XII indicate inter-item correlations of 0.394, 0.470, 0.490, 0.560, 0.580, and 0.690 which was adequate to conclude that the research results was valid.

3.5.2 Instrument reliability

Reliability is the measure of the degree to which the research instrument yields the same results of data after repeated trials, Mugenda Mugenda (2003). To ensure reliability, the researcher used the split-half technique whereby two-halves of a test from a pilot sample of the first 37 which was10% of study sample according to Mugenda & Mugenda, (2003). Estimation of reliability was based on correlating the results of the two halves of the same scale. The resulting coefficient indicated the degree to which the two halves of the test provided the same results and hence consistency of the test. The reliability coefficient was calculated using the Spearman-Brown prophecy formula whereby according to Brown et al (2004) a correlation coefficient value above 0.70 is generally considered sufficient and reliable .From reliability statistics in Appendix XII, a coefficient value of 0.745 was obtained according to spearman-Brown. Thus the instrument was considered consistent and reliable.

Reliability of the overall test

$$= \frac{2 \times \text{reliability for } ½ \text{ tests}}{1 + \text{reliability for } ½ \text{ tests}}$$

3.6 Data collection procedures

The researcher distributed 370 questionnaires for tea farmers at each of the 60 tea buying centers in which 6 respondents were interviewed. In addition, 6 research assistants filled a questionnaire. The remaining 4 were filled by tea farmers with unique characteristics (2 with purple tea and 2 with over 100 acres). Interviews were conducted at the tea buying centers except for the 4 farmers whose involvement was crucial though could not be captured by systematic sampling. The research was conducted for a period of 18 days and only covered Mondays to Saturdays.

3.7 Data analysis techniques

The data was entered in the Statistical Package for Social Scientist (SPSS) version 17.0 and analysed. Frequency tables with frequencies and their percentages were used. The Ordinal

Logistic Regression Model was used to determine factors influencing climate change adaptation by analysing relationship between the binary/categorical dependent variable (whether a farmer adapted or otherwise) and a set of independent variables which were coded as either dichotomous variable (for nominal data, taking values of 1 or 0) and continuous (for ordinal data). Gujarati (2004) provides a theoretical exposition of the Logit model that can be estimated as probability. The Logistic Model used a logistic cumulative distribution function to estimate probabilities as follows:

$$P = \frac{e^{\beta' x}}{1 + e^{\beta' x}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$1 - P = 1 - \frac{e^{\beta' x}}{1 + e^{\beta' x}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where, P is the probability of success or failure given X_i

e - Denotes the base of natural logarithms, which is approximately equal to 2.718.

X_i - represents the i^{th} independent variables; and

β – Represents the vector of parameters to be estimated.

Then, the general form of the logit model estimated was as follows:-

Prob (Y_i = 1) = F (β'x) ………………………………(3)

Prob (Y_i = 0) = 1 – F (β'x) ………………………………(4)

Where, Yi is the observed response for the i^{th} observation of the response variable Y.

Y_i = 1 for a farmer who adapts to climate change.

Y_i = 0 for a farmer who will not have adapted to climate change.

X – is a set of independent variables that determine the farmers' probability to adapt to climate change. These include educational level of the farmer, access to information, size of the farm and farmers' demographics.

The specified logit model for this research study was:

Adapt = F((β'x) = F(educ, info, demo, farmsiz)

$$Adapt^* = \beta_0 + \beta_1 educ_i + \beta_2 info_i + \beta_3 demo_i + \beta_4 farmsiz_I \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$Adapt_i = \left\{ \begin{array}{l} 1i\ f\ adapt^*_i > 0 \\ 0i\ f\ adapt^*_i \leq 0 \end{array} \right\}$$

Where:

adapt* - unobserved latent variable for adaptation to climate change.

educ - education level of the farmer and is a categorical variable.

info - access to information on climate change and is a dummy variable.

demo – age and experience of the farmer and is a continuous variable.

farmsiz – size of the farm and is a continuous variable.

The research used a binary dependent variable taking the value 1 if the farmer adapted to climate change and 0 otherwise. This was done to distinguish whether a tea farmer had adopted adaptations to climate change or not in Chebut catchment area. A farmer's ability to adapt to climate change was gauged on the number of adaptations ranging from 1 – 13 listed in the questionnaire which the farmer had adopted.

3.8 Ethical Consideration

The research first sought permission from the relevant authorities before collecting any data. The researcher ensured that the respondents understood that the exercise was voluntary and assured the respondents that any information given was treated with utmost confidentiality.

Table 3.1 Operational definition of variables

Objectives	Variables	Indicators	Measurement	Measurement Scale	Tools of analysis
To assess the extent to which farmers' access to information influences adaptation to climate change	Access to information	Field exhibitions	No. of field exhibitions on climate change attended	Ordinal	Logit regression Frequencies and percentages
		Media	Information through Radios, T.V & K.T.D.A Booklets	Ordinal	Logit regression Frequencies and percentages
		Seminars and workshops	No. of seminars and workshops attended	Ordinal	Logit regression Frequencies and percentages
		Trainings	Trainings on climate change attended	Ordinal	Logit regression Frequencies and percentages
To examine the extent to which farmers demographics influence adaptation to climate change.	Farmer's demographics	Farming experience	No. of years in tea farming	Ordinal	Logit regression Frequencies and percentages
		Age of farmer	Age of the farmer	Ordinal	Logit regression Frequencies and percentages

		Gender	Male or female	Ordinal	Logit regression Frequencies and percentages
		Marital status	Single or married	Ordinal	Logit regression Frequencies and percentages
To establish the extent to which the size of farm influences farmers' adaptation to climate change		Small scale		Nominal	Logit regression Frequencies and percentages
	Farm size	Small scale	Range between 0-8acres	Nominal	Logit regression Frequencies and percentages
		Large scale	Over 8acres	Nominal	Logit regression Frequencies and percentages
To determine the extent to which farmers' level of education influences adaptation to climate change.	Level of education	Primary	Years in school	Ordinal	Logit regression Frequencies and percentages
		Secondary	Years in school	Ordinal	Logit regression Frequencies and percentages

	College	Years in school	Ordinal	Logit regression Frequencies and percentages
	University	Years in school	Ordinal	Logit regression Frequencies and percentages

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter provides an analysis, presentation and interpretation of data collected from respondents on climate change adaptations .Information obtained was on access to information, farmers' demographics, and size of the farm and level of education.

4.2 Questionnaire return rate

From the 370 questionnaires issued, 364 were successfully filled and returned. The response rate was therefore 98% which was considered adequate for analysis and conclusion. According to Frankel and Wallen (2004), a response rate of above 95% of respondents adequately represent the study sample and offer adequate information for the study analysis.

4.3 Access to information on climate change adaptation

This variable was examined in an attempt to answer the research question on its influence on climate change adaptations. The research analysed the following sub-thematic areas: attendance of field exhibition, involvement of media, attendance of seminars or workshops and training on climate change issues.

Table 4.1 shows the results obtained from respondents in response to their attendance to field exhibitions and organizations that conducted field exhibitions.

Table 4.1: Attendance to field exhibition

Variable	Frequency	(%)
Attended any field exhibition		
Yes	259	71.2
No	105	28.8
Total	364	100

Of the respondents interviewed, 259 (71.2%) had attended some field exhibitions which was mainly organized and conducted by tea factories in partnership with Rainforest Alliance. From the findings, majority of the farmers have been to field exhibitions which were organized by Chebut tea factory in partnership with Rainforest alliance.

Table 4.2 shows the results obtained from respondents in response to organizations that had conducted field exhibitions.

Table 4.2: Organizations that conducted field exhibitions

Variable	Frequency	(%)
Organizations that conducted the exhibitions		
Tea factories in partnership with Rainforest Alliance	259	100.0

Of the respondents interviewed, 259(71.2%) said that Chebut tea factory in partnership with Rainforest Alliance had conducted field exhibitions on climate change adaptations. The rest of the respondents 105 (28.8%) had neither been to field exhibitions conducted by the factory nor by any other organization.

Table 4.3 shows results obtained from respondents on other sources of information on climate change.

Table 4.3: Other sources of information on climate change

Variable	Frequency	(%)
Other information sources on climate change		
Radio	21	5.8
Television	42	11.5
Fellow farmers	245	67.3
Extension officers	49	13.5
None	7	1.9
Total	364	100

The research revealed that 245(67.3%) farmers in chebut catchment area got climate change information from fellow farmers, 49 (13.5%) from extension officers, television 42(11.5%) and radio 21(5.8%).The findings reveal that few tea farmers in the area get information on climate change through Television and Radio. Findings revealed that majority of tea farmers in the area have got information on climate change through fellow farmers. The role of extension officers in the area has not been felt much as evident from the findings.

Table 4.4 shows results obtained from respondents on attendance to seminars/workshops and the extent to which they had helped climate change adaptations.

Table 4.4: Attendance to seminars/workshops

Variable	Frequency	(%)
Attended any seminar or workshop		
Yes	14	3.8
No	350	96.2
Total	364	100
Extent they have helped adapt		
To a moderate extent	7	50.0
To a limited extent	7	50.0
Total	14	100

Of the respondents interviewed, 14(3.8%) had attended seminars or workshops on climate change. Of those respondents who had attended seminars and workshops on climate change, 7(50%) of them said seminars and workshops had helped them adapt to a limited extent and 7(50%) of them to a moderate extent.

Table 4.5 shows results obtained from respondents on training on climate change adaptation.

Table 4.5: Training on climate change adaptation

Variable	Frequency	(%)
Received any training on climate change adaptation		
Yes	7	1.9
No	357	98.1
Total	364	100

Of the respondents interviewed, 7(1.9%) had received training on climate change adaptation whereas 357 (98.1%) had not received any training on climate change adaptation. Findings of the study reveal that majority of the tea farmers have not received any training on climate change adaptation.

4.4 Size of the farm on climate change adaptation

The researcher investigated its influence on farmer's decision to adapt to climate change. Table 4.6 shows the results obtained from the respondents on the land sizes occupied by tea, other crops and uncultivated or covered by trees.

Table 4.6: Size of farm

Variable	Frequency	(%)
Acres of tea		
0-8 acres	273	75.0
More than 8 acres	91	25.0
Total	**364**	**100**
Acres of other crops		
Min-Max	0.4-19	
Uncultivated or covered by trees (acres)		
Min-max	0.2-30	

When asked about the size of farms under tea, majority of the respondents 273(75%) were found to be small scale farmers had (0-8) acres of tea in their farms, whereas 91(25%) were large scale farmers who had more than 8 acres of tea in their farms. With regard to farm size under other crops, the research revealed that farms ranged from (0.4-19) acres. When asked about the size of the farm which was covered by trees or uncultivated, the research revealed that farmers had between (0.2-30) acres covered by trees or uncultivated .From the findings, majority of the tea farmers are small scale and few are large scale. Findings also reveal that all the respondents had some land reserved for other crops and some covered by trees or uncultivated.

4.5 Farmers' Demographic Factors on climate change adaptation

This variable was investigated by the researcher to determine the influence of age, gender, and marital status of the farmer on climate change adaptations.

Table 4.7 shows results obtained from the respondent's age.

Table 4.7: Age of the Farmer

Variable	Frequency	(%)
Age bracket		
18-30 years	63	17.3
31-45 years	119	32.7
Over 45 years	182	50.0
Total	364	100

From the research, it was revealed that 182(50%) of the respondents were over 45 years of age and that 63(17.3%) were aged 18-30years, and 119(32.7%) were aged 31-45years. From the findings, majority of the tea farms are owned by farmers over 45 years and few tea farms are owned by younger farmers who were below 30 years.

Table 4.8 shows results obtained from the respondent's gender

Table 4.8: Gender of the farmer

Variable	Frequency	(%)
Gender		
Male	336	92.3
Female	28	7.7
Total	364	100

Of the respondents interviewed 336(92.3%) were males and 28(7.7%) were females. Findings reveal that tea farming is dominated by the males. This indicated that majority of the tea farmers in the area are men.

Table 4.9 shows results obtained from respondents on their marital status.

Table 4.9: Marital status of the farmer

Variable	Frequency	(%)
Marital status		
Single	119	32.7
Married	245	67.3
Total	**364**	**100**

Of the respondents interviewed, majority 245(67.3%) was married and 119(32.7%) were single. This reveals that most of the tea farms are owned by married farmers.

4.6 Level of Education of the farmer on climate change adaptation

This variable was investigated to determine its influence on climate change adaptations. Education has been analysed under: level of education, and the extent to which it has helped adapt to climate change.

Table 4.10 shows results obtained on respondents' level of education.

Table 4.10: Level of Education of the farmer

Level of education	Frequency	(%)
Primary	63	17.3
Secondary	126	34.6
College	119	32.7
University	35	9.6
None	21	5.8
Total	**364**	**100**

Of the respondents who were interviewed, the researcher established that 63(17.3%) had attained primary education only, 126(34.6%) had completed secondary education, 119(32.7%) had completed college education, 35(9.6%) had attained university education and 21(5.8%) had not attended school. From the findings, most tea farmers in the region have attained formal education with over three-quarters attaining secondary level and over, which has been cited as aiding farmers adapt to climate change evident in the extent expressed by the respondents

Table 4.11 shows results obtained on respondent's perception and extent to which education has helped them adapt to climate change.

Table 4.11: Influence of education on climate change adaptation

Level of education	Frequency	(%)
Whether education has helped adapt to climate change		
Yes	343	94.2
No	21	5.8
Total	**364**	**100**
Extent to which education has helped in adapting to climate change		
To a limited extent	63	19.0
To a moderate extent	120	36.3
To a large extent	43	13.0
To a very large extent	105	31.7
Total	**364**	**100**

As to whether education had helped them adapt to climate change, 343(94.2%) of the respondents thought education had helped in adaptation to climate change whereas 21(5.8%) had not been helped by education. When asked the extent to which education had helped them adapt to climate change, 63(19.0%) said to a limited extent, 120(36.3%) to a moderate extent, 43(13.0%) to a larger extent and 105(31.7%) to a very large extent. Findings reveal that education has greatly affected climate change adaptations among tea farmers in chebut area.

4.7 Farmer's perception on climate change

Table 4.12 shows results obtained from respondents on their awareness of climate change, possible causes, whether the rain and temperature had changed and who between men and women played a greater role in adapting to climate change.

Table 4.12: Farmers perception on climate change

Variable	Frequency	(%)
Aware of climate change		
Yes	357	98.1
No	7	1.9
Total	364	100
Number of hot days		
Increased	364	100.0
Number of rainfall days		
Reduced	364	100.0
Cause of climate change		
Human activities	364	100.0

From the findings, high proportion 357(98.1%) of the farmers was aware of climate change and all the respondents thought the number of hot days had increased and rainfall had reduced. Respondents cited delayed rains, frost, drying of tea bushes and maize disease as indicators that climate was changing. Also, all the respondents attributed climate change to human activities which was as a result of indiscriminate felling of trees and clearing of vegetation for human activities.

Table 4.13 shows results on respondent's perception on who between men and women played a greater role in climate change adaptations.

Table 4.13: Influence of gender on climate change adaptation

Variable	Frequency	(%)
Who between men and women play a greater role in adapting to climate change		
Men	133	36.5
Both (men and women)	231	63.5
Total	364	100

Of the respondents interviewed, 231(63.5%) thought both men and women played a role in adapting to climate change and 133(36.5%) thought that only men played a greater role. None of the respondents interviewed, cited women only as playing a greater role in adaptation. From the findings, majority of the respondents were aware that climate was changing and cited decreased rainfall and increased temperature as evidence. Therefore, there was perception of climate change by tea farmers in Chebut area. In addition, human activities in chebut area was cited as responsible for climate change which was a result of indiscriminate felling of trees, cultivation along river banks and intensive cultivation.

4.8 Climate change adaptation activities

Table 4.14 shows results obtained from the respondents on climate change adaptations adopted in their farms.

Table 4.14: Climate change adaptation

Variable	Frequency(N=364)	(%)
Diversification to other activities	357	98.1
Minimum tillage	196	53.8
Mulching	147	40.4
Terracing	350	96.2
Planting of trees	343	94.2
Planting drought resistant tea	350	96.2
Using improved jikos	7	1.9
Forestation and reforestation	203	55.8
Mixed farming	336	92.3
Planting cover crops	154	42.3
Water harvesting	203	55.8
Embracing crop insurance	0	0
Crop rotation	343	94.2

As to whether farmers had adopted various climate change adaptations, 357(98.1%) of the respondents had diversified into other activities besides tea, 196(53.8%) practiced minimum tillage, 350(96.2%) practiced terracing, 147(40.4%) practiced mulching, 343(94.2%) planted

trees, 350(96.2%) had planted drought resistant tea, 7(1.9%) used improved jikos, 203(55.8%) practiced afforestation, 336(92.3%) practiced mixed farming 42.3% planted cover crops 55.8% harvested water, 343(94.2%) practiced crop rotation, 203(55.8%) practiced water harvesting and none of the respondents embraced crop insurance. The farmers scored poorly in certain climate change adaptation activities like use of improved jikos with none of them having embraced crop insurance. From the findings, majority of the tea farmers had other activities running concurrently with tea farming. Findings reveal that farmers had other crops like beans, maize, potatoes, and kept animals like cows and sheep in their farms. Terracing was adopted by farmers on a large scale as well as planting of drought resistant tea varieties, crop rotation, mulching, mixed farming and planting of trees. However, the use of improved jikos was not popular due to availability of firewood and none of the respondents had ever adopted crop insurance as an adaptation measure to climate change

4.9 Results of ordered logistic regression model

A logistic regression analysis was conducted to predict factors influencing climate change adaptations for 364 tea farmers using access to information, size of the farm, demographic factors and level of education as predictors. Cumulative ordinal logistic analysis was incorporated by first ranking farmers' responses on adaptation methods as follows: farmers with no adaptation = (1), 2≤ adaptations≤6 = (2), 7≤ adaptations≤ 9 = (3) and 10 ≤ adaptations≤ 12 =(4). Since binary logistic regression alone was inappropriate to use to estimate model parameters, thus cumulative ordinal logistic analysis that incorporates orderings in responses potentially was adopted as it has a greater power to explain (Agresti and Finlay, 1997).

Table 4.15 shows ordered groups of adaptation ranked according to the number of adaptations a farmer had adopted in his /her farm.

Table 4.15: Ranked categories

Variable	Frequency	(%)
Farmers adaptation rank		
None (1)	19	5.2
2-6 (2)	86	23.6
7-9 (3)	140	38.5
10-12 (4)	119	32.7

From Table 4.15, 19(5.2%) had none of the adaptation in place, 86(23.6%) of the farmers had (2-6) adaptations, 140(38.5%) had (7-9) adaptations and 119(32.7%) had over ten of the listed adaptations. From these groupings, majority of the farmers 259 (71.2%) had more than half (6) of the adaptations in their farms out of the 13 listed adaptations.

Table 4.16 shows results of ordered logistic model on the factors influencing climate change adaptations among the respondents.

Table 4.16: Results of ordered logistic regression model

Parameter Estimates (N=364)

							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Threshold	[adaptrank = 2]	-2.893	.942	9.421	1	.002	-4.740	-1.045
	[adaptrank = 3]	-.345	.813	.180	1	.671	-1.938	1.248
Location	[18-30_Age=2.00]	1.056	1.594	.438	1	.508	-2.069	4.181
	[31-45_Age=3.00]	.432	1.080	.160	1	.689	-1.684	2.549
	[over45_Age=4.00]	0[a]	.	.	0	.	.	.
	[fem_Gender=.00]	.212	1.456	.021	1	.884	-2.642	3.066
	[male_Gender=1.00]	0[a]	.	.	0	.	.	.
	[mar_M_status=1.00]	-.442	.858	.265	1	.607	-2.123	1.240
	[sing_M_status=2.00]	0[a]	.	.	0	.	.	.
	[Exhibition=1.00]no	.381	.692	.303	1	.582	-.975	1.736
	[Exhibition=2.00]yes	0[a]	.	.	0	.	.	.
	[Acres=1.00]sma	.553	.811	.465	1	.495	-1.037	2.144
	[Acres=2.00]large	0[a]	.	.	0	.	.	.
	[edlevel=1.00]pri	-3.539	1.036	11.675	1	.001	-5.569	-1.509
	[edlevel=2.00]sec	-2.533	.772	10.766	1	.001	-4.046	-1.020
	[edlevel=3.00]coll/un	0[a]	.	.	0	.	.	.
	[farmyears=1.00]<10	-1.276	1.092	1.364	1	.243	-3.416	.865
	[farmyears=2.00]>10	0[a]	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

From the results of the logistic regression, a test of the full model against a constant only model was statistically significant indicating that the model distinguished between those factors that are likely to make farmers adapt to climate change and those that don't. The Wald criterion demonstrated that only education made a significant contribution to adaptation (p =0.001). As compared to farmers with higher levels of education, those with primary and secondary level of education were more likely to rank poorly in climate change adaptation (β= -3.539, p=0.001 and β= -2.533, p=0.001). From the results, farmers who had only attended primary school were 3.539 times less likely to adopt climate change adaptations than those who had attended college or university. On the other hand, those respondents who had attended secondary school only were 2.533 times less likely to adopt climate change adaptations than those who had either college or university. This therefore revealed that education had a major influence in adoption of adaptations as it diminishes the likelihood of a farmer not adopting adaptations to climate change.

As to whether age was a factor influencing climate change adaptations, the research revealed that it did not play a significant role in adapting to climate change. Results indicate that as the farmer's age increases, adoption of adaptation also increases. Findings reveal that a farmer who 18-30 years was 1.056 times more likely to adopt adaptation to climate change than one who was over 45 years and a farmer who was 31-45 years was 0.432 times as likely to adapt to climate change as was a farmer whose age was over 45 years. This therefore indicates that a farmer who was 18-30 years was more likely to adopt climate change adaptations than all the other age groups.

Results on gender revealed that though insignificant (0.884) in influencing adoption of climate change adaptations in Chebut area, the female farmer was 0.212 times as likely to adopt adaptation to climate change as their male counterparts. This indicated that male tea farmers in the area were more likely to adopt climate change adaptations.

On marital status of the respondents, findings revealed that it did not play a significant role in adopting adaptations (0.607). A farmer, who was single, decreased his/her likelihood of adopting climate change adaptations 0.442 times as a married tea farmer. This indicates that a married farmer was more likely to adopt adaptation than a single farmer.

Exhibition was found to be insignificant in influencing adaptation (0.582). However, those who had not attended exhibitions were 0.381 times less likely to adopt climate change adaptations as those who had. On the size of the farm under tea, small scale farmers were 0.553 times as likely

to adopt adaptations as their large scale counterparts. Findings further revealed that size of the farm under tea was insignificant (0.495) in influencing adoption of climate change adaptations in chebut area. Therefore, large scale farmers were more likely to adopt adaptations than their small scale counterparts.

On farming experience, findings revealed that, number of years a tea farmer had in farming tea did not play a significant role in influencing adoption of climate change adaptations. Those farmers who had less than ten years farming experience decreased their likelihood of adopting climate change adaptations 1.276 times as those who had more than ten years experience, the results indicate that although farming years in general was insignificant (0.243) in adopting climate change adaptations, those with over ten years experience in farming tea were in a better position to adopt adaptations to climate change.

Findings of the logistic regression established that education played a significant role in influencing adaptations (0.001) whereas demographic factors, size of the farm, and access to information through exhibition were not significant predictors. At 95% confidence interval (0.05 level of significance), gender was insignificant at (0.884), exhibition at (0.495), years of farming at (0.243), size of farm under tea at (0.495) and age (0.508, 0.689)

CHAPTER FIVE
SUMMARY OF FINDINGS, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This section presents the research's summary of findings, conclusions and recommendations in line with the research questions. The summary of each research indicator is explained from analysis, associated recommendations and suggestions for further research.

5.2 Summary of findings

Results from the descriptive analysis of the respondents on access to information, revealed that majority of the respondents had attended field exhibition which were administered by Chebut tea factory in partnership with Rainforest alliance. In regard to access information through media, a few of the farmers got the information through Radio, and Television. Most of the respondents had got climate change information through fellow farmers and only a few through extension officers. As to whether the respondents had attended seminars or workshops on climate change, the researcher established that majority had neither attended any seminar nor workshops. When asked whether the respondents had received any training, the researcher established that little had been done and only few farmers had received training.

On investigating the size of farm as a factor influencing climate change adaptation, results from the descriptive analysis revealed small scale dominance over large scale farmers with each having land reserved for other crops and tree planting or uncultivated.

The question of the extent to which age, gender, and farming experience of the farmer influenced climate change adaptations; it revealed that of the respondents interviewed, majority were over 45 years of age and that most of whom were male. It also revealed that majority of the respondents were married.

As to whether education level had an influence on climate change adaptation, the researcher established that majority of the respondents had attended formal and only few had not. The research also revealed that respondents reported education as having contributed to a large extent in adapting to climate change.

A high proportion of the farmers were aware of climate change and all the respondents thought the number of hot days had increased and rainfall had reduced. Respondents cited delayed rains, frost, drying of tea bushes and maize disease as indicators that climate was changing. Hailstones had also been noticed to be on the increase which damaged tea and reduced production. Also, all the respondents attributed climate change to human activities which was as a result of indiscriminate felling of trees and clearing of vegetation for human activities. Both men and women were reported to playing a role in adapting to climate change and a few thought that only men played a greater role. None of the respondents interviewed, cited women only as playing a greater role in adaptation. Some of the reasons given were that men are the heads of families and major decision makers. Men were viewed as land owners and all decisions concerning land was in their hands including what should be planted and what method of climate change adaptation to be adopted.

As to whether farmers had adopted various climate change adaptations, the researcher established using logistic regression that education significantly influenced climate change adaptations by tea farmers with those who had attended college and university more likely to adapt than those who hadn't. It was also discovered that although age ,gender, marital status, exhibition, acres of land under tea, and years of farming were found to be insignificant, findings revealed that male farmers were better adopters of adaptations than female farmers. In addition, those who were married were better placed in adaptations than single farmers. Those who attended exhibitions were likely to adopt adaptations than those who hadn't. Farmers who owned large scale tea farms were more likely to adopt than those who practiced small scale tea farming. Finally, less than ten years of tea farming was found to decrease the likelihood of a farmer adopting climate change adaptations, those with over ten years experience in tea farming were more likely to adopt adaptations to climate change.

5.3 Discussion of the study

The researcher established that the respondents were aware of the impact of climate change, especially in temperature and rainfall. There was a general consensus among the respondents that temperature had increased over the years which implied that temperature around chebut area had

indeed increased. Farmers reported that they had experienced increased daily temperatures and low night temperature which became extreme in the mornings in the form of frost which has caused scorching in tea resulting to heavy losses. These perceptions about temperature increase confirm Intergovernmental Panel on Climate Change predictions about an overall in temperature (IPCC, 2007).Respondents reported that they had experienced delayed rainfall coming in April in contrast to March and early cessation in June. This early stopping of rain had discouraged tea farmers from planting tea, as many of the seedlings planted in May wilted in June.

Findings reveal that some tea farmers had adopted some adaptations in their farms for other reasons and that it was a coincidence that such actions helped adapt to climate change. A case for example of 90% of the respondents diversifying to other activities was found to be as a result of higher incomes but not necessarily to combat climate change. Those who observed minimum tillage was purely because tea farms need minimal tillage to reduce root disturbance but not as an adaptation to climate change. Mulching in the same way was done to seedlings in the nursery to reduce wilting before transplanting as was established by the researcher but not to combat climate change. Of the respondents interviewed, 96% had planted drought resistant tea. The researcher established that most of the respondents had C12 as the tea variety of choice due to its resistance to drought, four tea farmers of all the respondents had planted purple tea in anticipation of better income. The response on use of improved jikos was very low at 1.9%, the respondents said they had heard about it but had not used because firewood was still available and the jikos were expensive. Of the respondents interviewed, 42.3% had cover crops like sweet potatoes and nappier grass. Again, this was established that they were planted as animal feeds and was only a coincidence that it helped combat climate change. Water harvesting was practiced by 55.8% of the respondents as a convenience to provide water for domestic use but was not mentioned as a conservation measure. None of the respondents reported embracing crop insurance, they mentioned that Majani insurance was what they knew but it insured against farm machineries and workers but not crop losses

In this study, age of the farmer did not have a significant relationship with adaptation to climate change. Although over 50% of the respondents were over 45 years of age, age and years of experience in tea farming was insignificant at 0.508 and 0.243 respectively at 95% confidence interval. Deressa et al (2009) established that age and experience did not play a greater role

because there was no specific age for the respondents to start farming. Therefore, one might be old and start farming late while another might be young and start farming early. Gender of the farmer did not seem to be of significance in influencing adaptation, from the findings, although men were as more likely to adapt to climate change than women, it was insignificant (0.884) at 95% confidence interval. This was because the proportion of men (92.3%) was higher than that of women (7.7%, rather it was level of education that influenced most in adaptation irrespective of gender, thus making it insignificant. According to Patt et al (2009), women are more risk averse than men and therefore more likely to take decisions that minimize risks. They are found to be open to advice and are more willing to change their strategies in response to new information.

5.4 Conclusion of the study

The study focused on factors influencing climate change adaptation among tea farmers in Chebut area, Nandi Central District. Findings revealed that although the respondents appear to be well aware of climate change, few seem to actively take steps towards adjusting their farming activities. Results from the descriptive analysis and logistic regression results revealed that respondents were characterized by small scale farmers (75%) and few were large scale farmers (25%). Farmers land used for other crops ranged from 0.4 -19 acres whereas land under trees ranged from 0.2- 30 acres. It can be concluded that size of the land was not significant as evident by 0.495 values at 95% confidence interval. With regard to farmer's perception on climate change, majority 98.1% were aware that climate was changing and had perceived changes in temperature and rainfall patterns.

From the logistic regression estimates of (p= 0.001), it can be concluded that education was a major predictor of the probability that a farmer adapts to climate. Education level of the farmer is significantly and positively related with adaptation to climate change. Higher level of adaptation was associated with access to information on improved methods of farming and higher productivity. Higher education was more likely to expose farmers to any available information on climate change.

From findings of this study, it can be concluded that a unit increase in the level of education as one moves from primary onwards, would result in an increase in climate change adaptation by

the farmer. It is thus concluded that education create a favorable mental attitude for the acceptance of new practices especially of the information-intensive and management practices.

From the findings in Chebut area, it can be concluded that there is inadequate access of information through training (1.9%) which is very low, yet crucial for sensitizing farmers on climate change issues. Little effort is being done by tea factory at Chebut, since the actual field exhibition was conducted by Rainforest Alliance which is an environmental organization less related to tea farming. Seminars and workshops were so few that only 3.8% of the respondents had attended and of those who had attended, 50% had moderately gained from it, 50% had gained to a limited extent. It can be concluded that if climate change information was availed to tea farmers in Chebut catchment area, adoption of adaptation practices is likely to increase from the current capacity and boost awareness to climate change and hence adaptations

5.4 Recommendations of the study

Farmers' adaptation to climate change is crucial to combating food insecurity and poverty. For this reason, a sustainable infrastructure of adaptations is required from all stakeholders. Considering the results of this study, it is recommended that:

Effective policies should be put in place such as extension services, consider running programs on television and radios to increase awareness on climate change. These policies should address imperfections such as access to information and linking farmers with extension services and farmers groups in order to reach small-holder farmers. Massive campaigns on the reality of climate change and its serious consequences on food production so as to persuade farmers to adopt adaptations need to be conducted. The social network through farmer to farmer extension should be promoted and strengthened so as to boost awareness level from the current position to a level where all tea farmers are better placed in adaptation practices.

Since education was a major predictor on uptake of adaptations, regular meetings, seminars and workshops should be put in place to improve adoption of new skills and technology that will boost uptake of climate change adaptations. Tea farmers' handbook should contain information on appropriate practices to be embraced by tea farmers in light of climate change.

Readily available emerging technologies and land management practices that could greatly

reduce agriculture's negative impacts on the environment and enhancement of its positive impacts should be in place. In addition, Crop insurance need to be availed to farmers so as to cushion them against losses brought about by vagaries of weather. This is because none of the respondents had embraced insurance. Majani insurance which respondents mentioned should be tailored to include crop losses.

5.5 Suggestions for further research

The focus of this research study was to investigate on the factors influencing climate adaptations where four variables: access to information on climate change, size of the farm of the farmer, demographic factors such as age, gender and farming experience and level of education of the farmer. It is therefore suggested that other variables be identified and researched to establish their influence on climate change adaptation.

A research especially on the factors influencing implementation of climate change adaptation may bring into light more information which might be useful in understanding the reasons why, even after farmers are aware of climate change, they still haven't adopted fully as this current study has established.

Research on barriers to climate change adaptations among tea farmers need to be done. This is because, findings revealed that farmers were aware of various adaptations but have not been able to adopt them. Findings from this study on barriers to adaptations may help create an understanding which will go a long way in devising sound climate change adaptation strategies.

A research on the involvement and contributions of stakeholders in the tea industry towards climate change should also be done. The role of such stakeholders as; Kenya Tea Development Agency, Tea Board of Kenya, tea processors, and tea research institute, should be established in order to explore ways that a common front towards combating climate change is realized.

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APPENDIX I: LETTER OF TRANSMITTAL

WILSON KIPTOO LIMO
P.O. BOX 77
KAPSABET
0722 588 722

Dear Sir/Madam,

RE: AN ASSESSMENT OF CLIMATE ADAPTATION STRATEGIES IN SELECTED TEA FARMS IN CHEBUT CATCHMENT AREA, NANDI COUNTY

I am a student at the University of Nairobi (Reg No. L50/68303/11). I am undertaking a study that seeks to assess the factors influencing adaptation to climate change in tea farms in Chebut catchment area.

You have been selected to provide information on the various adaptation strategies you may have participated or currently taking part in. This is a request for your participation in responding to the attached questionnaire. Please be assured that any personal information will be treated with utmost confidentiality and will be purposely used for this study.

Yours faithfully,

Wilson Kiptoo Limo.

APPENDIX II: QUESTIONNAIRE FOR TEA FARMERS

PART I

PERSONAL INFORMATION

Please Tick in the box where appropriate and write your responses on the spaces provided.

1. Please indicate your age bracket

☐ Below 18years ☐18-30years ☐ 31-45 years

☐ Over 45 years (specify)……

2. For how many years have you been farming tea?

☐Less than 5years ☐6-10 years ☐Over 10 years (specify)……

3. Gender:

☐Male ☐Female

4. Marital status

☐Married ☐Single

PART II:ACCESS TO INFORMATION

Please Tick in the box where appropriate:

1. Have you attended any field exhibition on climate change?

☐Yes ☐No

If yes, which organization(s) conducted these exhibitions?

☐ Government ☐ Tea factories ☐ others (specify)……

2. Where else do you get information on climate change? Tick where appropriate

☐Radio ☐Television ☐Fellow farmers ☐Extension Officers

3. Have you ever attended any seminar or workshop on climate change adaptation?

☐Yes ☐No

If yes, to what extent have they helped you adapt to climate change?

☐To a limited extent ☐ to a moderate extent ☐to a large extent

☐To a very large extent

4. Have you received any training on climate change adaptation?

☐Yes ☐ No

If yes above, give details of the training ……

……

……

PART III:SIZE OF THE FARM

Please Tick in the box where appropriate:

1. How many acres of tea do you have?

☐0-8acres ☐More than 8 acres (specify)…….

2. How many acres of land are occupied by other crops? ……

3. Approximately how many acres of your land are covered by trees or uncultivated?.....

PART IV:FARMERS' DEMOGRAPHICS

Please Tick in the box where appropriate:

1. Are you aware of climate change?

☐Yes ☐No

If yes above, given indications that climate is changing

……
……..……
……
……..……
……..……

2. Has the number of hot days stayed the same, increased, or reduced over the last 10 years?

☐Increased ☐reduced ☐stayed the same

3. Has the number of rainfall days stayed the same, increased or reduced over the last 10 years?

☐Increased ☐reduced ☐stayed the same

4. What do you think causes climate to change in Chebut area?

☐Human activities ☐Act of God ☐ Don't know

5. Who between men and women play a greater role in adapting to climate change?

☐Men ☐women ☐ both

Give reason for your answer above…….....

PART V:LEVEL OF EDUCATION

Please Tick in the box where appropriate:

1. What is your level of education?

☐Primary ☐Secondary ☐College ☐University

☐Other (specify)…….

2. Do you think education has helped you adapt to climate change?

☐ Yes ☐No

3. If yes above, to what extent has it helped you adapt to climate change?

☐ Limited extent ☐ To a moderate extent ☐ To a large extent

☐ To a very large extent

PART VI: CLIMATE CHANGE ADAPTATIONS

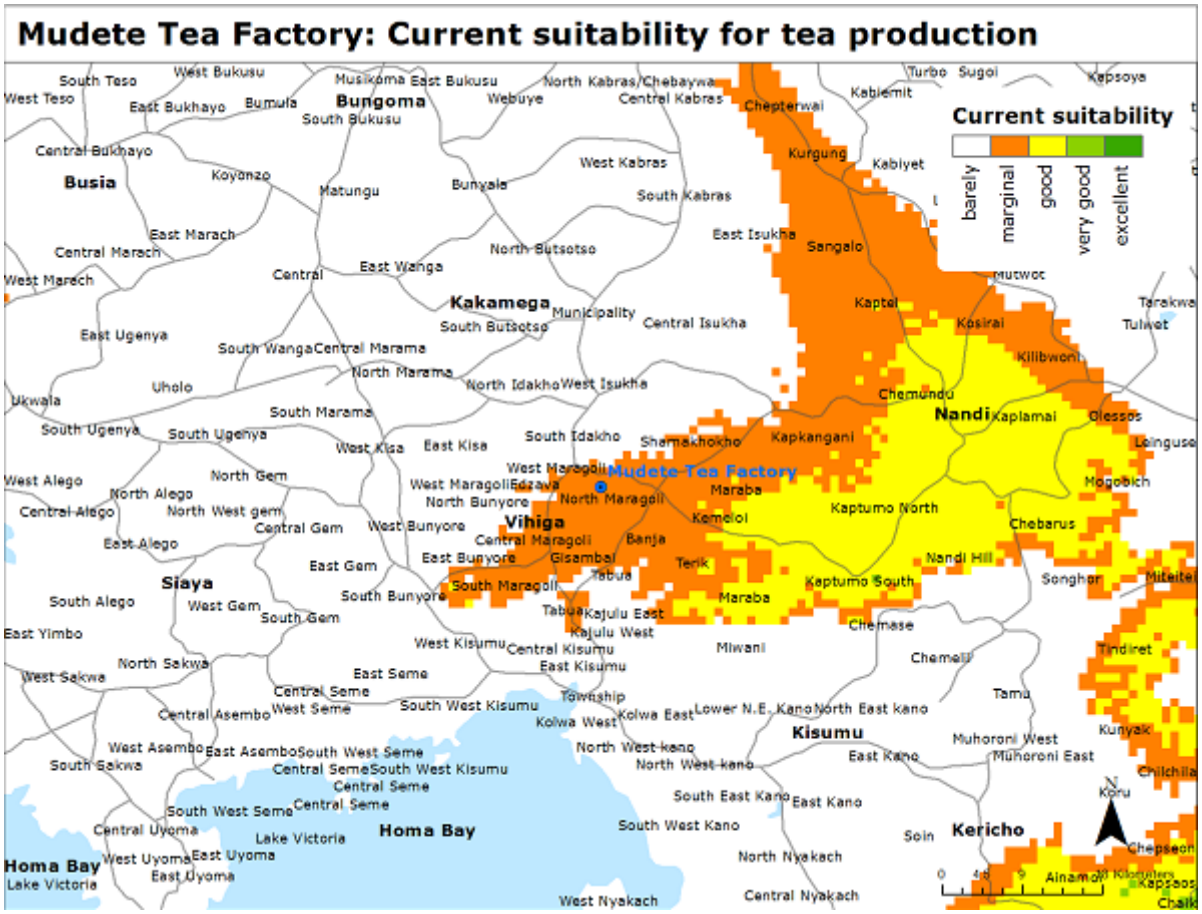
Tick in the boxes where appropriate,

1. What adjustments in your farming have you made in response to climate change?

☐ Diversification to other activities like maize, peas, passion, beans, livestock keeping (Identify the activity……)
☐ Minimum tillage
☐ Mulching
☐ Terracing
☐ Planting of trees in the farm and around water catchment areas
☐ Planting drought resistant tea varieties
☐ Use of improved jikos
☐ Forestation and reforestation
☐ Mixed farming
☐ Planting cover crops
☐ Water harvesting
☐ Embracing crop insurance
☐ Crop rotation

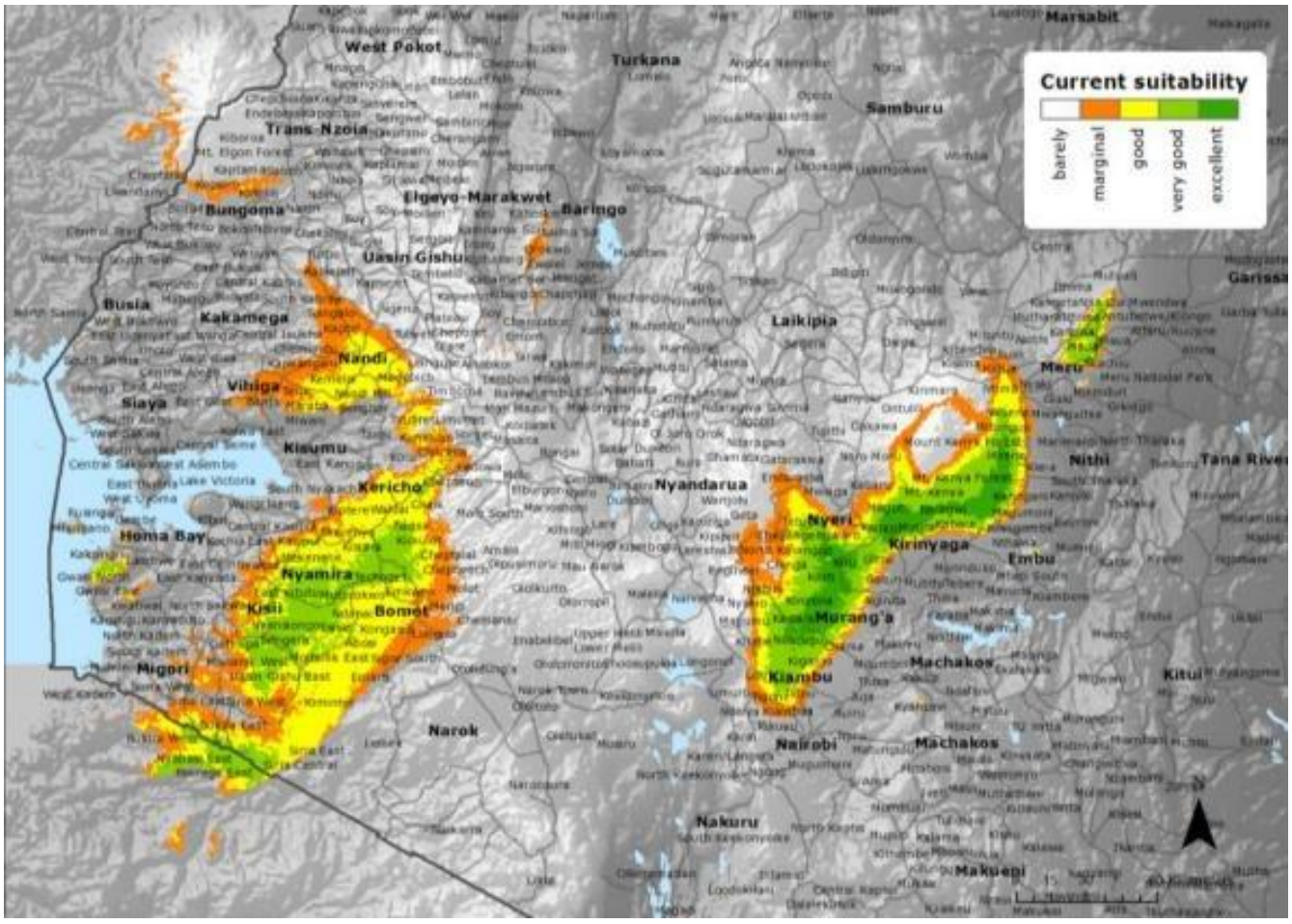
Thank you

APPENDIX III: SUITABILITY MAPS OF MUDETE TEA FACTORY (CHEBUT AREA)



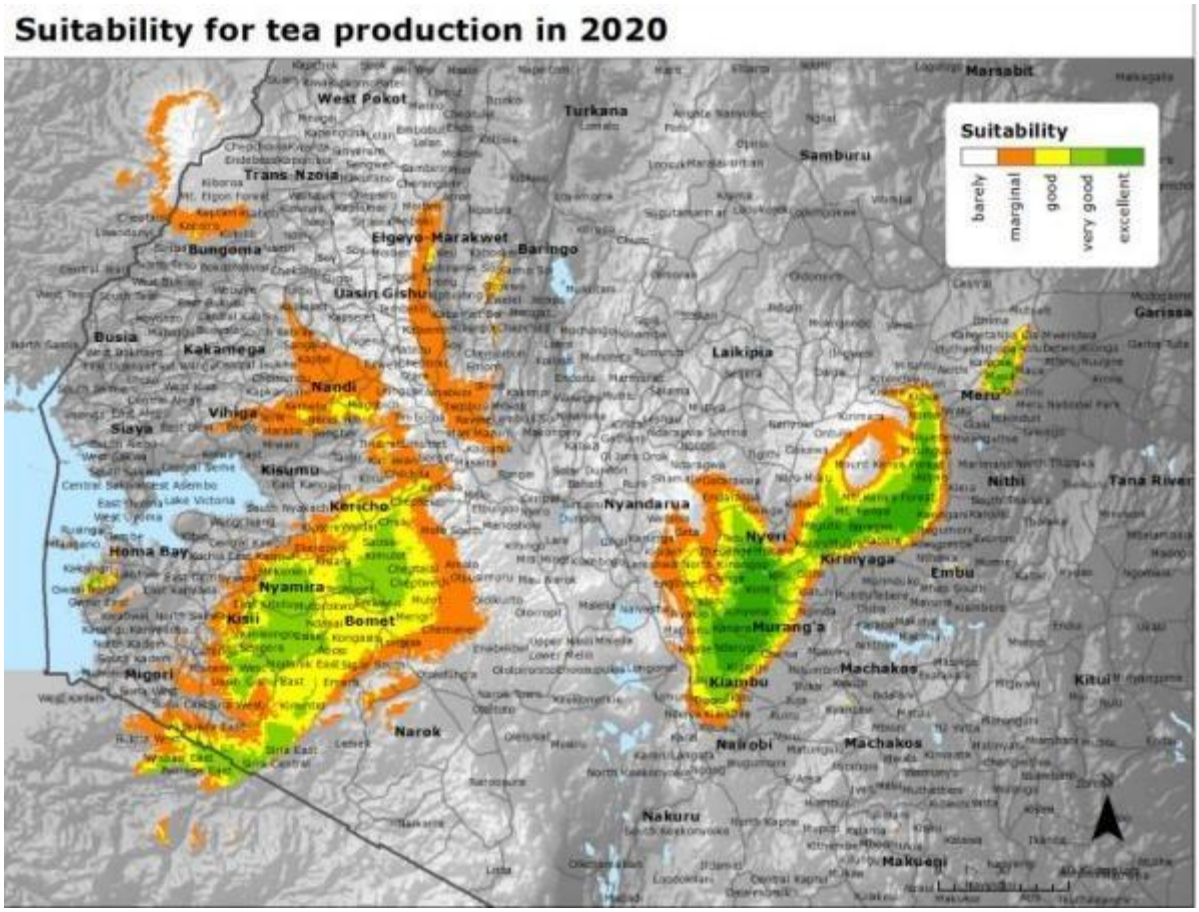
Source: International center for tropical agriculture, 2011

APPENDIX IV: CURRENT SUITABILITY OF TEA PRODUCTION AREAS



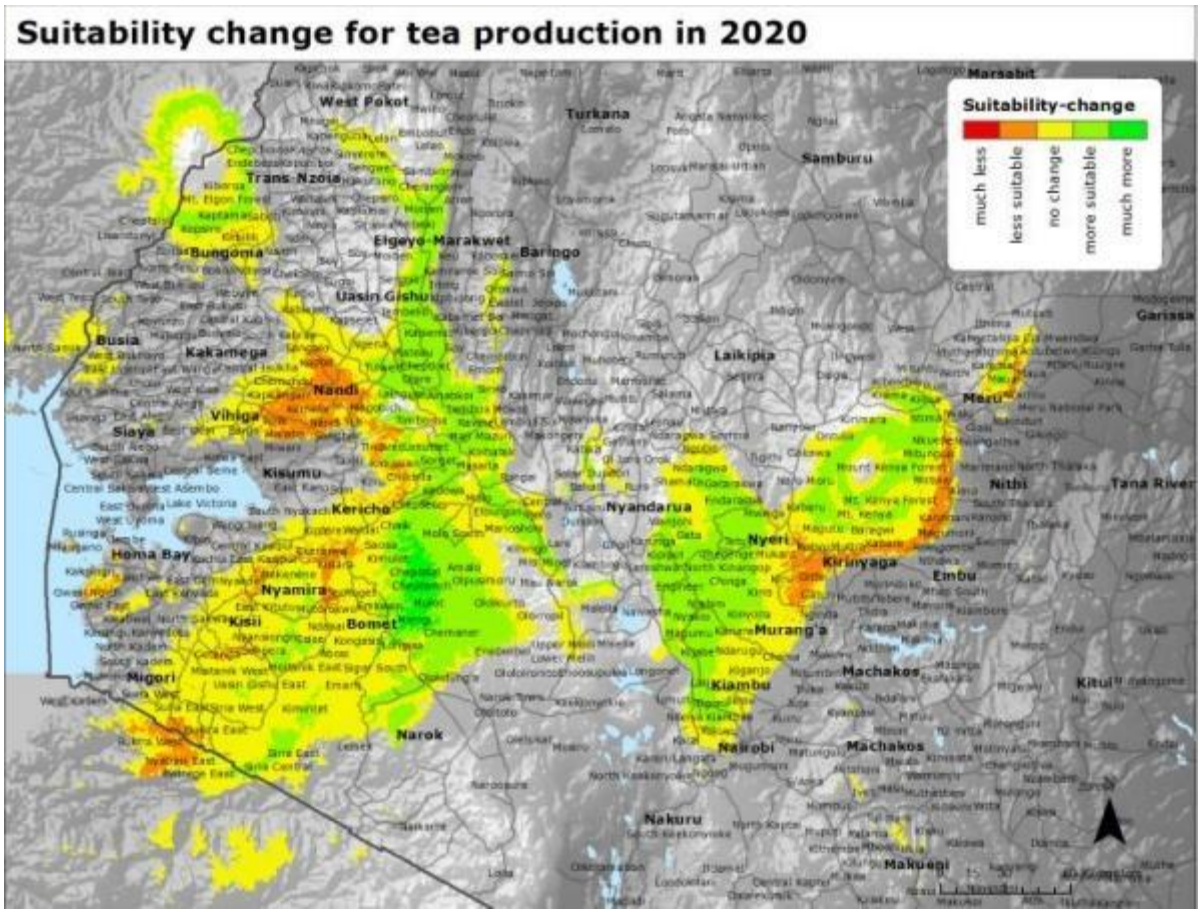
Source: International center for tropical agriculture, 2011

APPENDIX V: FUTURE SUITABILITY OF TEA PRODUCTION AREAS IN 2020



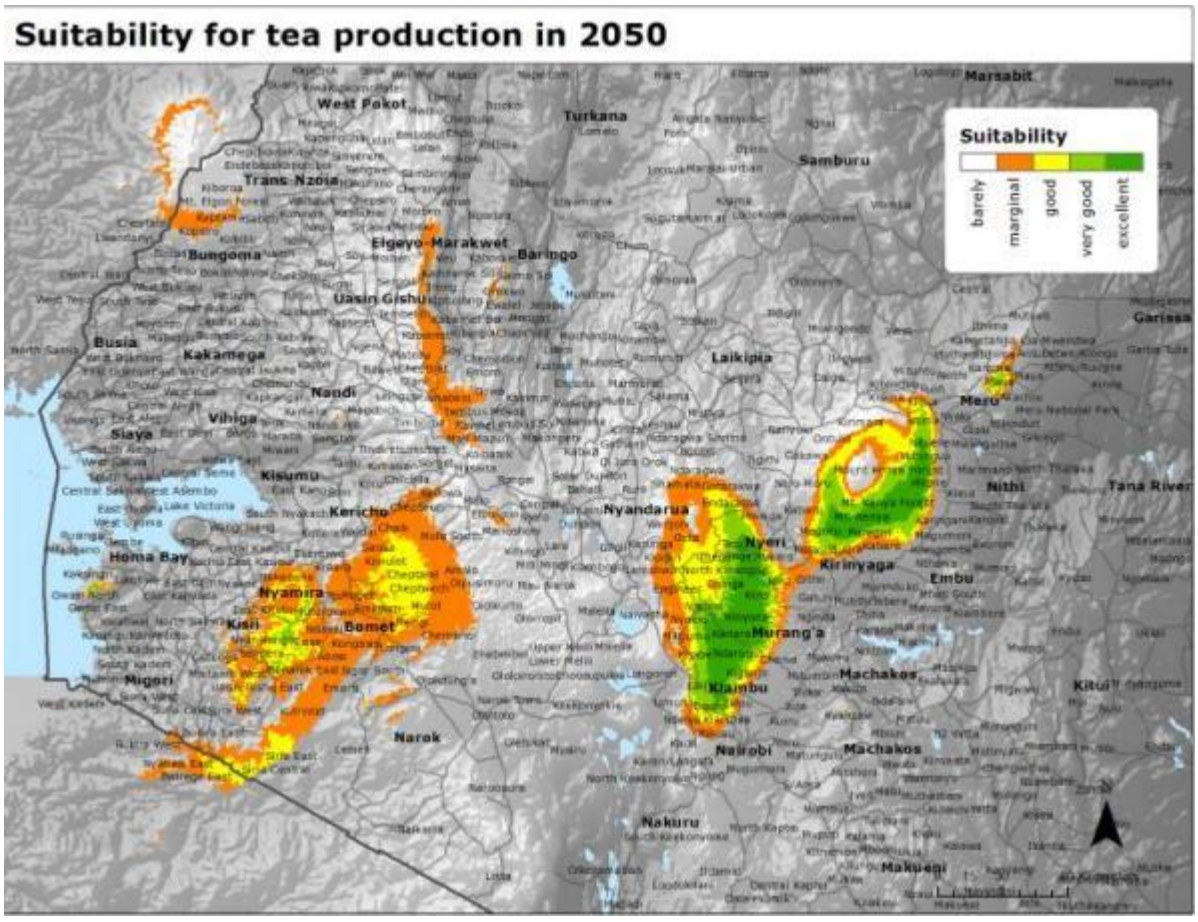
Source: International center for tropical agriculture, 2011

APPENDIX VI: SUITABILITY CHANGE OF TEA PRODUCTION AREAS IN 2020



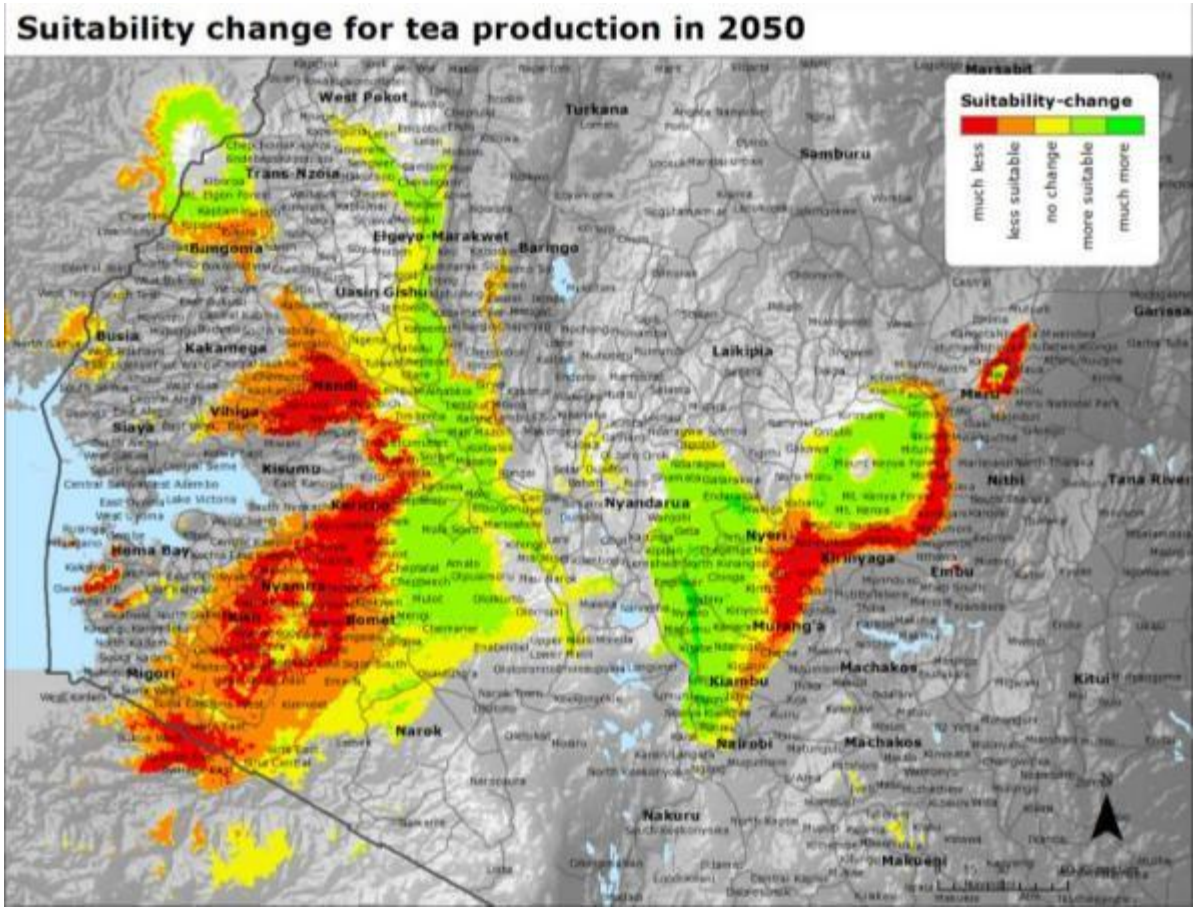
Source: International center for tropical agriculture, 2011

APPENDIX VII: SUITABILITY FOR TEA PRODUCTION AREAS IN 2050



Source: International center for tropical agriculture, 2011

APPENDIX VIII: SUITABILITY CHANGE FOR TEA PRODUCTION IN 2050



Source: International center for tropical agriculture, 2011

APPENDIX IX: LIST OF TEA BUYING CENTERS

APPENDIX X: SAMPLING POINTS

APPENDIX XI: SAMPLE SIZE TABLE

APPENDIX XII: INSTRUMENT RELIABILITY AND VALIDITY TEST

The researcher conducted the reliability test based on 4 items extracted from the questionnaire that was developed to investigate factors influencing climate change adaptation. The four items were identified as follows:

1. Have you attended any field exhibitions on climate change?
2. Have you ever attended any seminars or workshops on climate change adaptations?
3. Have you received any training on climate change adaptations?
4. Do you think education has helped you adapt to climate change?

Respondents were asked to respond to each item according to the following scale:-
YES or NO.
For data analysis on SPSS, these responses were converted to scores of either (1) or (2), where 1 represented YES and 2 represented NO.

The following is the tabulated data scored on 37 respondents in response to the 4 items.

	Items			
Respondents	**1**	**2**	**3**	**4**
1.	2	2	2	1
2.	1	2	2	1
3.	2	2	2	1
4.	1	2	2	1
5.	2	2	2	1
6.	1	1	2	1
7.	1	2	2	2
8.	1	2	1	1
9.	2	2	2	1
10.	2	2	2	2
11.	1	2	2	1
12.	1	1	2	1
13.	1	2	2	1
14.	1	2	1	1
15.	1	2	2	2
16.	2	2	2	1
17.	1	2	2	1
18.	1	1	2	1
19.	2	2	2	1
20.	1	2	2	1
21.	1	2	2	1
22.	1	2	2	1
23.	1	2	2	2
24.	1	2	2	1
25.	1	2	2	1
26.	1	1	2	1
27.	2	2	2	1
28.	1	2	1	1
29.	1		2	1
30.	1	2	2	1
31.	1	2	2	1
32.	2	2	2	1
33.	1	2	2	1
34.	1	2	2	1
35.	2	2	2	1
36.	1	2	2	1
37.	1	2	2	1

The SPLIT HALF model for reliability analysis was conducted and the results of reliability revealed that the equal length of the Spearman – Brown coefficient had value of 0.745. This is an

inference of reliability of the entire scale, which according to Brown et al (2004) a correlation value above 0.70 is generally considered sufficient and reliable.

Reliability Statistics

Cronbach's Alpha	Part 1	Value	.712
		N of Items	2[a]
	Part 2	Value	.738
		N of Items	2[b]
		Total N of Items	4
		Correlation Between Forms	.740
Spearman-Brown Coefficient		Equal Length	.745
		Unequal Length	.745
		Guttman Split-Half Coefficient	.673

b. The items are: item1, item2.

c. The items are: item3, item4.

Factors analysis

Correlation Matrix[a]

		Have you ever attended any field exhibitions on climate change?	Have you ever attended any Seminars or Workshops on Climate change adaptations?	Have you received any Training on Climate change Adaptations?	Do You think Education has helped you adapt to climate change
Correlation	Have you ever attended any field exhibitions on climate change?	1.000	.580	.560	.470
	Have you ever attended any Seminars or Workshops on Climate change adaptations?	.580	1.000	.394	.490
	Have you received any Training on Climate change Adaptations?	.560	.394	1.000	.690
	Do You think Education has helped you adapt to climate change	.470	.490	.690	1.000

a. Determinant = .906

APPENDIX XIII: RESEARCH AUTHORIZATION LETTER