PERCEPTIONS OF AGRICULTURE TEACHERS TOWARD INTEGRATION OF SELECTED CLIMATE CHANGE TOPICS INTO SECONDARY SCHOOL AGRICULTURE SYLLABUS IN MACHAKOS COUNTY, KENYA

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A Thesis Submitted to Graduate School in Fulfilment of the Requirements for the Award of the Degree of Doctor of Philosophy in Agricultural Education of Egerton University

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DECLARATION AND RECOMMEDATION

Declaration

I hereby declare that this thesis is my original work and has not been presented for conferment of a degree or award of a diploma in this or any other University.

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DEDICATION

I dedicate this work to God Almighty for directing and guiding me all through and secondly, to Mike Raymond of Indianapolis, USA for his mentorship.

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ABSTRACT

Secondary school agriculture curriculum was introduced in Kenya to equip learners with knowledge on the basic principles of farming. The intention was to bring out school graduates who would embrace self-employment and even create employment for others in their farms. Agriculture sector contributes significantly to economic development of this country through; provision of food, employment, market for industrial goods, raw materials for industries and foreign exchange. To realize these, agriculture syllabus need to be abreast with the contemporary issues influencing the agricultural production. Successful farming is partly dependant on climatic conditions. Therefore, the escalating climate change and variability occasioned by global warming has added to the numerous risks and uncertainties facing farming practices. The knowledge gap this study sought to bridge, therefore, was the inconsistencies in the existing secondary school agriculture syllabus to address climate change and variability problem. Descriptive opinion survey research design was adopted for the study. The target population was one hundred and thirty five (135) respondents who were purposefully drawn for the study. The target population was used, implying there was no sampling. However, due to natural attrition, the respondents who participated in the study to the end were one hundred (100). A Likert's score scale rating process was deemed an ideal instrument for data collection. Validation of the instrument was done in close consultation with supervisors and other experts in Agricultural Education and Extension Department of Egerton University. Reliability of the instrument was established through a pilot study in Makueni County and calculated to a Coefficient alpha of 0.72 using Cronbach's Coefficient formula. Data were analysed and presented using frequencies and percentages. The key finding of the study was that, 79.1% of the respondents held positive perceptions on integrating climate change topics into secondary school agriculture syllabus. The main conclusion drawn from the key finding was that, there is a need to integrate climate change topics into the existing secondary school agriculture syllabus. The finding further validated the conventional agriculture teaching resources and methods as reliable in teaching the climate change concepts.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACCESA	Adaptation to Climate Change into Sustainable Development Policy Planning and Implementation in Eastern and Southern Africa
ANAFE	African Network for Agriculture, Forestry and Natural Resources Education
CAP	Common Agricultural Policy
CBS	Conservation of Biodiversity
CDM	Clean Development Mechanism
ECDGARD	European Commission Directorate-General for Agriculture & Rural Development
EUROP	European Rural Development Policy
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHGs	Green House Gases
$GeCO_2e$	Gigatonnes of Carbon Dioxide Equivalent Emissions
IFAD	International Fund for Agricultural Development
IPCC	Intergovernmental Panel on Climate Change
KFSSG	Kenya Food Security Steering Group
KIE	Kenya Institute of Education
MDGs	Millennium Development Goals
MTP	Medium Term Plan
NACOSTI	National Council for Science and Technology Innovations
NDMA	National Disaster Management Agency
PES	Payments For Environmental Services
PPM	Parts Per Millions
PWPOSU	Presidential Working Party on Second University
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SASACID	Strengthening Africa's Strategic Agriculture Capacity for Impact on Development
TAE	Tertiary Agriculture Education
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund
USA	United States of America

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Agricultural education is a fundamental tool in the development of Agriculture sector, a key pillar of the Kenya's economy (Wanyama & Chang'ach, 2013). The sector contributes directly about 24 per cent of Gross Domestic Products (GDP) and about 19 per cent of the formal wage employment (Lewa & Ndungu, 2012). An estimated 60 per cent of all households in the country are engaged in farming activities and 84 per cent of rural households keep livestock. The sector also indirectly contributes a further 27 per cent to the country's Gross Domestic Product (GDP) through linkages with other agro-based industries.

According to Jinzun and Young gong (2004), the Agriculture curriculum is crucial in achieving both Education For All (EFA) goals and the ten Millennium Development Goals (MDGs), which include eradicating extreme poverty, hunger, promoting gender equity, and ensuring environmental sustainability by 2015. However, this target has not been realized by many Sub-Sahara African countries especially the one on environmental sustainability, Kenya included.

The UN General Assembly of World leaders held in New York in 2015 under United Nations Framework Convention on Climate Change (UNFCCC) further adopted and ratified a raft of 17 Global Goals replacing the previous ten MDGs with Sustainable Development Goals (SDGs). The SDGs objectives more than double those of MDGs and emphasize, among others: eradicating extreme poverty and hunger, creating decent work and increasing economic growth, producing affordable clean energy, building sustainable cities and communities, creating sustainable consumption and production and offering quality education for all (UNFCCC, 2016). Creation of sustainable consumption and production focuses on: strengthening resilience and adaptive capacity to climate related hazards, integrating climate change into national policies and, raising awareness through improving education on climate change early warning, mitigations and adaptations both individually and collectively.

What is striking about both goals is the urgent action to combat climate change and its impacts, which pose a significant challenge to the world agriculture sector, by contributing risks and uncertainties in agricultural production. Subsequently, the Agriculture sector has a critical role to play in circumventing the climate change phenomena. Agriculture provides

carbon sink function in plants through photosynthesis, agricultural soils, and production of renewable energies that constitute an alternative to high carbon fossil fuels (European Commission Directorate-General for Agriculture & Rural Development (ECDGARD, 2008).

The major concern facing Agriculture and the associated sectors the world over is the rampant climate change and variability. In the wake of the last quarter of the 20th Century, climate change became the single most significant challenge to Agricultural production. This calls for concerted efforts from the world policy makers to tame the climate change and variability phenomena and rescue Agriculture and allied sectors from collapse through transformed education policies.

Education is a social institution, which prepares individuals to become functional members of their societies (Temu, Mwenje & Mogotsi, 2003). This brings to focus the linkage between education and societal needs. Therefore, unless education is able to respond to societal challenges, society will also begin to question the relevance of the educational institution. Climate change therefore, needs to be addressed within educational context, which involves the interaction of several participants, reaching beyond the academic wall to impact the entire society. Without an effective education curriculum, learners may not be able to understand or meet the challenges that confront the society (Temu & Chakeredza, 2008).

To adjust education in response to climate change, the subjects studied ought to be re-examined to bring the concepts under investigation closer to a correlated subject. This ensures the school leavers to keep abreast of relevant knowledge on climate change issues. Secondary school Agriculture subject provides education that caters for the basic principles of farming (Kenya Institute of Education (KIE, 2008). The Agriculture syllabus addresses itself to two fundamental objectives in relation to learners: first, to predispose them to the basic principles relevant to agricultural production; and second, to involve them in various practical work and projects to reinforce skills and abilities necessary in the day to day production in various Agricultural enterprises (KIE, 2008).

Since its early years, the secondary school Agriculture syllabus has undergone several reviews in an effort to make it conform to contemporary issues affecting the Agriculture sector. Climate change is one of the emerging issues threatening not only Kenyan Agriculture but also the world agriculture sector (Intergovernmental Panel for Climate Change (IPCC, 2010). It is, therefore, expected that if climate change concepts were integrated into the

agriculture syllabus, it would instil values, attitudes, knowledge as well as practical skills in learners needed to counter climate change and improve the livelihoods of farming communities.

Konyango (2010) observed that, a well-structured secondary school agriculture course must be responsive to the needs of the learners and the wider society in general. In order for the agriculture syllabus to remain relevant to the societal and learners' needs, constant reviews are inevitable. Reviews are ongoing processes, constant and unavoidable. They might be uncomfortable to the stakeholders, and have their shortcomings, but as observed by Covington and Dobbins (2004), and Laauwen (2004), agricultural education particularly at secondary school level must adopt strategies for change so as to remain focused and address the dynamic changes pertinent to Agricultural production.

The agriculture syllabus reviews and improvements have direct implications on: the scope and breadth of the syllabus content, teaching resources, teaching methodologies and the broad and specific objectives. Therefore, any attempt geared towards agriculture syllabus review necessitates inclusion of the agriculture teachers who constitute the key curriculum developers and implementers (Konyango, 2010). This view, which lays emphasis on the success of the teaching of vocational Agriculture on the quality and competency of the teachers of Agriculture, is also shared by U.S. Department of Education (1999).

Konyango (2010) specifically singled out agricultural education to have not seen significant change in methods of teaching for over eighty (80) years. At one time the emphasis was on gardening, while at later times it became too much theoretical. The task facing the agriculture teacher is therefore to teach students not only to pass examinations but also to be able to, and willing to transfer the skills and knowledge learned to productive labour. How this is going to be achieved depends on their professionalism as teachers, the opinions they uphold concerning agriculture education and its objectives in view of the contemporary issues.

The agriculture syllabus content broadly covers principles of crops production, livestock husbandry, and soil science. Other areas covered are: agricultural economics and agricultural engineering. Agricultural skills and knowledge are recommended to be taught both theoretically in a formal classroom setting and practically in a school farm/laboratory by professionally qualified teachers (KIE, 2008). However, the changing climate and its impacts on the environment pose a major concern for agricultural practitioners today more than ever

before in human history (IPCC, 2010). This is a problem which the secondary school agriculture education needs to curtail.

It is expected that, if a significant breakthrough in agriculture education at secondary school will be made, it will first have to review the syllabus in an attempt to adjust it to respond to the climate change and variability phenomena. However, there can be no meaningful breakthrough in the agriculture syllabus appraisal if the agriculture teachers are not allowed to participate in it because they play significant role in the agriculture curriculum implementation. Their views, opinions, perceptions, feelings and attitudes regarding climate change therefore form the foundation upon which this study focused (KIE, 2008).

Despite agricultural production being highly sensitive to climatic conditions, there is strong scientific evidence that, the changing climate is real and if not checked poses a serious challenge to the agriculture sector and other interrelated sectors. Paradoxically however, the secondary school agriculture syllabus is silent on pertinent issues pertaining to climate change and its consequent impacts on the environment upon which agriculture activities are predominantly practiced. Climate change issues are inadequately addressed in the entire secondary school agriculture syllabus. For instance, out of a total of thirty three units constituting the agriculture syllabus, only one unit, scarcely addresses aspects of climatic variables particularly on rainfall, temperature, wind, humidity, and light. While two units provide aspects tending to climate change adaptations in particular, water supply, irrigation and drainage, and risks and uncertainties in farming. Yet, two other units provide pertinent information on aspects for mitigating impacts ensuing from climate change, specifically soil fertility, and soil and water conservation (KIE, 2008).

Two other units focus on aspects relevant to cost reduction and sustainability strategies from climate change, like farm power and machinery, and agro-forestry (KIE, 2008). Proportionately, these climatic related fragments represent only a fifth of the entire secondary school agriculture syllabus content, which translates to significant discrepancies in the agriculture syllabus. These few areas therefore, provide a credible gap, link and background upon which the study on integration of selected climate change topics into secondary school agriculture syllabus was based.

A well designed secondary school agricultural education syllabus can turn out to become integral part of the concerted efforts to tackle climate change and variability through:

preparing agriculture to reduce its own gas emissions, enhancing the carbon sink function of agricultural soils, and finally contributing to production of renewable energies and bio-products (United Nations Development Program (UNDP, 2012). The government need not spend resources educating the general public on how to cope with the devastating climate change and variability. However, what it should do is to simplify the science of climate change and integrate it into the education system so that the schooling generation whose future belong to it, can acquire and internalize skills and knowledge on how to deal with the climate change for sustainable development and livelihoods (Food Agricultural Organization (FAO, 2012).

The concepts of climate change are simple if explained well, even though the science is multifaceted (Prasad, Ranghieri, Trohanis, Kessler & Sinha, 2009). Climate change by definition refers to any change in climate over time. Climate variability on the other hand refers to variations in the mean state and other statistics of climate on all sequential and spatial scales beyond that of individual weather events (Prasad, *et al.,* 2009). United Nations Population Fund (UNFPA, 2009) explains climate change as the variation of the earth's climate caused by atmospheric accumulation of greenhouse gases (GHGs) such as carbon dioxide (CO_2) and methane (CH_4) because of human activity.

The European Commission Directorate-General for agriculture and Rural Development (ECDGARD, 2008) further concurs that, climate change is caused by high concentrations of greenhouse gases in the atmosphere, due to human activities that add to the natural "greenhouse gases" thus increasing the earth's temperature. As asserted by Prasad, *et al.,* (2009), climate change is triggered by human-induced GHGs emissions which absorbs and re-emits infrared radiation. When pollution adds these gases to the earth's atmosphere, they trap more solar energy on the planet earth (like in a greenhouse) warming the earth's surface and contributing to the unpredictability of the climate.

Studies on the secondary school agriculture curriculum (Onyango, 1982; Kathuri, 1990; & 1993; Konyango, 2010) have revealed inconsistencies in its teaching approaches, where at one time the emphasis is on practical work, and at another time theory. However, the main objective remains striking a balance between helping the students not only to pass examinations but also to acquire a motivation to transfer the skills and knowledge learned to productive labour. Therefore, despite the scientific explanation of climate change and variability being too wide in scope and too complex to explain in simple language, secondary

school agricultural education was presumed to be the vehicle to transmit skills and knowledge useful in circumventing the susceptibility of the agriculture sector from emerging issues including climate change and variability (GOK, 2013).

The adaptations to climate change and variability were contemplated to be attained via integrating selected climate change topics into secondary school agriculture syllabus. The methodology for achieving it was visualized through creating an independent unit on climate change and variability and adding the few climatic aspects in the existing syllabus to constitute integral parts of it. This was visualized to operate through rearranging the proposed aspects of climate change and variability into four key concepts/themes, namely; introduction to climate change and variability, adaptations to climate change, mitigations against climate change and cost-reduction and sustainability strategies from climate change. The unit is expected to borrow a few ideas pertinent to climate change from the existing agriculture syllabus as well as from the robust growing body of literature on climate change phenomenon to constitute an elaborate unit. These concepts / themes are to be addressed within the level and scope of understanding by the secondary school agriculture learners and spread across the four year secondary school cycle (Schneider, 2008).

The problem this study sought to solve, therefore, was the inadequacy by the existing secondary school agriculture syllabus content to address climate change and variability issues. The study in particular sought to establish the perceptions of the agriculture teachers toward integration of selected climate change and variability topics into secondary school agriculture syllabus in Machakos County, Kenya.

1.2 Statement of the Problem

It is exactly thirty three years now, since the ratification of the 8-4-4 system of education that recommended the introduction of agriculture subject in most secondary schools in Kenya with the motive to revitalize the agriculture sector. Yet agriculture and the associated sectors in the economy are increasingly faced with profound risks and uncertainties from the escalating climatic changes. Therefore, there exist inconsistencies on the existing secondary school agriculture syllabus in meeting its key objectives in the face of rising climatic changes. Key among these objectives include: promoting self-reliance, resourcefulness, and problem-solving abilities in agriculture; promoting agricultural activities which enhance environmental conservation; and lastly promoting consciousness of health enhancing activities in agricultural production. Studies have revealed inconsistencies in secondary

school agriculture teaching approaches, where at one time the emphasis was on practical work, and at another time theory. However, none of the studies have examined the negative influences that climate change and variability have exerted on farming and how the agriculture syllabus can be reviewed to overcome and revitalize sustainable agricultural production in Kenya. Therefore, there is need to study and document the perceptions of agriculture teachers toward integration of selected climate change topics into secondary school agriculture syllabus in Machakos County, Kenya. Positive perceptions may trigger a process of reviewing the agriculture syllabus to conform it to the contemporary circumstances. Negative perceptions may suggest the syllabus is adequately addressing climate change and variability issues.

1.3 Purpose of the Study

The purpose of the study was to determine the perceptions of agriculture teachers toward the integration of selected climate change topics in secondary school agriculture syllabus, in order to control its effects on agricultural production.

1.4 Objectives of the Study

The specific objectives of the study were:

i) To determine the perceptions of agriculture teachers toward integration of adaptation strategy topics on climate change into secondary school agriculture syllabus.
ii) To establish the perceptions of agriculture teachers toward integration of mitigation strategy topics against climate change into secondary school agriculture syllabus.
iii) To find out the perceptions of agriculture teachers toward integration of cost reduction and sustainability strategy topics on climate change into secondary school agriculture syllabus.

1.5 Research Questions

The following research questions derived from objectives i, ii, and iii, respectively were used to realize the objectives of the study.

i) What are the perceptions of agriculture teachers toward integration of adaptation strategy topics on climate change in secondary school agriculture syllabus?
ii) What are the perceptions of agriculture teachers toward integration of mitigation strategy topics against climate change in secondary school agriculture syllabus?
iii) What are the perceptions of agriculture teachers toward integration of cost reduction and sustainability strategy topics on climate change in secondary school agriculture syllabus?

1.6 Significance of the Study

The outcome of the study if adopted is expected to contribute significantly in transforming secondary school agriculture syllabus to address climatic issues influencing the agriculture sector. Consequently, it may transfer applicable skills and knowledge to learners who are the agents of change in their communities to champion measures on adapting and mitigating climate change and variability impacts. Additionally, the study may create resilience among people through seizing and utilizing opportunities brought forth by the changing climate such as carbon free renewable energies from solar radiation, wind and biogas. Finally, other interlinked sectors predisposed to climate change impacts like the energy, forestry and water sectors may learn from the study findings and make sectoral adjustments in creating peoples resilience from the impacts of climate change phenomena.

1.7 Scope of the Study

The study on the perceptions of agriculture teachers toward the integration of selected climate change topics into secondary school agriculture syllabus was investigated in relation to its relevance to key aspects of the syllabus including the content, teaching resources, and teaching methodologies. The climate change topics were identified to enlighten the farming communities on adaptation, mitigation, and cost-reduction and sustainability strategies in the context of adjusting agriculture syllabus to address climate change impacts such as droughts, heat stress and frost. The study used data collected using a self-administered questionnaire based on a 5-pint Likert's score scale. The respondents were drawn from trained secondary school agriculture teachers working in public secondary schools in Machakos County, Kenya.

1.8 Assumptions of the Study

The study was based on the assumptions that the respondents:

i) Had acquired versatile knowledge on climate change and its adverse effects on agricultural production from international, regional, and local forums and conferences to make informed decisions regarding the agriculture education and its applicability to solve real-life farming issues;

ii) Gave unbiased and honest responses to the Likert's score scale rating questionnaire items; and

iii) Lastly, were equally and adequately exposed to the secondary school agriculture syllabus to make informed decisions regarding the study enumerate

1.9 Limitations of the Study

The limitations experienced during data collection was that, respondents relied on recall and therefore some of the information may not have been accurate. The large sample size helped to correct for any inaccuracies that may have been reported.

1.10 Definitions of Terms

The following terms were operationalized as follows:

Agriculture teachers: These are trained teachers at diploma level and above with biasness in teaching agriculture subject in secondary and tertiary institutes. In this study, the Agriculture teachers in public secondary schools within Machakos County were the teachers in Teachers Service Commission employment.

Agro-biodiversity: Refers to the variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels, which are necessary to sustain key functions of an agricultural ecosystem, including its structure and processes (adapted from CBD, 2000). In this study, agro-biodiversity referred to adoption of adaptable plants and animal species by farmers in site specific locations to optimise agricultural productivity.

Bio-energy: Refers to sources of energy other than fossil fuels that have reduced carbon emissions. They are derived directly from crops and agriculture, agro-industrial and animal by-products such as dung, maize and soya (Van zyl, *et al.*, 2008). In this study, it referred to adopting farm practices to creation and utilization of bio-energies (renewable energies) which are environmental friendly due to their low carbon emissions.

Climate change: This refers to alteration of the earth's climate due to atmospheric accumulation of greenhouse gases leading to "greenhouse effects" that sets off a process that modifies weather patterns (UNFPA, 2009). In this study climate change phenomena referred to changes in temperatures, sea levels and storm frequencies which influence farming activities negatively occasioning droughts, heat stress frost and other hazards.

Climate change adaptations: These refer to processes through which people reduce the adverse effects of climate on their health, livelihoods and well-being, by taking advantage of the opportunities that the environment provides (Saka, 2008). In this study, it meant inclusion of climate change adaptation sub-topics (knowledge) into secondary school agriculture syllabus to empower farmers with relevant skills to generate positive responses toward climate change and variability impacts in their farming practices.

Climate change mitigations: These refer to measures that aim at moderating or reducing the severity of the climate change impacts such as limiting greenhouse gas emissions. In this study it referred to integration of climate change modification sub-topics or programs into

secondary school agriculture syllabus to equip learners with competent skills to respond to the devastated environment by climate change in their farming practices (Saka, *et al.*, 2008).

Climate change topics: Refers to carefully selected subject matter on climate change and variability with relevance to agricultural practices. In this study, these topics were identified as; adaptations to climate change, mitigations against climate change, and cost-reduction and sustainability from climate change phenomena.

Cost-reduction and sustainability: This refers to measures that aim at making best uses of beneficial opportunities brought about by climate change phenomena under different situations such as erratic rains and extreme heat. In this study, it was operationalized to refer to farm practices such as organic farming, zero/reduced tillage, and growing of protein crops, as well as taping renewable energy from solar radiation, wind and biogas to relieve farmers from use of expensive and high carbon dioxide fossil fuels.

Descriptive survey: It refers to an *ex-post facto* research design using non statistical analysis and organization of data and presentation of the findings using explanatory procedures. In this study, it referred to presentation of research findings by use of frequencies and percentages and finally interpretation by brief descriptions.

Global warming: Refers to rise in average temperature on earth due to the increasing amounts of greenhouse gases in the atmosphere which trap more solar energy warming the earth's surface to intolerable levels for man, livestock and crop survival. In this study it was referred to as a process that triggers the onset of climate change and variability on land.

Geo-engineering: These are 'philosophical translations' being investigated for possible creation of low-carbon economies, such as enhancing removal of excess CO_2 from the atmosphere, reducing the amount of sunlight reaching the ground, recycling CO_2 into fuel through reaction with H_2 or ejecting it from the atmosphere using the planet's magnetic field and deliberately polluting the stratosphere with sulphate in order to reflect solar heat into space (Schneider, 2008). In this study, it was operationalized to include one of the possible measures to mitigate the atmosphere from high carbon dioxide concentrations which trigger climate change and variability.

Integration: This refers to the inclusion of new concepts, ideas or skills and knowledge to an existing knowledge content. In this study, it implied instillation of selected climate change

topics to the secondary school agriculture syllabus to adjust agricultural education to counteract climate change phenomena.

Perceptions: These refer to perspectives or ideas people hold regarding a certain phenomenon, event, occurrence, observable fact, experience, or trend (Gall, *et al.,* 1996). In this study, it was operationalized to capture the varied feelings agriculture teachers hold toward integration of the selected climate change topics into secondary school agriculture syllabus to conform it to contemporary issues on climate change and variability.

Secondary school agriculture syllabus: This is an outline of topics that constitute the secondary school agriculture course through a systematically organised and predetermined curriculum which is studied in a formal classroom-setting within four year-cycle.

Vulnerability: This is a term used in the analysis of climate change impacts on livelihoods of farming communities. According to The New York Times (2008), it is defined as the susceptibility of individuals in a group to an adverse event. It is measured as the likelihood that an individual (or a proportion of individuals in a group) will cross a critical threshold. In this study it was operationalized to refer to crops / livestock failure to produce optimally due drought, heat stress and frost, or farmer's failure to meet expected gains due to climate change impact on farm productivity.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter presents literature review on: ideological perceptions and genesis of climate change; the vulnerability of global agriculture to climate change; and impacts of climate change on Sub-Sahara African agriculture. Other areas reviewed included effects of climate change and adaptations in Kenya, synopsis of secondary school agriculture syllabus, prospective climate change topics proposed, and finally theoretical and conceptual framework of the study.

2.2 Ideological Perceptions and Genesis of Climate Change

Climate change has become a significant contentious issue in the World. It refers to significant variation of expected weather patterns of an area over a long period of time that is over thirty (30) years. Climate change is perceived to be caused by emissions of greenhouse gases into the atmosphere mainly carbon dioxide and methane. These gas emissions are attributed to human activities such as deforestation and excessive use of fossil fuels, disrupting atmospheric balance, hence global warming and heating of the earth's surface. The increase in atmospheric temperatures due to emissions of greenhouse gases (GHGs) has led to global warming. The GHGs form an invisible film over the atmosphere which traps heat leading to increasing atmospheric temperatures and global warming. This has triggered change in climate which has become a major challenge to human existence and survival (National Environmental Management Authority (NEMA, 2013).

The largest contributors of GHGs are carbon dioxide and water vapour. Others include methane, nitrous oxide and other chlorofluorocarbons also existing in the atmosphere. Climate change is caused predominantly through human induced activities especially the combustion of fossil fuels, deforestation to support both agriculture and settlements and other land use changes. It is estimated that the concentration of carbon dioxide has increased in the atmosphere from 270 to 370 parts per million (ppm) over the past several decades. Climate is arguably one of the greatest challenges to human existence and survival. The situation has been aggravated by limited mitigation and adaptation measures thus threatening livelihoods and survival (NEMA, 2013).

The scientific thinking behind climate change came into limelight in the early 19th century, when ice age and other natural changes in paleoclimate were first suspected and the natural greenhouse effect first identified. In the late 19th century, scientists first argued that human emissions of greenhouse gases could change the climate, but these propositions were disputed. Many other theories of climate change were advanced, involving forces from volcanism to solar variation. In the 1960s, the argument for the role of the warming effect of carbon dioxide gas became increasingly convincing, although some scientists also pointed out that human activities, in the form of atmospheric aerosols such as pollution could have cooling effects as well.

During the 1970s, scientific opinion increasingly favoured the warming view point. By the 1990s, as a result of improving fidelity of computer models and observational work confirming the Milankovitch theory of the ice ages, a consensus position was formed. It was agreed that, greenhouse gases were significant contributors to most climate changes, and human emissions were bringing serious global warming. Since then most work has been oriented towards producing reports on the Intergovernmental Panel on Climate Change (Spencer, 2011).

The concepts of climate change are simple if explained well, even though the science is complex (Prasad, *et al.*, 2009). United Nations Population Fund (UNFPA, 2009) explains climate change as the alteration of earth's climate caused by atmospheric accumulation of greenhouse gases (GHGs) such as carbon dioxide, due to human activity. The European Commission Directorate-General for Agriculture and Rural Development (ECDGARD, 2008) further concurs that, climate change is caused by high concentrations of greenhouse gases in the atmosphere, due to human activities that adds to the natural "greenhouse effects" thus increasing the Earth's temperature.

According to Prasad *et al.*, (2009), climate change is triggered by human-induced GHGs emissions which cause a build-up of greenhouse gas in the atmosphere (carbon dioxide-CO_2 and methane-CH_4) which absorbs and re-emits infrared radiation. When pollution adds these gases to the earth's atmosphere, they trap more solar energy in our planet (like in a greenhouse) warming the earth's surface and contributing to climate variability. Concentrations of GHGs, mainly CO_2, have increased by 70% since 1970, leading to increased levels of heat trapped in the atmosphere, thus setting off a process that modifies

weather patterns, which in turn affect temperatures, sea levels, and frequency of storms, hence upsetting the nature's control systems.

It is widely agreed by the scientific community that climate change is already a reality. The Intergovernmental Panel on Climate Change (IPCC, 2007) points out that, the rate and duration of warming observed during the twentieth century is unprecedented in the past thousand years. Increase in maximum temperatures, numbers of hot days, and heat indices have been observed over nearly all lands during the second half of the twentieth century. Collective evidence suggests that, observed warming over the past fifty years can be mostly attributed to human activities. The warming trend in the global average surface temperature is expected to continue, with increases projected to be in the range of 1.4 to 5.8^0C by 2100 in comparison to 1990 (IPCC, 2010).

There is increasing observational evidence that, regional changes in climate have contributed to various changes in physical and biological systems in many parts of the world (IPCC, 2001a; 2001b). Science tells us that climate change will bring about gradual changes, such as sea level rise, and shifts of climatic zones due to increased temperatures and changes in precipitation patterns. Also, climate change is very likely to increase the frequency and magnitude of extreme weather events such as droughts, floods, and storms. While there is uncertainty in the projections with regard to the exact magnitude, rate and regional patterns of climate change, its consequences will change the fate of many generations to come and particularly impact on the poor if no appropriate measures are taken (IPCC, 2010).

The IPCC report (2007) warns that, these climate changes would continue for decades, even if emissions stop today, due to the historical build-up of gases in the atmosphere. Climate change impacts will become progressively more severe throughout the world. According to the IPCC, most of the temperature increase results from human activities, especially the burning of fossil fuels and deforestation both of which cause CO_2 and other gas emissions. Climate change presents a double challenge today: to cut the emissions of gases responsible for warming (known as mitigation); and to adapt to future climate change to lessen its adverse effects. These are major challenges for agriculture and agricultural policy-making the world over (ECDGARD, 2008).

2.3 The Vulnerability of Global Agriculture to Climate Change

The world cannot safeguard its food supplies if it is unable to get a grip on climate change, and it will not get a grip on climate change unless agriculture is allowed to play a central role (Food Agricultural Organization (FAO, 2008). By 2050 the world's population is projected to grow by three billion to more than nine billion. To feed so many people, it will be necessary to increase world food production by 70%. There is therefore, a need for concerted efforts from the world policymakers to prepare the agriculture and allied sectors to meet climatic limitations, using new financing instruments and appropriate strategies that will enable food production to be increased (Antle, *et al.*, 2006). To speed up climate protection, incentives must be created-for example through payments for ecosystem services, besides adaptation and mitigation strategies.

The growth and productivity of most crops is susceptible to a number of critical environmental thresholds, including minimum and maximum temperatures, cumulative temperature (degree days), and water availability. These stresses interact in complex ways with site-specific soil and other environmental conditions (aspect, slope, and elevation), atmospheric CO_2 concentrations, and management (Hatfield, Boote, Fay, Hahn, Izaurralde, Kimball, Mader, Morgan, Ort, Polley, Thomson, & Wolfe, 2008). Although agronomic studies have investigated the vulnerability of crops to failure as a result of these stresses, the economic studies based on aggregated data do not effectively quantify these vulnerabilities. In United States of America (USA/US) for instance, assessment indicates that the South and the West are the region's most vulnerable to the adverse impacts of climate change as a result of increased heat stress, drought, and competition for surface and groundwater resources (McCarl, 2008).

According to a report in The New York Times (2008), the facts about farm structure and income have implications for the vulnerability of farm households. Both small and large farms appear likely to be resilient for different reasons. Smaller farms often produce a more diverse mixture of crops and livestock, and also depend to a large degree on nonfarm income that is less impacted by climate change. Larger farms tend to be more specialized and thus more vulnerable to climate changes, but are stronger financially, have greater wealth, and receive a larger share of their income from government subsidies. Larger, more specialized farms are also more likely to use market-based risk management tools and to sell their products in national and international markets that are less vulnerable to local climate variation.

A study by Antle, Capalbo, Elliott, and Paustian (2004), addressed agricultural production vulnerability quantitatively, used field-level and farm-level data to assess the vulnerability of dry land grain producers in Montana, a semi-arid region where the risk of low soil moisture is a key vulnerability. Several measures of vulnerability were used, including the likelihood of crop income falling below a threshold as well as the percentage change in income for all farms. One of the goals of this study was to test the hypothesis by IPCC (2001), assessment reports that vulnerability is inversely related to resource endowments. The results supported the hypothesis that the most adverse changes occur in the areas with the poorest resource endowments and when the mitigating effects of CO_2 fertilization or adaptation are absent.

The study also found that the vulnerability of agriculture to climate change depends on how it is measured (in relative versus absolute terms, and with respect to a threshold) and on complex interactions between climate change, CO_2 level, adaptation, and economic conditions. The results showed that relative vulnerability did not increase as resource endowments become poorer and that, without adaptation, there may be either a positive or negative association between endowments and relative vulnerability. However, vulnerability measured in relation to an absolute threshold did vary inversely with resource endowments, and a positive relationship was found between absolute gains from adaptation and the resource endowment of a region (Antle, *et al.,* (2004).

On financial vulnerability of farm businesses, the study by Antle *et al.*, (2004) observed that, although in the past, farms faced periodic financial crises when adverse climatic or economic conditions occurred because of high debt-to-asset ratios and imperfect capital markets, this is much less true today for commercial farms. As noted earlier, farm households with commercial farm operations have higher incomes and more wealth than most US households, and are financially sound. Debt-to-equity ratios range from 5 to 20 percent by state, and farm failure rates are far lower than nonfarm failure rates. However, one feature of farm household businesses that may increase their financial vulnerability is that a much larger share of their total wealth is invested in their business than is typical of nonfarm businesses (Antle, *et al.,* 2004).

In addition to marketed products, agricultural lands produce ecosystem services that are valued by individuals and society (Backlund, Schimel, Janetos, Hatfield, Ryan, Archer, and Lettenmaier, 2008). For example, extreme weather events, such as droughts, may lead to overgrazing, making arid pasture lands vulnerable to erosion and the loss of organic soil

matter. Both biophysical and economic thresholds may exist, making soil degradation and other losses of natural capital irreversible (Antle, Stoorvogel, and Valdivia, 2006b). Also "planned adaptations" by policymakers may have unintended consequences, as illustrated by the US policy to subsidize corn ethanol. The resulting increase in corn production in the Midwest is likely to increase the application of nutrients, intensifying the problem of hypoxia in the Gulf of Mexico and magnifying other water quality problems associated with intensive agricultural chemical use.

Increased CO_2 may increase plant growth but result in lower protein content of grains, for example. In addition, vegetable and fruit quality are highly vulnerable to temperature and water stresses (Hatfield, *et al.*, 2008). Food safety is also likely to be impacted by climate change through several mechanisms (FAO, 2008). Food-borne pathogens, such as cholera and mycotoxins, are likely to expand their geographic range, and outbreaks are often associated with extreme weather events. Increased stress on water resources is also likely to increase pathogen growth and human infection. Climate change is also likely to increase the occurrence of harmful algal blooms and the contamination of fish and seafood by pathogens and toxins, including through the increased pesticide contamination that is likely to be associated with climate change. Increased disease incidence in livestock is also likely to increase the use of veterinary drugs and thus increase the risk of food contamination, antibiotic resistance, and related health issues. Addressing these increased risks will require the adaptation of existing public information, disease surveillance, and intervention practices (FAO, 2008).

Another potentially important impact of climate change on agriculture is its impacts on the location and functioning of transportation infrastructure. Climate change is likely to result in the spatial reorganization of agricultural production such that, for example, maize and soybean production move westward and northward in the United States of America. These geographic shifts may mean that storage and shipping facilities and rail infrastructure may need to be relocated. Changes in sea level also could have important implications for the location and operation of storage and shipping facilities at major ports. As yet, these issues have not been investigated systematically to assess the possible costs of changing transportation infrastructure that supports agriculture and the food system. The rate of climate change and sea level risk can be expected to be critical factors in determining these costs (Schneider, Semenov, Patwardhan, Burton, Magadza, Oppenheimer, Pittock, Rahman, Smith, Suarez, & Yamin, 2007).

Regarding food safety in particular, higher temperatures would increase the costs of refrigeration, packaging, handling, and storage of perishable meats that are vulnerable to dangerous pathogens such as *Escherichia coli*. Changes in the location of livestock production could also necessitate changes in the location of livestock transport, feedlots, and slaughter plants. Most components of the food processing and distribution system are dependent on fossil fuels for transportation and packaging and on electricity to power processing operations and refrigeration. Thus, policies to reduce GHG emissions that raise fossil fuel costs are likely to have significant impacts across many dimensions of this sector as well as production agriculture. Researchers studying climate change impacts and adaptation have devoted little attention to this issue (FAO, 2008).

2.4 Impacts of Climate Change on Sub-Sahara African Agriculture

Agriculture is the backbone of the vast majority of Sub-Saharan African economies, accounting for up to 40% of the gross domestic product, 15% of exports and 60–80% of employment. Yet Africa is the only continent where hunger and poverty are projected to worsen in the 2020s, and the number of malnourished children will increase correspondingly (Yayé, Chakeredza & Temu, 2011). Agriculture sector therefore remains highly important for sustainable development and poverty reduction and eradication in Sub-Sahara Africa.

According to the Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2010), the global average surface temperature is projected to rise by between 1.8 degrees and 4.0 degrees Celsius by 2100. The sea level may rise by between 30 and 60 centimeters. Although climate change and variability has increased almost everywhere, affecting the whole continent, the distribution of these changes varies significantly. In the already arid North Africa, climate change is expected to increase desertification and decrease forest cover. Climatologists predict acute rainfall shortages in the Sahara and Sahel, with severe soil degradation and increased number of dust storms. Scientists expect more frequent and longer dry periods in West Africa. Rising sea levels are expected to affect coastal areas of Africa (Toulmin & Huq, 2006).

The significant shifts in greenhouse gases (GHG) emissions have considerable implications in Sub-Sahara African agriculture sector and related sectors. Warming is predicted to induce sudden shifts in regional weather patterns such as the El Nino phenomenon. These are changes that would have severe consequences for water availability and flooding in tropical regions and threaten the livelihoods of millions of people. Most countries in Sub-Saharan

Africa (SSA) are already experiencing a number of adverse climatic hazards including dry spells, seasonal droughts, intense rainfall, riverine floods and flush floods. Some of these cases, especially droughts and floods have already increased in frequency, intensity and magnitude over the last two decades, and have adversely impacted on food and water security, water quality, energy and the sustainable livelihoods of rural farming communities (Kandji, Verchot & Mackensen, 2006).

Agriculture being a significant sector in the whole of Sub-Saharan Africa in terms of subsistence food, contribution to Gross Domestic Product (GDP), employment and foreign exchange earnings (Diao, Hazell, Resnick & Thurlow, 2006), it is common knowledge that farmers are struggling to cope with the current climate change phenomena. With continued adverse climate change therefore, there will be decreased food production in the meantime, and in the near future. It is, therefore, predicted that the declining crop yields could leave hundreds of millions without the ability to produce or purchase sufficient food. In addition to the effects on food production, vector borne diseases such as malaria and dengue fever could become more widespread if effective control measures are not put in place. This could increase the already negative impact of HIV/AIDS on food production. The rising sea levels will also result in tens to hundreds of millions more people flooded each year (Diao, Hazell, Resnick, & Thurlow, 2006).

Ecosystems and biodiversity are particularly vulnerable to climate change, with around 15-40 percent of the species potentially facing extinction after only 2°C of warming. Ocean acidification, a direct result of the rise in CO_2 is also predicted to cause major concerns on marine ecosystems, with possible adverse effects on fish stocks and general seafood. The general public in the Sub-Saharan Africa therefore cannot continue with business as usual approach if they wish to stabilize the GHGs. Stabilization at whatever level demands that annual emissions be brought down to levels that balances the earth's own inbuilt capacity to remove greenhouse gases from the atmosphere naturally. In the long term, annual global emissions will need to be reduced to below five (5) gigatonnes ($GtCO_2e$) of carbon dioxide equivalent emission, the level that the earth can absorb without adding to the concentration of the GHGs in the atmosphere (Diao, *et al.,* 2006).

Reversing the historical trend in the growth of emissions is a major challenge. Greenhouse-gas emissions can be cut in four ways: reducing demand for emissions-intensive goods and services; increased efficiency which can save both, money and emissions; action on non-

energy emissions, such as avoiding deforestation and ecosystem degradation; and switching to lower carbon technologies for power, heat and transport. Graduating agriculture students from learning institutions including secondary schools in Sub-Saharan Africa, need to have a good grip of the science of climate change and its effects on the livelihoods of the communities including the mitigation and adaptation options available for cutting the GHG emissions (Saka, 2008).

The way in which the civic society deals with such vital resources including, water and soil, should be made a matter of global security. Climate change and a growing world population mean that these resources are becoming short in supply, which could lead to conflict about their distribution. Investments in the more efficient use of water, in water recycling and storage are just as necessary efforts to maintain the fertility of the soil and use of underground facilities for disposing of unwanted carbon. A peaceful world will not be possible unless the currently under developed countries particularly in Sub-Sahara Africa can undergo a process of development (FAO, 2008). In an effort to combat climate change through agriculture therefore, FAO calls for a networking by every country by analysing its own agriculture sector policies and subjecting all the various climate-relevant processes to close scrutiny. Moreover, a global network should be created, to which each country can contribute its knowledge and experience in combating climate change (FAO, 2008).

Despite the international efforts to cushion the poor from the pangs of poverty, it has become widespread in many countries in the last decade making it the core challenge for development in the twenty first century (United Nations Development Programme (UNDP, 2000). Climate change poses a serious risk to poverty reduction and threatens to undo decades of development efforts (IPCC, 2010). As the Johannesburg Declaration on Sustainable Development (JDSD) states, "the adverse effects of climate change are already evident, natural disasters are more frequent and more devastating and developing countries in the Sub-Sahara Africa more vulnerable."

While climate change is a global phenomenon, its negative impacts including heat stress, drought and frost are more severely felt by poor people and poor countries. They are more vulnerable because of their high dependence on natural resources, and their limited capacity to cope with climate variability and extremes (IPCC, 2010). Experience warns that the best way to address societal concerns including climate change impacts on the poor is by integrating adaptation responses into development planning and educational systems. This is

fundamental to achieve the Sustainable Development Goals (SDGs) including over-arching goal of halving extreme poverty, and sustaining progress beyond 2015 (UNDP, 2015).

Agricultural activity is highly sensitive to climate change, largely because it depends on biodiversity and ecosystems (Clements, 2009). Climate change affects food production directly through change in agro-ecological conditions and indirectly by affecting growth and distribution of incomes and thus demand for alternative food sources (Schmidhuber & Tubiello, 2009). Clements (2009) notes that, sufficient freshwater supplies, fertile soil, the right balance of predators and pollinators, air temperature and average weather conditions all contribute to continuing agricultural productivity. IPCC (2007) on the other hand points out that climate change has affected rainfall reliability, increased frequency of droughts and raised average temperatures, threatening the availability of freshwater for home use and irrigation. As a result, therefore, rural communities are faced with reduced availability of fisheries and forest products (FAO, 2008).

The changing temperatures and weather patterns occasioned by climate change also create conditions conducive for the emergence of new pests and diseases that affect animals, trees and crops, thus affecting agricultural production and food availability (IPCC, 2007). Rural farmers in Sub-Saharan Africa are the most affected by climate change partly because they make up the larger share of the agricultural workforce and partly because they tend to have access to fewer income-earning opportunities. They, therefore, are forced to work harder to produce food and walk further to access fresh and clean water, as the continent becomes a hotter and drier place to live in (UNFPA, 2009).

2.5 Effects of Climate Change and Coping Mechanisms in Kenya

Kenya's economy is agriculturally based (FAO, 2012). However, escalating climate change and variability has resulted in increased food insecurity. According to Kotir (2013), climate change has affected rain patterns, increased the frequency of droughts, and raised the average temperatures, threatening the availability of fresh water for agricultural production. Past studies show a negative impact of climate change on arable land and changes in crop productivity patterns in all agro-ecological regions of Kenya. The negative effect of future climate change on arable land is predicted to result in adverse impacts on cereal crop production and their net revenue (Songok, Kipkorir & Mugalavai, 2013). Such cereals (wheat, rice, barley, maize, millet, sorghum, groundnuts, cassava, rye and oats,) play an important role in the diets of Kenyans.

Climate change would result in more erratic and irregular rainfall regimes, shorter growing seasons, prolonged intra-seasonal and inter-seasonal dry spells (Songok, Kipkorir & Mugalavai, 2013). The decreasing rainfall in Kenyan ASALs implies worsening food shortages if the current farming practices are not improved as most agricultural systems are predominantly rain-fed (Nyamadzawo, Wuta, Nyamangara & Gumbo, 2013). Consequently, this is expected to decrease crop production, severely disrupt or destroy livelihood opportunities, increase local food prices, and increase household vulnerability to food insecurity among other problems.

Kenya currently is among the developing nations that are way off track in fulfilling one of the primary promises made by the world governments a decade ago when they approved the Millennium Development Goals to halve the proportion of people who suffer from hunger by 2015 (Alexander, 2012). This translates to about 800 million people in the world who suffer from food insecurity, which has resulted to an estimated over 226 million children globally aged below 5 years old remain stunted, 67 million more get wasted and 183 million weigh less than they should for their age (Macharia, Makau & Muroki, 2010).

According to Forest Society of Kenya (FSK, 2010), Kenya is among food crisis nations with 3.8 million people being food insecure. In addition, about 80 per cent of the people's household budget goes to food, and often there is lack of resources to deal with food security problems. Though the country's agriculture sector has been inadequately financed for decades (FAO, 2012), agriculture remains the backbone of Kenyan food security. A key policy lesson from climate change on Kenyan agriculture is that, it will have adverse effects on the agriculture sector (Mariara & Karanja, 2006). Given the difficulties in averting the global warming, adaptation to climate change is essential to counter the expected impacts of short and long-term climatic changes.

Agricultural production has not kept pace with population growth rate; this has led the country to become a net importer of its two major staple foods, maize and wheat included (Saina, Kathuri, Rono, Kipsat & Sulo, 2012). Therefore, there is an urgent need for expansion and development of the agriculture sector in order to reverse the worsening trend in agricultural production in Kenya. According to Nyamadzawo, *et al*., (2013), a positive relationship exists between agriculture education and agricultural productivity. Given the importance of the agriculture sector to the economy, agriculture education cannot be overlooked for it provides the human resource that drives the agriculture sector. This human

resource should be adequately trained and equipped with relevant skills to enable them keep agriculture at the top as the highest contributor to Gross Domestic Product (GDP).

With environmental disasters escalating due to occurrence of climate change with its attendant severe effects such as flooding due to *El Nino* rains, prolonged droughts, and disease outbreaks, there is need for concerted efforts from various relevant agencies to be appropriately responsive. In addition, disease outbreaks such as malaria and cholera have in the past stretched available health facilities leading to deaths. The launch in Kenya of the National Disaster Management Agency (NDMA) in 2013, which coordinates other agencies during disasters to reduce casualties, was timely. In addition, improved use of information and communication technologies in disseminating information related to disasters to enhance mobilization of relevant stakeholders and actors during a disaster occurrence is imperative. Disaster preparedness ought to be embraced across sectors in order to ensure the availability of relevant and functional facilities (NEMA, 2013).

2.5.1 Adaptations to climate change

Climate change is a cross-cutting development issue that requires high level political goodwill and support to effectively address the risks and maximize the opportunities it presents. Adaptation to climate change must be made the top priority to reduce vulnerability and enhance resilience of the social and bio-physical systems, especially the vulnerable communities and groups. Consequently, mitigation actions that deliver sustainable development benefits are of importance as the country strives to remain a low emitter in the context of the national economic development as set out in Vision 2030. Climate smart strategies should be embraced in order to promote use of clean energy technologies for improved and sustainable livelihoods. Stakeholders should be encouraged to mainstream climate proofing and climate change responsive activities in their daily activities (GOK, 2013).

The country has only 20 percent of the territorial surface area classified as highly potential, receiving high amounts of rainfall to support agricultural productivity. The other part of the country comprising of over 88 percent of the total territorial area is arid and semi-arid lands (ASALs) with minimal annual rainfall ranging from 200-850mm. Over 80 percent of the total population occurs within the potential areas while only 20 percent of the population occurs in the vast ASALs comprising of ecological zones III-VII. In addition, the ASALs are

dominated by pastoralists supporting over 70 percent of the livestock in the country (GOK, 2013).

Kenyan economy is agriculture based employing 60 percent of the total population. This implies that natural resources constitute the major source of livelihoods for majority of the population. This often has led to over-exploitation, unsustainable use, and environmental degradation. This condition is worsened by encroaching desertification and environmental degradation resulting from climate change (NEMA, 2013). Climate change has resulted in negative socio-economic effects across most sectors with the most vulnerable being agriculture and livestock, forestry, water, health, fisheries, energy, tourism as well as physical and social infrastructure.

According to a NEMA (2013) report, the general adverse effects from climate change experienced in Kenya include; variations in weather patterns (reduced rainfall and failed seasons), frequent and prolonged droughts and diminishing water resources, floods/flash floods and landslides, environmental degradation and habitat destruction, resurgence of pests and diseases, loss of biodiversity, severe famine and hunger causing food insecurity, and resource-use conflicts particularly among the nomadic pastoralist communities (NEMA, 2013). Although climate change occasionally brings about some positive and beneficial consequences such as high crop yield during El Nino rains, majority of the effects have an overall net negative effect likely to cause irreversible and detrimental damages to agriculture and allied sectors.

To deal with the negative effects of climate change, a number of adaptation strategies that can be adopted in different situations are necessary. Adaptation to climate change is a process through which people reduce the adverse effects of climate on their health and well-being and take advantage of opportunities that the environment provides. Saka (2008) notes that adaptation measures to climate change among communities should be considered with two broad activities in mind: measures that reduce vulnerability, and measures that increase resilience through the utilization of the available common assets.

At the local farm level, these can be distinguished for the crops, forestry and livestock sub-sectors. Changes in land-use and changes in crop and livestock management strategies have to be embraced. Examples include; changes in cultivated land area, changes in crop types, growing crop species or varieties with higher thermal requirements or those that are tolerant

to drought and floods, changes in crop location; and intensive and extensive use of irrigation water and improved fertilizer-use efficiency to counter the effects of droughts, periodic water stress and low soil fertility conditions. Other examples comprise of control of insect pests and diseases associated with floods and droughts, improvements in soil management practices to reduce surface runoff and soil erosion, establishment and creation of food grain reserves at farm and community levels for safe-keeping and storage of harvested produce. And finally, diversifying species and intercropping crops with trees to benefit from improved micro-climate and tree products and services (GOK, 2013; Saka, 2008).

At the national level, the government needs to enact affirmative laws in the various sectors that are vulnerable to climate change impacts. In the water sector for instance increase in capture and retention of rainwater, water quality monitoring, de-silting rivers and dams, protecting and conserving water catchment areas, investing in decentralized municipal water recycling facilities, campaigns on water harvesting, and developing hydrometric network to monitor river flows and flood warning. In the forestry sector; up-scaling in efforts on intensified afforestation, promoting agroforestry-based alternative livelihood systems, promoting alternative energy sources, community forest management, reducing emissions from deforestation and forest degradation (REDD+) initiatives, and reduced mono-species plantation stands are necessary. Consequently, in the energy sector; promotion on the use of alternative energy including geothermal, wind, solar, and mini hydro power generation, and the promotion of improved cook stoves are equally essential (Forest Society of Kenya (FSK), 2010).

2.5.2 Mitigations against climate change

To mitigate the impacts of climate change, there is a need to identify measures for limiting greenhouse gas emissions (GHGs) in the atmosphere. Mitigation measures are aimed at moderating or reducing the severity of the climate change impacts by limiting greenhouse gas emissions. Empirical data demonstrate that, GHGs emissions results from man's activities and are responsible for global warming and subsequent changes in the climate system. To identify measures for limiting greenhouse gas emissions into the atmosphere, people must embrace the use of cleaner technologies that do not emit a lot of GHGs, while at the same time providing sinks for the already emitted GHGs in the atmosphere.

Most mitigation measures are available in the energy, forestry and agriculture sectors (GOK, 2013). In the forestry sector for example, mitigation strategies include planting of tree species

in woodlots, in forestry plantations, along the farm boundaries and other agro-forestry systems that can increase tree cover and subsequently enhance carbon sink function in woody tissues. In the energy sector, mitigation strategies take account of biomass-based technologies such as use of wood fuel in improved mud stoves and ceramics, biogas fuel from bio-wastes to produce biogas for cooking, lighting and heating, as well as briquettes for cooking instead of wood. Other non-biomass based strategies can be adopted including rural electrification through grid extension, mini-hydropower, compact fluorescent lamps for lighting, renewable energy sources (solar cookers and heaters) and wind power for pumping water. In the agriculture sector, strategies aimed at reducing the GHG emissions include; incorporating crop residues into the soil instead of burning, good management of livestock manure to reduce emission of methane, and proper management of nitrogenous fertilizers in rice and upland agricultural soils to reduce nitrous oxide emissions (FSK, 2010).

The energy sector which plays a critical role in socio-economic development of Kenya has not been spared by the effects of climate change. For instance, the wood fuel and biomass accounting for 68% of total energy consumption have direct correlation to vegetation which depends heavily on climatic factors (rainfall, temperatures, light intensity, relative humidity, altitude, atmospheric pressure and soils among others) for growth. The power current generated from hydro-power stations, has also been affected by climate change due to its reliance on rainfall and water sources in rivers. The water sector too needs to embrace water conservation technologies including drip irrigation, construction of water harvesting and, or recycling technologies, while the health sector has a duty and obligation to embark on research to develop methods and strategies of prevention and cure of various emergence diseases associated with global warming. Thus the need to use the available tools as efficiently as possible and measures put in place to mitigate and adapt to global climate change (GOK, 2013).

The general public needs to promote environmentally friendly technologies and practices including recycling and enhanced compliance with environmental regulations and standards. Early warning data and information is supposed to be availed and disseminated in order to enhance disaster preparedness across all sectors vulnerable to climate change and variability. For instance, the application of weather data and information is critical in mitigation of climate change. This information guides farmers and the civil community on the expected time and quantities of rainfall as well as the recommended type of crops to be planted (NEMA, 2013).

Some scientists think mitigation of climate change needs a more radical approach. For instance, the Royal Society Academy (RSA) in England has published papers in "Philosophical Transactions" proposing "geo-engineering" as a transition to a low-carbon economy yet to be achieved in the near future (Schneider, 2008). Broadly the ideas fall into two categories: one is to remove excess CO_2 from the atmosphere; while the other is to compensate for climate-warming greenhouse effects of CO_2 and other gases by reducing the amount of sunlight reaching the ground. The strategies include increasing photosynthesis to wipe out excess CO_2 through planting more trees and also through encouraging increased phytoplankton growth which eventually will sink to the bottom of the ocean and not release the carbon.

The CO_2 can also be recycled into fuel through a reaction with H_2 or it can be ejected from the atmosphere using the planet's magnetic field. The stratosphere can also be deliberately polluted with sulphate in order to reflect solar heat into space. These ideas are all being tested and if successful they could offer mankind the space and opportunity to think through more sustainable mitigation strategies to the challenges posed by climate change. It will be important that students in tertiary agricultural institutions have a good understanding of the issues surrounding climate change mitigation and the new concept of geo-engineering (Schneider, 2008).

2.5.3 Cost-reduction and sustainability opportunities from climate change

Climate change, while viewed as a challenge to general economic development, has the potential to transform economies and place them on a lower carbon, resource – efficient Green Economy Path way. Some business opportunities arising from climate change are; mitigation measures to reduce Green House Gas emissions (GHGs) such as developing and harnessing Renewable Energy Resources (RER), and adaptation measures to adjust to new incoming impacts of climate change such as water recycling and waste management techniques which adapt to climate change (NEMA, 2013). Other opportunities from climate change responsive to creation of cost-reduction and sustainable strategies include; carbon credit trade, global environment facility, and payments for ecosystem services that cushion people's economies (FAO, 2008).

Through a well-structured agricultural education and agriculture practices, significant amounts of CO_2 can be removed from the atmosphere and stored in soils using a range of farming practices, for example organic farming, zero or reduced tillage systems that avoid or

reduce soil disturbance, growing protein crops, planting hedgerows and maintenance of permanent pastures and conversion of arable land to grass land. Consequently, bio-energies produced from agricultural biomass can replace other emission-intensive energy sources, such as fossil fuels. Farmers are increasingly adopting growing of energy crops for bio-fuels, small or even large power stations, or for on-farm combined heat and power plants. There is also an emerging trend for greater use of renewable agricultural resources in industry such as agro-materials, bio-plastics and bio-chemicals (FAO, 2010).

The aspects of mitigations against climate change at local and international forums all concur with the key broad objectives of secondary school agriculture curriculum in Kenya (KIE, 2008). However, while the international forums focus their attention on the reduction of GHGs, enhancement of carbon sink function in agricultural soils, and contribution of renewable energies. Secondary school agriculture curriculum addresses environmental conservation for sustainable agriculture production, climate change and variability resilient notwithstanding. This, therefore, creates the link between climate change topics and secondary school agriculture syllabus content.

2.6 Adjusting Education Curricula in Response to Climate Change

Temu, Mwanje and Mogotsi (2003), in reference to agriculture education in Malawi described the linkage between education and society. Education in broad terms refers to the process of preparing an individual to become a functional and acceptable member of society. Two concepts are inbuilt in the definition of education, namely; creation of knowledge and experience, and growth and development. The study observed that, unless agriculture education is able to respond to societal challenges and expectations, society will also have difficulties in understanding the roles of agriculture education. Another observation by Jingzun and Young gong (2004), referring to China farmer's formal and non-formal education argued that, education for rural people which was considered to be the basis of the Agriculture curriculum, is crucial in achieving both Education for All (EFA) goals and the Sustainable Development Goals (SDGs) for eradicating extreme poverty, hunger, promoting gender equity, and ensuring environmental sustainability.

To adjust education in response to climate change, there is need for institutional innovations and changes to ensure graduates from these learning institutions are abreast with knowledge on climatic issues. The curriculum content, teaching materials and methods of delivery ought to be redesigned in a way to equip the learners with the necessary skills and knowledge to

tackle global challenges and their interpretations in specific local situations. A report by African Network for Agriculture, Agro-forestry and Natural Resources Education (ANAFE) observed that learning materials are generally not adequately contextualised in the local African environment. This is true for agriculture curriculum and for other related subjects in relation to climate change an implication that educational institutions are not responding adequately to societal challenges (Temu, *et al.,* 2003).

In their study, Chakeredza, Temu, Saka, Munthali, Muir-Leresche, Akinnifesi, Ajayi and Silesh (2008), identified significant shortfalls in Agriculture education's failure to integrate climate change issues. Against the background of brain drain, the study further observed that among other problems, the major constraints in agricultural education include; poor staffing of institutions to meet the desired curriculum coverage, training predominantly based on curricula adopted from countries that had colonies in Africa and founded on agricultural philosophies aimed at the production of cash crops for consumption by the colonizing countries, and teaching modes that are not learner-centered.

There is very little interaction with farming communities as most of institutions are located in towns where there are no farming communities nearby to work with. In most cases even the farming community is not involved in the design and delivery of agriculture education curricula. Therefore there is absence of private-sector involvement in the design and delivery of agriculture curricula. As a result, it is not surprising that Sub-Saharan Africa learning institutions have so far done very little in the integration of climate change issues into their Agriculture curricula.

The general public and policymakers have a duty to rethink and transform the agriculture curricula to become responsive to the needs of the society. From the ANAFE symposium of 2003, Temu *et al.,* suggested a guiding framework in addressing shortfalls in learning institutions. These recommendations are still relevant today as they were in 2003 and need to be addressed as we move into the future. ANAFE has further developed a program dubbed Strengthening Africa's Strategic Agricultural Capacity for Impact on Development (SASACID).

This visionary program addresses all the major key weaknesses in African agriculture curricula. The challenge is for countries to play their roles in the transformative program. Although the identified shortfalls are not directly contextualized in the Kenyan situation on secondary school agriculture syllabus in response to addressing climate change, the

challenges are similar. Therefore, there is need to adopt the study recommendations in order to counter and reduce the impacts of climate change in agriculture and the allied sectors.

2.6.1 General objective in Kenyan secondary school agriculture curricula

Secondary school agriculture syllabus in Kenya aims at equipping learners with the basic principles of farming (KIE, 2008). The syllabus aspires to accomplish two fundamental objectives: first, to develop the basic principles of agriculture production relevant to Kenya in general and specific to learners' environment; secondly, it seeks to involve the learners in practical work to make them acquire the necessary skills useful in agricultural practices in various environments. Among principles the syllabus covers include; crop production, livestock production, soil science, agricultural economics and engineering. The course aims at developing an understanding of agriculture and its importance to the family and the nation, promotion of interest in agriculture as an industry, and creation of awareness of the opportunities existing in agriculture and related sectors. It also enhances skills needed in carrying out agricultural practices, provides a background for further studies in agriculture and develops self-reliance, resourcefulness and problem solving abilities in agriculture among others (KIE, 2008).

Agriculture is described as the science and art of crop production and livestock production (KIE, 2008). As a science, agriculture makes explanations of "why" certain events and phenomena occur the way they do. This involves careful observation of how things interact with each other, their interrelationships and the phenomena that occurs. Making explanations usually involves showing the connections between events and phenomena. The nature of work of a scientist is to make knowledge more applicable and to extend our confidence in its validity and make predictions to new situation (Ouma, 2012). As an art agriculture involves learning by doing. The learner needs to be provided with a suitable environment where they can experience, see and feel the matter they are handling. Practicing agriculture in the field brings theory close to reality and possibly enhances motivation.

In order to make Agriculture more interesting and to develop an agricultural attitude of questioning, examining, open-mindedness and suspending judgment, the teaching methodologies adopted need to be rigid. According to Ouma (2012), the only true teacher is one who can transform himself to a thousand persons at a moment's level of the student and transfer his soul to the student's soul and see through the student's eye, hear through student's ears and understand through student's mind. In this case the role of the agriculture

teacher is vital in the syllabus adjustment to guide and change the learner's attitude towards a desired goal. When learners attend an educational program they gradually acquire interrelated patterns of emotional, verbal and other behavioural reactions to various aspects of the projected environment.

As climate change is increasingly becoming a challenge to agricultural production by increasing risks and uncertainties, it also increases the cost of production for farmers. Therefore, there is a need for secondary school agriculture students to be well versed with the challenges posed by climate change to the environments they will work and live in after schooling. They also need to understand the implications of climate change to economic development and international trade. Thus educating those currently at school about climate change will help to shape and sustain future policy-making. The concepts on climate in the existing secondary school agriculture syllabus have been limited to rainfall, temperature, wind, light and relative humidity (KIE, 2008).

Secondary school agriculture learners need also be abreast with various International platforms, conventions and protocols on climate change, including UN Framework convention on climate change (UNFCCC), Kyoto protocol among other informal partnerships that provide a framework that supports co-operation, and a foundation from which to build further collective action. The challenges are to develop well-structured secondary school agriculture syllabus, produce relevant learning resources and capacitate agriculture teachers to effectively address climate change issues at school level.

Agriculture teachers through the available teaching resources and methodologies should be able to contribute to the development of the body of knowledge addressing selected concepts on climate change such as adaptations, mitigations and cost-reduction and sustainability strategies. Integration of these concepts into secondary school agriculture syllabus should be a matter of urgency. There is need for concrete scientific data based on local experiences to be infused into the secondary school agriculture syllabus.

The suggested units of emphasis in this study pertinent to climate change include; introduction to climate change and highlighting the meaning, importance, implications and impacts, climate change adaptations stressing, the meaning, measures that reduce people's vulnerability as well as those increasing peoples' resilience to the change, climate change mitigations including, meaning and importance, mitigation strategies under different situations and measures limiting greenhouse gas emissions as well as those creating sinks,

and, cost-reduction and sustainability strategies, such as climate change implications to the people's livelihoods, environment, concepts of agro-biodiversity, bio-energy production, and geo-engineering among others.

Issues of concern on climate change are the causes, which have been attributed to the rising stocks of greenhouse gases in the atmosphere including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chloro-and-fluoro-carbons and a number of other gases that arise from industrial processes (Stern, 2006). Each day, the body of knowledge on the causes of climate change is expanding. With the current accelerating levels of emissions, in part due to the fast-growing economies investing in high carbon infrastructure as the demand for energy and transport increase, it is envisaged that there is between 77-99% chance that by about 2035 the world would have warmed by greater than 2^0C (Stern, 2006). These changes will in all likelihood adversely impact food production, health, and the entire environment.

2.7 Psychoanalysis of the Current Secondary School Agriculture Syllabus

An analysis of the existing secondary school agriculture syllabus (Appendix A) reveals that, there are thirty three (33) units/topics and their sub-units/topics demonstrated as objectives under each topic (KIE, 2008). The thirty three topics are further summarized into five key areas/branches each spread over the four-year cycle of the secondary education. These branches are:

i) Principles of crops production, comprising of eleven (11) units; introduction to agriculture, crops production I, II, III, IV, V and VI, weeds, crop pests and diseases, forage crops and agro-forestry.
ii) The principles of livestock production constituting nine (9) units; common breeds of livestock, livestock health I, II, III & IV, livestock production III, IV, V & VI.
iii) Agricultural economics composed of five (5) units; agricultural economics I, II, III and IV, and agricultural marketing and organizations.
iv) Agricultural engineering comprised of six (6) units; farm tools and equipment, water supply, irrigation and drainage, farm structures, and farm power and machinery.
v) Soil science consisted of four (4) units; factors influencing agriculture, soil fertility I & II, and soil and water conservation (KIE, 2008).

Despite agricultural production being highly sensitive to climatic conditions and the strong scientific evidence that the drifting climate is real and will continue causing severe damages to the agriculture sector and the allied sectors unless measures are taken to stem and reverse the trend. The current syllabus is silent on the pertinent issues of climate change and the

consequent challenges it poses to the environment upon which agricultural production is based.

For instance, out of a total of thirty three (33) units constituting the syllabus, only one unit that is 'factors influencing agriculture' addresses aspects of climatic variables particularly on rainfall, temperature, wind, humidity, light and soil. Consequently, two more units provide aspects pointing to climate change adaptations including water supply, irrigation and drainage, and agricultural economics III. Further, two other units provide relevant information on aspects for mitigating impacts occasioned by climate change, specifically soil fertility, and soil and water conservation. Lastly, three more units focus on aspects of cost-reduction and sustainability strategies from climate change that is forage crops, agroforestry, and farm power and machinery (KIE, 2008).

Proportionately, these units represent only a fifth of the entire secondary school agriculture syllabus content. This translates into an inconsistency on the part of the agriculture syllabus to address climate change and variability concerns. These few units therefore, provided a credible gap, link and background upon which this opinion survey among the secondary school agriculture teachers on integration of selected climate change topics into secondary school agriculture syllabus was studied.

A well designed education system can translate to an integral part of the concerted efforts to tackle climate change and variability through: preparing agriculture to reduce its own gas emissions; enhancing the carbon sink function of agricultural soils; and contributing to production of renewable energies and bio-products (United Nations Development Program (UNDP, 2012). Policy makers and other likeminded stakeholders need not spend resources educating the general public on how to cope with the devastating climate change and variability. However, what they could do is to simplify the science of climate change and integrate it into the education systems so that the schooling generation whose future belong to it, can acquire and internalize skills and knowledge on how to deal with the climate change for sustainable livelihoods (Food Agricultural Organization (FAO, 2012).

2.8 Prospective Climate Change Topics

To refocus the existing secondary school agriculture syllabus to tackle climate change impacts on farming, the researcher formulated a proposal on integrating an independent unit on selected climate change and variability topics into the syllabus (Appendix B). The

methodology involved drawing the few concepts on climate in the current syllabus to constitute integral parts of the new unit. To arrive at that, a reorganization of the selected topics on climate change and variability gave rise to four key topics, that is: introduction to climate change and variability; adaptations to climate change; mitigations against climate change; and cost-reduction and sustainability strategies from climate change.

Apart from the unit borrowing a few ideas pertinent to climate change from the existing agriculture syllabus, a lot more was borrowed from the robust growing body of literature on climate change phenomenon to constitute an elaborate unit. The new unit was presumed to be addressed within the level and scope of understanding by the secondary school agriculture learners and spread across the four year secondary school cycle (Appendix B).

To accomplish this, a careful analysis on the increasing impacts of climate change and variability on farming was done in relation to the conventional knowledge and skills learned from the present agriculture syllabus. The outcome revealed numerous inconsistencies in the practices and skills emphasized in the syllabus compared to the contemporary trends especially in relation to acclimatizing agriculture to climate change and variability. To cite a few, principles like primary, secondary, and tertiary cultivation in land preparation are no longer ideal in some site-specific situations. They have been surpassed by the principle on minimal soil disturbance practices to enhance nutrient, biotic and moisture conservation. The principle on adoption of genetically modified or altered organisms (GMOs) with better adaptation traits to the ecosystem are currently on the dominance in almost all agro-ecological situations. As yet another emphasis is on the principle of adoption of agro-innovative technologies with minimal environmental contamination (FAO, 2012).

Therefore, to adjust the agriculture syllabus to deal with the rampant climate change, the content of the existing syllabus will need to be reorganised, to contain units with relevant information on climate, including adding other principles pertinent to climate change and variability from the robust growing research on climates. Some agriculture principles borrowed from the present secondary school agriculture syllabus relevant to mitigating the ecosystem against climate change impacts include: conversion of animal wastes into biogas; conversion of significant amounts of CO_2 from the atmosphere into the soil through organic farming; minimum tillage; mixed cropping and intercropping. Consequently, other principles that lead to cost-reduction and sustainability include: harnessing renewable energy from sun

radiation; wind and organic residues and bio-energies, and bio-products obtained through growing oil producing crops (UNDP, 2012).

More relevant climate change adaptation principles that were borrowed from the present agriculture syllabus to enable the farmers and the general public in acclimatizing to climate changes include: crop rotation programmes; dry planting/early planting and planting early maturing crop varieties / species. Further, other principles consist of agro-forestry and biotech farming using innovative technologies that enable farmers to adjust to risks and uncertainties (KIE, 2008). It is, worthy noting that the climate changes and variability unit which has significantly borrowed from the present agriculture syllabus will not necessarily broaden the syllabus beyond the recommended time allocated for its coverage in the 4-year cycle of secondary school level. Therefore, the stipulated agriculture coverage timetable remains legitimate.

2.9 Theoretical Framework of the Study

This study was guided by the 'needs analysis theory' (Dewey, (1924). Dewey, whose studies specialized on progressive curriculum development philosophy between 1910s and 1950s, was later regarded as the father of all philosophy. Later on Goodlad (1968), further reviewed Dewey's theory on curriculum and came up with a discipline (subject)-centred curriculum philosophy where scholars' perceptions are thought to be influenced by other forces including, socio-economic and political forces (Tedesco, Opertii & Amadio, 2014). On this basis, therefore, an analysis was carried out on the nature of the influence of changing climates of broad social and political circumstances as they intrude upon the development of curriculum and the selectivity of perceptions of curriculum developers when encountering this theory.

Dewey's (1924) theory was reinforced by a conventional perspective of scientific theory by Charles Tyler's technical model of vocational education (Kliebard, 1970). The technical model of vocational education attempts to identify and describe the variables and their relationship in curriculum development. The rationale of the model is primarily conceptual in nature, and research is utilized for empirical validation of curriculum variables and relationships rather than as a test of efficiency and effectiveness of a curriculum prescription. Tyler summarized the technical model process into the following variables: (1) specification of the role for which training is to be provided, (2) identification of the specific tasks that comprise the role, (3) selection of the tasks to be taught, (4) analysis of each of the tasks, (5)

statements of performance objectives, (6) specification of the instructional sequence, (7) identification of conditions for learning, (8) designation of an instructional strategy, (9) development of instructional events, and (10) creation of student and curriculum evaluation procedures and devices (Kliebard, 1970).

Both theories re-conceptualise the subject matter of the study around the structure of the subjects and the modes of discipline inquiry. This has been adopted by specialists of many subjects and has resulted in authentic landslide of curriculum revisions, new programmes, revised, and or new materials and in service programmes for teachers. Essentially, the rationale for the priority of subjects lies in the argument that, mans' essential nature is most reasonably fulfilled by his symbolic capacities with priority on general ideas and especially those most teachable and learnable. Thus, the secondary school agriculture curriculum in this study was basically grounded in a conception of general ideas which can be best communicated to and learned by others.

The major concern in this study was climate change and variability, which impair the development of agriculture and interconnected sectors. The realization of the objectives of teaching agriculture in secondary school is strengthened by the two theories which give emphasis to vocational education, perceived to upgrade the secondary school agriculture curriculum toward sustainable agricultural development in the country. These theories were considered to contribute significantly to the conceptual framework which demonstrates the relationships between the independent and dependent variables of the study.

2.10 Conceptual Framework of the Study

The study sought the agriculture teachers' perceptions as the independent variable, and the integration of selected climate change topics as the dependent variable. Some intervening variables were as well captured in the study. Figure 1: illustrates the interplay among these variables.

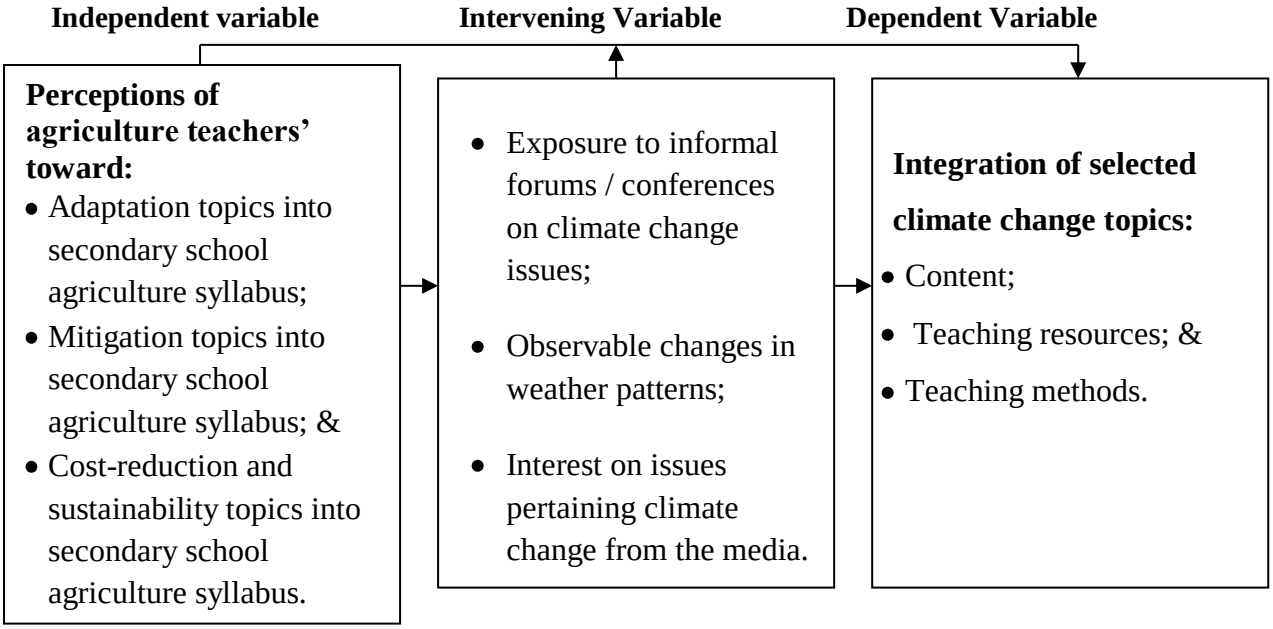

Figure 1. Conceptual framework on perceptions of agriculture teachers toward integration of climate change topics in secondary school agriculture syllabus

This conceptual framework was adopted from the theories by Dewey and Tyler. The variables sought to contextualise the theoretical framework to the objectives of the study, the research questions, and how the procedures of data analyses related to the problem of the study. The independent variable comprised of the perceptions of the agriculture teachers toward; adaptations, mitigations, and cost-reduction and sustainability topics. The dependent variable was derived from the agriculture syllabus and included; the content, the teaching resources and the teaching methodologies. Consequently, some intervening variables captured in the study comprised of; respondents' exposure to informal forums / conferences on climate change issues, observable changes in weather patterns and interest on issues pertaining climate change from the media. The intervening variables were suspected to have a potential influence on the expected outcome that the researcher may not have had adequate control over in the study.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides a description of how the research was carried out with regard to the objectives and research questions of the study. It outlines the research design, location of the study, target population, sampling procedure and sample size, instruments' validity and reliability, data collection and data analysis procedures.

3.2 Research Design

The research design used was descriptive survey with aspects of *ex-post-facto* research design. However, due to its small population which is a characteristic feature of quantitative research design, it qualified to borrow heavily from a phenomenology approach of qualitative studies. Phenomenology approach studies describe experiences as they are lived and the methodology used for sampling and data collection focus on a population with particular knowledge to the subject matter. In this case, this study used respondents who were information rich in relation to the subject matter. Consequently, it employed a descriptive survey research design to present the research findings. The task was to determine the perceptions of the agriculture teachers toward integration of selected climate change topics into secondary school agriculture syllabus. The quantitative aspect of the research enabled the researcher to consider issues such as the economy of the design and rapid data collection (Gall, Borg & Gall, 2003).

3.3 Location of the Study

The study was carried out among agriculture teachers employed by the Teachers Service Commission (TSC) in public secondary schools within Machakos County. The study location comprises of eight Sub-counties as follows: Machakos; Athi-River; Kathiani; Kangundo; Matungulu; Mwala; Yatta; and Masinga. The counties boardering Machakos include; Embu to the East, Kitui to the North, Makueni to the South and Nairobi to the West.

The location was preferred because it is characterised by varying agro-climate zones ranging from zone I to VI, which represent high, medium and low agriculture potential areas prevalent in the entire country. Machakos County generally experiences a flourishing agriculture economy, and has consistently been rated highly in terms of development since devolution government was rolled out in Kenya.

3.4 Target Population

The target population was secondary school agriculture teachers in Machakos County who were two hundred and fifty (250) in 2013. Out of the 250 teachers, only one hundred and thirty five (135) comprised the accessible population according to Machakos County Education Office 2013 census on secondary schools. Accessible population represented the trained secondary school agriculture teachers under TSC employment in public secondary schools. All of them met the criterion for inclusion into the study becoming the accessible population. The researcher identified the agriculture teachers because they were 'information rich' with respect to the purposes of the study in terms of knowledge and skills in facilitating secondary school agriculture syllabus (Gall, Borg & Gall, 1996). The accessible population characteristics were identified with respect to distribution; per sub-county, age, gender, and teaching experience. Schools that didn't have TSC employed teachers either chose not to offer the agriculture subject in their curricular due to the optional nature of the agriculture subject. Others had the subject facilitated by intern teachers or university students in their long holidays. These groups' agriculture teachers were not admissible in the study because they did not have the skills and experiences required for the study.

3.5 Sampling Procedures and Sample Size

The study did not merit a sampling process to determine the sample size since the target population was small that is a hundred and thirty five (135) respondents. Such a number is small for quantitative research designs to sample further to a smaller representation group. Therefore, the total population was allowed to participate in the study. Inclusion of the total population in the study is a type of purposive / census sampling technique where the researcher opts to study the entire population because of a particular set of characteristics of interest (Gall, e*t al*., 2003).

3.6 Instrumentation

The researcher developed a questionnaire that captured four variables on demographic characteristics of the respondents. Other three sections each on adaptations, mitigations and cost-reduction and sustainability variable items were developed. The questionnaire items were measured on a 5-point Likert's scale rating. The Likert's scale was used to obtain a self-administered data. The selection of the instrument was guided by the objectives of the study as well as the type of information sought from the respondents which was based on an opinion survey. Opinion surveys are best accomplished through use of a Likert's score scale

rating (Gall, *et al.,* 1996). Likert's scale rating was deemed ideal since the respondents were literate and unlikely to experience difficulties while scoring.

The respondents were required to score by ticking (√) in the spaces provided, their perceptions on the proposed sub-topics on climate change and variability in relation to their suitability in the agriculture syllabus. The study relied on variables that could not have been directly observed but rather perceived by the respondent's and make informed judgements. The questionnaire comprised four sections. The first section sought to gather information on the biographic information of the respondents. The second, third and firth sections sought to gather data on the respondents' perceptions toward integration of enlisted adaptation, mitigation and cost-reduction and sustainability strategy sub-topics from climate change into secondary school agriculture syllabus respectively.

3.6.1 Validity

Validity is the extent to which the instrument measures what it is supposed to measure (Wiersma, 1995). Content, construct and face validity of the instrument were determined. Content validation refers to the process of establishing the representativeness of the items with respect to the domain of skills, tasks, knowledge etc. (Wiersma, 1995). The content validity in this case was determined in consultation with various groups of people including; supervisors, experts and colleagues in the Department of Agricultural Education and Extension of Egerton University, researchers in various conferences and symposiums attended, as well as colleagues at other informal forums. These individuals helped to advice on whether the Likert's score scale rating technique offered a true representation of the subject matter under investigation.

The Construct validity was determined with regard to the suitability of Likert's score scale rating method to measure perceptions of the respondents toward the integration of selected climate change topics into secondary school agriculture syllabus. Construct validity refers to the extent to which the inferences from test's scores accurately reflect what the test is claimed to measure (Gall, *et al.,* 2003). Face validation was determined through formatting and rearranging the questionnaire items in line with the objectives and research questions of the study after the piloting stage. This determined the instrument's accuracy and meaningfulness on the basis of the overall research results. An expert in the field of statistics and research methods at Chuka University was adversely consulted during validation and reliability exercises.

3.6.2 Reliability

According to Gall, *et al.,* (2003), reliability is the extent to which other researchers would arrive at similar results if they studied the same case using the same procedures as the first researcher. To ensure the items asked in the score scale were reliable, the instrument was piloted in the neighbouring Makueni County using thirty (30) respondents. This number of respondents was used as per the recommendations by Kathuri and Pals (1993), that, at least 30 respondents represent an ideal number for piloting purposes. The 30 respondents used for piloting had closely related characteristics to those of the sample population under investigation that is, TSC employed and teaching agriculture in public secondary schools. Reliability of the instrument was calculated using Cronbach's Coefficient alpha formula (Fraenkel & Wallen, 2000). A reliability coefficient alpha of 0.72 was obtained which was above the recommended minimum coefficient alpha of 0.70. The Likert's score scale rating questionnaire items which were found to be ambiguous during piloting were re-examined and modified accordingly.

3.7 Data Collection Procedures

Data collection process started with obtaining a clearance letter to proceed for field work from the graduate school, Egerton University. The clearance letter was to confirm and recommend the researcher to acquire a research permit from the National Council for Science, Technology, and Innovations (NACOSTI) office at Nairobi. Upon obtaining the research permit, the researcher proceeded to Machakos County where the main fieldwork was to commence. Other supporting authorization documents were obtained from the County Director of Education's and County Commissioner's offices at Machakos respectively. Consequently, other visits were made to all the eight Sub-county Education and Commissioners' offices to notify them about the intended research exercise. The specific Sub-Counties visited were Machakos, Kathiani, Athi-river, Kangundo, Matungulu, Mwala, Yatta and Masinga.

The logistical information obtained from the Sub-County visits revealed Machakos County had a total of 310 both public and private secondary schools by 2013. Further enquiries revealed a total of 135 respondents (TSC posted agriculture teachers) in the County qualified for inclusion in the data collection exercise. The public schools in which respondents were based were thus identified alongside their approximate distances from the Sub-county offices. Those that were located along certain main roads or feather-roads were identified and visited on same dates. Formal self-introduction was done either at the Principal's, Deputy Principal's

or Senior Teacher's offices depending on who was available at station at the time of the visit. Then permissions to meet the agriculture teacher(s) were sought.

The teachers present at the time of the visits were briefed about the exercise and their consent to fill the questionnaires sought. They were then inducted and allowed to react to the briefing through asking questions where they needed further clarifications. The respondent's mobile phone contacts were taken and all assured of the confidentiality of the information they provided. Each respondent was then given a questionnaire to fill before being allowed to say the date(s) the questionnaires were to be collected back. Further communications were done through cell phone to establish whether the questionnaires were filled, and the appropriate day and time they could be collected.

The optimum time the respondents were allowed to fill the questionnaires was three weeks from the delivery date. However, those who requested additional time were given in accordance to their convenience. The return rate to the filled questionnaires after eight months was 74.1 percent. Since the respondents were 135, the 74.1% return rates amounted to realization of 100 well filled questionnaires, the minimum required number for quantitative survey research in social sciences as per Kathuri and Pals, (1993). Thirty five (35) respondents declined from the study, by never filling the questionnaires even when they were allowed two more months to fill and surrender them back.

3.8 Data Analysis

Data obtained from the field was in accordance with the arrangement of the questionnaire items whose structural and content organization followed the layout of the selected climate change concepts. The selected climate change concepts further build up from the topic, objectives and test questions of the study. The concepts were: adaptations, mitigations and cost-reduction and sustainability strategy topics on climate change respectively. After the agriculture teachers filled the Likert's score scale questionnaire with regard to their perceptions on each concept's suitability for integration into secondary school agriculture syllabus. The concepts were drawn together to constitute chapters four and five. Arrangement of the data in line with the questionnaire items focused a systematic linkage of the background information, literature review and the research methodology with the research findings and conclusions.

Data analysis involved coding and categorizing data into numerical values based on the appropriate scales of measurements including; string, nominal, ordinal and scale levels. This

aimed at converting the raw data into a language understandable by the computer, before finally keying it into a computer master data sheet for analysis and reorganization using Statistical Package for Social Sciences (SPSS) programme version 17 (Ouma, 2012). The output data transformed and presented in form of tables were further synthesized, interpreted, simplified and presented in a descriptive perspective using frequencies and percentages. The descriptive analyses involved working out frequencies and percentages of the occurrence of the responses for the purpose of further inferences. The researcher critically examined the responses in relation to the respondent's perceptions, which translated to a logical presentation of the findings. The entire research methodology involved data collection, analyses, interpretation and explanation, after which inferences, conclusions and recommendations were drawn. The outcome of the data analyses, descriptions and inferences are presented in chapter four as the results and discussions, while the summary, conclusions and recommendations are presented in chapter five.

Table 1

Summary of Data Analysis

Research Question	**Independent Variable**	**Dependent Variable**	**Data Analysis**
i) What are the perceptions of agriculture teachers toward integration of adaptation strategy topics on climate change into secondary school agriculture syllabus in Machakos County?	Adaptation strategy topics on climate change.	Agriculture syllabus content, teaching resources & methods.	Descriptive (percentages and frequencies) statistics
ii) What are the perceptions of agriculture teachers toward integration of mitigation strategy topics against climate change into secondary school agriculture syllabus? and	Mitigation strategy topics on climate change.	Agriculture syllabus content, teaching resources & methods.	Descriptive (percentages and frequencies) statistics
iii) What are the perceptions of agriculture teachers toward integration of cost-reduction and sustainability strategy topics on climate change into secondary school agriculture syllabus?	Cost-reduction & sustainability strategy topics on climate change.	Agriculture syllabus content, teaching resources & methods.	Descriptive (percentage and frequencies) statistics

CHAPTER FOUR
RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the results and discussions of the study, whose purpose was to investigate the perceptions of agriculture teachers toward the integration of selected climate change topics into secondary school agriculture syllabus. Due to natural attrition thirty five (35) respondents dropped out of the study. Therefore, data were collected from the remaining 100 respondents who cooperated up to the end of the study. Data were obtained using a Likert's score scale rating questionnaire. The respondents drawn from secondary schools within Machakos County were singled out because they are "information rich" with respect to the purpose of the study. After data were analysed, results were presented in form of tables followed by brief discussions.

The first section of this chapter provides an overview of the biographic information on the respondents' set of characteristics of interest. These pertained to their distribution per Sub-county, age category, gender and teaching experiences. The second section illustrates the respondents' perceptions toward integrating selected climate change topics into the agriculture syllabus. The section gives the proportions of respondents whose perceptions were positive, neutral or negative toward integration of the proposed sub-topics on climate change into the agriculture syllabus. The third section exemplifies the cumulative perceptions of the respondents toward integration of the three (adaptations, mitigations and cost-reduction and sustainability) climate change topics into the agriculture syllabus. The entire chapter, therefore, was structured in order of the specific study objectives and research questions as stated in Chapter One sections 1.4 and 1.5 respectively.

4.2 Characteristics of the Respondents

The sample size population (n) captured in chapter 3. was 135, but due to the natural attrition, these who participated to the end of the study were 100 (n = 100). The biographic information illustrates the respondents characteristics with respect to their; distribution per Sub-county, age category, gender and teaching experience. The respondents were required to tick (√) in the blank spaces provided, the Sub-county in which the school is located, their age category, gender, and teaching experience. Results for these variables were presented in Tables 2 to 5 followed by brief discussions.

4.2.1 Distribution of study population per sub-county

The findings on distribution of respondents, who took part in the study, are presented in Table 2.

Table 2

Sample Size per Sub-county

Sub-County	**No. of Respondents (n=100)**	**Percent (%)**
Mwala	21	21
Kathiani	9	9
Machakos	22	22
Kangundo	9	9
Yatta	12	12
Matungulu	9	9
Athi River	3	3
Masinga	15	15
Grand Total	**100**	**100.0**

The finding on the distribution of the respondents per sub-county pointed out that Mwala and Machakos sub-counties had the largest proportion of representation, followed by Masinga, Yatta, Kathiani, Kangundo, and Matungulu sub-counties. Athi-River had the lowest representation in the study. Five respondents in the study did not indicate the sub-counties they were based in.

4.2.2 Distribution of study population based on age

The outcome of the respondents' distribution based on age, are presented in Table 3.

Table 3

Distribution of Study Population Based on Age

Respondent's age bracket (yrs)	**No. of Respondents (n= 100)**	**Percent (%)**
30 and below	27	27
Between 31-40	39	39
41 and above	28	28
No responses	6	6
Grand Total	**100**	**100.0**

The study findings revealed that, the highest proportion of the respondents were in the age category of 31 and 40 years. These were followed in representation by respondents in the age bracket of 41 years and above, while the lowest proportion of participants were aged 30 years and below.

4.2.3 Distribution of study population based on gender

The results of the respondents' gender are presented in Table 4.

Table 4

Distribution of Study Population Based on Gender

Gender of respondent	**No. of Respondents (n = 100)**	**Percent (%)**
Male	53	53
Female	40	40
No responses	7	7
Grand Total	**100**	**100.0**

The results on the distribution of the respondents based on gender indicated that the male respondents were more than the female respondents.

4.2.4 Distribution of study population based on teaching experience

The distribution of the study population based on teaching experience is presented in Table 5.

Table 5

Distribution of Study Population Based on Teaching Experience

Teaching experience (yrs)	**No. of Respondents (n = 100)**	**Percent (%)**
5 and below	22	22
Between 6-10	26	26
11 and above	44	44
No responses	8	8
Total	**100**	**100.0**

As for the number of years in teaching, the findings illustrated majority of the respondents had a teaching experience of more than 11 years. These were followed in representation by

respondents with between six and 10 years teaching experience, while the least proportion of respondents in terms of teaching experience had five years and below.

4.3 Adaptation Strategy Sub-topics to Climate Change

The sub-topics on adaptation measures to climate change were keenly selected by the researcher in consultation with the supervisors and other subject specialists in the department of Agricultural Education and Extension of Egerton University. The main focus was their suitability and relevance for integration into secondary school agriculture syllabus. Three aspects of the existing agriculture syllabus were examined in line with integration of adaptation sub-topics of climate change. These were; the syllabus content, teaching resources and teaching methodologies.

The adaptation strategy sub-topics on climate change included:

a) The meaning of adaptations to climate change;
b) Adoption of adaptable crops and livestock;
c) Adoption of bio-tech crops and livestock;
d) Adoption of innovative agro-technologies in agriculture;
e) Flexible approaches to agricultural production;
f) Alternative sources of food;
g) Diversification of farm enterprises;
h) The concept of insuring crops and livestock;
i) The concept of mixed farming; and
j) The concept of pre and post-harvest crop management.

The sub-topics were critically examined for their appropriateness for integration into secondary school agriculture syllabus on the context of relevancy to content, teaching resources and teaching methodologies.

Objective 1: Perceptions of agriculture teachers toward integration of adaptation strategy topics on climate change in secondary school agriculture syllabus

This objective determined the respondents' perceptions on the identified climate change adaptation sub-topics proposed for integration in secondary school agriculture syllabus.

The respondents were subjected to a Likert's score scale rating questionnaire which required them to respond by ticking (√) the appropriate degree to which the sub-topic was relevant for positive, neutral or negative perceptions to secondary agriculture syllabus content, teaching resources, and delivery methods. Their Perceptions were presumed to have been influenced by the present agriculture syllabus. Scoring was done in accordance to the rating scale ranging between 1 to 5, where; 1 represented Very negative (V.N), 2 - Negative (N), 3 – Neutral (U), 4 – Positive (P) and 5 – Very Positive (V.P).

4.3.1 Adaptation sub-topics on climate change in relation to syllabus content

Data on the perceptions of agriculture teachers toward integration of adaptation strategy sub-topics on climate change in secondary school agriculture syllabus based on their relevancy to agriculture content are presented in Table 6, followed by interpretations and brief discussions on each sub-topic. However, score on (negative and very negative) were combined together and regarded simply as negative perceptions, while those on (positive and very positive) were likewise added up and regarded as positive perceptions in the discussions.

Table 6

Adaptation Sub-topics on Climate Change in Relation to the Syllabus Content

	Category of scores in Frequencies (F) & Percentages (%)											
	VN		**N**		**U**		**P**		**VP**		**TOTAL**	
Sub-topic	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
a) The meaning of adaptations to climate change	4	4	2	2	4	4	35	35	55	55	100	100
b) Adoption of adaptable crops and livestock	1	1	7	7	3	3	29	29	60	60	100	100
c) Adoption of innovative agro-technologies in agriculture	5	5	2	2	9	9	32	32	52	52	100	100
d) Adoption of bio-tech crops and livestock	6	6	10	10	20	20	37	37	27	27	100	100
e) Flexible approaches to agricultural production	2	2	8	8	8	8	35	35	47	47	100	100
f) Alternative sources of food	8	8	3	3	11	11	29	29	49	49	100	100
g) Diversification of farm enterprises	3	3	8	8	1	1	26	26	62	62	100	100
h)The concept of insurance schemes on crops and livestock	4	4	4	4	21	21	35	35	36	36	100	100
i) The concept of mixed farming, mixed cropping and intercropping	3	3	6	6	4	4	29	29	58	58	100	100
j) The concept of pre and post-harvest crop management	6	6	1	1	4	4	32	32	57	57	100	100
Average score per category	**4.2**	**4.2**	**5.1**	**5.1**	**8.5**	**8.5**	**31.9**	**31.9**	**50.3**	**50.3**	**100.0**	**100.0**

a) The meaning of adaptations to climate change

When data on this sub-topic were analysed, the results in Table 6 indicated that, majority of the respondents that is 90% either registered positive or very positive perceptions on the relevance of the sub-topic to the secondary school agriculture knowledge. However, a minimal segment of six percent of them endorsed negative or very negative perceptions on the proposal. Four percent of the respondent's returned a neutral verdict on the suggestion.

A similar idea is mentioned in Chapter Two of Form One Agriculture syllabus on "climatic factors influencing agriculture" where some aspects of climatic issues including rainfall, temperature, light, wind, relative humidity among others have been highlighted (KIE, 2008). However, the coverage of these climatic aspects has little bearing on the adaptations of climate change and variability as it has explicitly been proposed in this study. As observed by Stern (2006) report, with the current accelerating levels of emissions due to fast-growing economies investing in high carbon infrastructure, and as the demand for energy and transport increase, it is envisaged that there is between a 77-99 % chances that by about 2035 the world would have warmed by greater than 2^{o}C. These changes are likely going to worsen the negative impact on agriculture and food production in general.

This significant shift in greenhouse gas (GHG) emissions therefore has important implications in Africa and the world agriculture at large. Warming may induce sudden shifts in regional weather patterns such as the El Nino phenomenon. These are changes that would have severe consequences for water availability and flooding in tropical regions and threaten the livelihoods of millions of people. Thus adapting strategies to climate change should involve integration of climate change ideas into school curriculum particularly, the agriculture syllabus which aims at developing agriculture sector.

b) Adoption of adaptable crops and livestock

In reference to this sub-topic, the results in Table 6 illustrated that, a high proportion of respondents that is 89% either recorded positive or very positive perceptions toward integration of the sub-topic into agriculture syllabus content; 8% had either negative or very negative perceptions to the suggestion; and 3%of the respondents held neutral perceptions.

A similar concept is highlighted in the present secondary school agriculture syllabus, particularly in the chapter on "Production Economics" which addresses ways in which farmers can adjust to risks and uncertainties in farming, such as weather variability (KIE,

2008). Although in this context, the concept did not put emphasis on adaptation to climate change and variability, which currently poses great vulnerability to agricultural production. Similar sentiments were also observed by FAO's (2008) report which suggested that, adaptation strategies to climate change need to be taken in tandem with government policies and strategies of poverty alleviation and food security. A number of organizations World-wide, for example FAO are promoting the use of indigenous and locally adapted plants and animals as well as the selection and multiplication of crop varieties adapted or resistant to adverse conditions. The selection of crops and cultivars with tolerance to abiotic stresses (such as high temperatures, drought, flooding, and high salt content in the soil, pest and disease) allows harnessing genetic variability in new crop varieties; thus the significance of this sub-topic for integration in the school agriculture syllabus content.

c) Adoption of innovative agro-technologies in agriculture

The results in Table 6 on this sub-topic reflected that, 84% of the respondents either endorsed positive or very positive perceptions toward the sub-topic, terming it viable in relation to assimilating it in the agriculture syllabus content. On the other hand however, a small proportion of 7% of the respondents either registered negative or very negative perceptions to the suggestion, while another 9% endorsed neutral perceptions.

From the findings analysis, most respondents held the perceptions that adoption of innovative agro-technologies in agriculture was imperative. This concept is within the secondary school agriculture domain, particularly chapters four of the form two, and four of the form four agriculture syllabi (KIE, 2008). The principles of crop production IV, and agricultural economics" respectively have highlighted ways of adjusting to risks and uncertainties in farming through crop rotation, early planting, planting early maturing crops among others. Although these concepts are scarcely covered in the light to adapt to climate change and variability, they also contribute to increased farm production efficiency, minimising the cost of production, and increasing farm productivity.

The findings also concurred with the research findings of European Commission Directorate-General for Agriculture & Rural Development (ECDGARD, 2008) that the use of traditional production methods that help to protect the soil could play a part in reducing GHGs, although there must be transfer of modern technologies and skills if farmers are to succeed in adapting to climate change. There is therefore a necessity to integrate the sub-topic in the secondary school agriculture content as an adaptation measure to climate change and variability.

d) Adoption of bio-tech crops and livestock

The results on this sub-topic in Table 6 indicated that, 64% of the respondents either confirmed positive or very positive perceptions regarding insertion of the sub-topic into the agriculture syllabus content. Of a contrary opinion though, a total of 16% of the respondents either registered negative or very negative perceptions to the idea, while another 20% held neutral perceptions.

From the findings analysis, majority of the respondents perceived adoption of bio-tech crops and livestock as relevant to the agriculture syllabus content positively. Although the concept has not directly been articulated in the secondary school agriculture syllabus content as an adaptation strategy to climate change and variability, the finding is in tandem with Saka's (2008) recommendations that, adoption of bio-tech crops and livestock today is a significant goal to overcoming many difficulties faced by farmers. These include; growing crop species or varieties with higher thermal requirements or those that are tolerant to drought and floods, changes in crop location, control of insect pests and diseases associated with floods and droughts, diversifying species and intercropping crops with trees to benefit from improved micro-climate and tree products and services, and mass agricultural production to meet the market demand. The sub-topic on adoption of bio-tech crops and livestock therefore befits integration into secondary school agriculture content as an adaptation strategy to climate change and variability.

e) Flexible approaches to agricultural production

In response to this sub-topic, the results in Table 6 show that 82% of the respondents either endorsed positive or very positive perceptions that, the sub-topic was appropriate in view to permeate it to the agriculture syllabus content. Of a different opinion, however, 10% of the respondents either perceived the plan negatively or very negatively; 8% of them registered neutral perceptions.

From the findings analysis, a big proportion of the respondents perceived the proposal positively. A similar concept is mentioned in the current agriculture syllabus content particularly on principles of agricultural economics "adjusting to risks and uncertainties". It ascertains that, at farm level, farmers ought to design their enterprises in such a way that, should there be a need to change from one enterprise to another in responses to changes in market demand or weather, they can easily do so with minimum expenses (KIE, 2008). However, this idea is neither covered in details nor is it comprehensively articulated as a

significant strategy to adapt to climate change and variability, thus the need to have it discussed in details.

f) Alternative sources of food

The results pertaining to this sub-topic in Table 6 indicated that 78% of respondents held either positive or very positive perceptions on the relevance of the sub-topic for inclusion in the agriculture syllabus content domain. Of a contrary opinion though, 11% of them recorded negative or very negative perceptions to the suggestion, while a similar percentage of the respondents confirmed neutral perceptions.

From these findings, most respondents gave a positive verdict to the concept on integration of alternative sources of food topic into secondary school agriculture syllabus. Although this concept is not addressed in the secondary school agriculture syllabus content, the reality that Kenya is among food crisis nations with 3.8 million people being food insecure, there is every reason to embrace alternative sources of food (Schmidhuber and Tubiello, 2009). This view is shared by IPCC, (2010) report that the negative impacts of climate change are more severely felt by poor people in the poor countries, as their vulnerability is worsened by their high dependence on natural resources, and their limited capacity to cope with climate variability and extremes. Therefore, alternative food sources sub-topic if integrated into secondary school agriculture syllabus content will not only be significant as an adaptation to climate change, but will also be fundamental to achieve the Millennium Development Goals (MDGs) including over-arching goal of halving extreme poverty by 2015, and sustaining progress beyond 2015 (UNDP, 2000). Therefore, there is a felt need to address the sub-topic in detail in the agriculture syllabus content.

g) Diversification of farm enterprises

The results in Table 6 on this sub-topic revealed that 88% of respondents endorsed either positive or very positive perceptions regarding the sub-topic in relation to the agriculture syllabus content. However, 11% of them held a different view perceiving the suggestion negatively or very negatively. One percent of the respondents returned a neutral verdict to the proposition.

Based on the findings analysis, majority of the respondents perceived the proposal positively. A similar concept is shared in the secondary school agriculture syllabus content, in particular chapter four of form four work “principles of economics” which addresses ways of adjusting to risks and uncertainties. It puts emphasis on setting up several and different enterprises on

the farm so that should one fail, the farmer does not suffer a total loss (KIE, 2008). However, this concept is not comprehensively highlighted, and does not draw attention to its significance as a climate change and variability adaptation strategy, hence the need to make it more comprehensive in the agriculture syllabus revision.

h) The concept of insurance schemes on crops and livestock

The results in Table 6 on response to this sub-topic demonstrated that 71% of the respondents registered either positive or very positive perceptions regarding the sub-topics suitability toward incorporating it to the Agriculture syllabus content. Although 4% of them held negative or very negative perceptions to the idea, as yet another 21% of the respondents gave a neutral verdict.

From the findings analysis, most respondents perceived the suggested sub-topic as within the domain of agricultural education knowledge. A similar concept is mentioned in the present secondary school agriculture syllabus content, particularly in "the principles of agricultural economics" where ways of adjusting farming to risks and uncertainties are discussed. Insurance companies are expected to take the risk of insuring farm machinery, crops and livestock against loss. Farmers ought to pay small amounts of money (premium) as insurance covers to the insurance companies. The cover guarantees them compensation in the event of loss. It covers losses due to crop failure, death of livestock, theft, fire and accidents involving farm machinery (KIE, (2008). However, the idea is not comprehensively addressed as a sub-topic, and does not articulate its significance as an adaptation strategy to climate change, hence the need to expound further on it in the improved agriculture syllabus version.

Similar sentiments are shared in a FAO (2008) report to the effect that agriculture requires efficient and effective ways of managing resources and risks. An example is the System Agro, a multi-peril insurance scheme of India that takes account of the special circumstances of every region and every farm and therefore covers the risks that farmers are actually exposed to. The insurance should be available to all farmers and should preferably be organised in the form of a public-private partnership under central control of governments.

Other relevant sediments are also shared by ECDGARD (2008) report, citing India as an example where the online plat-form E-Choupal insurance scheme, is available for farmers to check market prices, order fertilizers and sell their products. A whole net-work of organisations has been involved in bringing this information together, and as a result millions

of small scale farmers-including those in remote regions-now have access to comprehensive solutions.

i) The concepts of mixed farming, mixed cropping and intercropping

The results in Table 6 on this sub-topic revealed that a total of 87% of the respondents held either positive or very positive perceptions regarding the sub-topic as pertinent to the agriculture syllabus content. Nine per cent held a contrary view (negative or very negative perceptions), and 4% of the respondents had no opinion (were neutral verdict) regarding this statement.

From the findings on this concept, majority of the respondents perceived it positively. The concepts of; mixed-farming, mixed-cropping and intercropping are highlighted in the present agriculture syllabus content. Though as strategies for diversifying farm enterprises to safeguard farmers against total loss should one enterprise fail to succeed. Mixed-farming in "the principles of agricultural economics" chapter four form four work highlights the product-product relationship. This articulates that, farm products can be used to complement each other in such a way that, an increase in the production of one product definitely leads to a simultaneous increase in the production of the other such as in the case of honey and wax (KIE, 2008).

Mixed-cropping and inter-cropping on the other hand are useful conservation measures against erosion as basically cultural control measures (KIE, 2008). Nevertheless, these concepts are not exhaustively addressed in the present syllabus content in the light to adapt to climate change and variability, thus the need to expound on them further in the would-be revised secondary school agriculture syllabus.

j) The concepts of; pre and post-harvest crop management

The results in Table 6 regarding the stated sub-topic were that 89% of the respondents revealed either a positive or very positive perceptions on the sub-topic terming it pertinent to the agriculture syllabus content domain. On the other hand, 7% of the respondents held negative or very negative perceptions with respect to the suggestion, while another four percent of them endorsed a neutral verdict to the proposal.

From the findings, most respondents perceived the concepts of; pre and post-harvest crop management positively regarding its integration into secondary school agriculture syllabus content. This finding agrees with the principles of agricultural economics "physical yield uncertainty". In this type of risk and uncertainty, farmers lack precise knowledge on how much to expect from the crop already in the field due to inevitable pre and post-harvest losses from weather changes, pests and diseases among other losses (KIE, 2008).

Similar sentiments were shared in Saka's (2008) report that, there is need for establishment and creation of food grain reserves at farm and community levels for safe-keeping and storage of harvested produce. There exists a need therefore to make the sub-topic on the concepts of pre and post-harvest more inclusive in the agriculture syllabus content.

k) Overall perceptions

After the perceptions from all the categories on "adaptation strategy sub-topics to climate change in relation to agriculture syllabus content" were computed on average, the results revealed that, the positive or very positive verdicts scored the highest rating with 8.2% of the respondents perceiving the topic valid for integration in the syllabus. Of a different opinion though, 9.3% of the respondents held negative or very negative perceptions on the suggestion, while yet another 8.5% of the respondents registered a neutral verdict on the scheme implying they were unbiased.

4.3.2 Adaptation sub-topics on climate change in relation to teaching resources

Data on the perceptions of respondents toward integration of adaptation strategy sub-topics on climate change in secondary school agriculture syllabus based on their applicability to the agriculture teaching resources are presented in Table 7, followed by explanations and brief discussions on each sub-topic.

Table 7

Adaptation Sub-topics on Climate Change in Relation to Teaching Resources

Sub-topic	Category of scores in Frequencies (F) & Percentages (%)											
	VN		N		U		P		VP		TOTAL	
	F	%	F	%	F	%	F	%	F	%	F	%
a) The meaning and importance of climate change adaptations	2	2	3	3	10	10	34	34	51	51	100	100
b) Adoption of adaptable crops and livestock	0	0	5	5	8	8	37	37	50	50	100	100
c) Adoption of modern technologies on farming	3	3	2	2	7	7	43	43	45	45	100	100
d) Adoption of bio-tech crops and livestock	6	6	7	7	19	19	36	36	32	32	100	100
e) Flexible approaches on farm production methods	1	1	6	6	10	10	41	41	42	42	100	100
f) Alternative sources of food	4	4	3	3	15	15	29	29	49	49	100	100
g) Diversification of farm enterprises	1	1	2	2	10	10	32	32	55	55	100	100
h) The concept of insurance schemes on crops and livestock	3	3	6	6	19	19	42	42	30	30	100	100
i) The concept of mixed farming, mixed cropping and intercropping	1	1	6	6	6	6	39	39	48	48	100	100
j) The concept of pre and post- harvest crop management	2	2	4	4	6	6	32	32	56	56	100	100
Average score per category	**2.3**	**2.3**	**4.4**	**4.4**	**11.0**	**11.0**	**36.5**	**36.5**	**45.8**	**45.8**	**100.0**	**100.0**

a) Meaning of adaptations to climate change

The results in Table 7 on this sub-heading indicated that 85% of the respondents scored either for positive or very positive perceptions on the statement for the integration of the sub-topic into present agriculture syllabus and to have it taught using the existing teaching resources. However, 5% of them upheld negative or very negative perceptions to the suggestion, while another 5% of the respondents scored for neutral perceptions.

Based on the findings, most respondents perceived the idea positively in terms of integrating the sub-topic into secondary school agriculture syllabus. The finding concur with some climatic aspects influencing agricultural production mentioned in Chapter Two of the present form one agriculture syllabus though to a limited scope. Owing to the fact that these climatic aspects are facilitated using the conventional agriculture teaching resources, it implies that adaptation measures to climate change and variability if integrated into the agriculture syllabus will conveniently be taught using the available agriculture teaching resources.

b) Adoption of adaptable crops and livestock

The results in Table 7 regarding this sub-topic revealed that 87% of the respondents either positively or negatively perceived the sub-topic as relevant to be taught by use of the existing agriculture teaching resources. On the other hand, as few as 5% of them scored for negative perceptions to the submission, while 8% of the respondents returned a neutral verdict.

From the findings, it is observable that majority of the respondents confirmed positive perceptions to the proposal to integrate the sub-topic on adoption of adaptable crops and livestock into the present secondary school agriculture syllabus. This concept correlates to the concept on crops ecological requirements featured in Chapter Eight of Form Three Agriculture syllabuses, on "crops production". Better agricultural potential in Kenya is categorized into agro-ecological zones, which determines the crops and livestock species adoptable in each zone. The concept is thus within the agricultural education domain and can conveniently be facilitated using the available agriculture teaching resources.

c) Adoption of innovative agro-technologies in agriculture

The results in Table 7 on this sub-heading indicated that a significant proportion of the respondents, 88%, scored either for positive or very positive perceptions, confirming the sub-topic as viable for implementation within the conventional agriculture programme. Five percent of them returned either negative or very negative perceptions on statements on this

item of inquiry; and another 7% of the respondents were neutral in their assessment of the item.

In view of these findings, majority of the respondents perceived the idea to integrate the sub-topic on adoption of innovative agro-technologies in agriculture into secondary school agriculture syllabus positively. This concept is within the agricultural education field of knowledge. Agriculture being an economic pillar in many Sub-Sahara African nations needs scientific transformation to be in tandem with developed nations; hence the need to borrow innovative agro-technologies, aimed at improving the agricultural education, and in turn developing the agricultural sector. It is, therefore, presumed that the conventional agriculture teaching resources will be handy to facilitate the sub-topic if integrated into the agriculture syllabus.

d) Adoption of bio-tech crops and livestock

The results in Table 7 on this sub-topic indicates that 68% of the respondents registered either positive or very positive perceptions, indicating that this sub-topic is appropriate for incorporation into, and implementation using the existing teaching and other resources in, the present agriculture regime. Thirteen per percent of them, though, either negatively or very negatively perceived of the idea, while another 19% of the respondents returned a neutral perception.

In this regard, majority of the respondents upheld positive perceptions on the idea to integrate the sub-topic on adoption of bio-tech crops and livestock into secondary school agriculture syllabus. The concept is relevant to the agriculture education domain of knowledge. Therefore, in view to this relevancy, the concept on adoption of bio-tech crops and livestock on farming is deemed fit to be taught by the use of the locally available agriculture teaching resources if integrated into the agriculture syllabus.

e) Flexible approaches to agricultural production

The results in Table 7 on this sub-topic revealed that 88% of respondents scored either for positive or very positive perceptions on the statements on this item. On the other hand 7% of them held either negative or very negatively perceptions on this research items; and 10% of the respondents scored were neutral in their perceptions on this item.

From the findings, majority of the respondents perceived the idea of integrating the sub-topic on flexible approaches to agricultural production into the existing secondary school agriculture syllabus positively. This concept concurs with another concept in the present agriculture syllabus on infusing modern techniques to traditional methods of agricultural production such as in upgrading local breeds of cattle with exotic breeds through crossbreeding (KIE, 2008). In view of the fact that this concept is taught by the use of the locally available agriculture teaching resources, it is on the same strength that, this sub-topic if integrated into the agriculture syllabus will be handled using the conventional agriculture teaching resources.

f) Alternative sources of food

The results in Table 7 regarding this sub-heading revealed that 77% of the respondents endorsed either a positive or very positive perceptions to the sub-topic as relevant and capable of being handled using the agriculture teaching resources. However, 7% of them indicated negative or very negative perceptions on the suggestion; and 15% of the respondents registered neutral perceptions.

From this finding, majority of the respondents perceived the idea to integrate the sub-topic on alternative food sources into secondary school agriculture syllabus positively. Agricultural education is basically an education on the basic principles of farming which in turn is a significant source of food for people. Therefore the concept on alternative food sources is deemed ideal to be taught by the use of the locally available agriculture teaching resources if integrated into the syllabus.

g) Diversification of farm enterprises

The results in Table 7 on this sub-topic revealed a large proportion of the respondents, 87%, perceived the sub-topic either positively or very positively in relation to its incorporation and delivery it using the agriculture teaching resources. Only 3% of them registered negative or very negative perceptions on the suggestion, while 10% of them upheld neutral perceptions.

With respect to the findings, majority of the respondents upheld positive perceptions on the idea to integrate the sub-topic on diversification of farm enterprises into secondary school agriculture syllabus. A similar concept is highlighted in the current agriculture syllabus in which diversification of the farm enterprises helps to cushion the farmers from total loss on farm investments. Therefore this subtopic could be taught by use of the already locally

available agriculture teaching resources if integrated into agriculture syllabus.

h) The concept of insurance schemes on crops and livestock

The results in Table 7 on this sub-topic illustrated that 71% of the respondents either positively or very positively perceived of the sub-topic as appropriate to be handled in an ordinary agriculture learning lesson. Only 4% of them negatively perceived of the scheme, while another proportion of 21% of the respondents returned a neutral verdict as their perception on the idea.

Based on these findings, majority of the respondents perceived the idea to integrate the sub-topic on the concept of insurance schemes on crops and livestock into secondary school agriculture syllabus positively. The concept is in line with another one mentioned in the agriculture syllabus as a strategy to cushion the farmers against total loss on farm investments in case of calamities such as fires, diseases, or the outbreak of pests in the farm. Though this concept is not covered exhaustively and in relation to climatic changes and variability, the concept may be facilitated by use of the locally available agriculture teaching resources, if integrated into the Agriculture syllabus.

i) The concepts of mixed farming, mixed cropping and intercropping

The data outcome in Table 7 on this sub-topic indicated that 87% of the respondents scored either for positive or very positive perceptions on the sub-topic as valid to be taught using the convectional agriculture teaching materials. Seven percent, on the other hand, held negative or very negative perceptions on the item's statements while another 6% of the respondents endorsed neutral perceptions.

Based on these findings, majority of the respondents positively perceived of the idea to integrate the sub-topic on concepts of mixed-farming, mixed cropping, and intercropping into secondary school agriculture syllabus. This idea is to be found in the existing agriculture syllabus, albeit to a limited extent. Since this concept is taught by the use of the locally available agriculture teaching resources, should the sub-topic be integrated into the agriculture syllabus, it would befitting of it to be taught using the same agriculture teaching resources.

j) The concepts of pre and post-harvest crop management

The results in Table 7 on this sub-heading indicate that 88% of the respondents endorsed either positive or very positive verdict regarding their perceptions on the sub-topic as relevant to for handling using the available agriculture teaching resources. However, 6% of them registered negative or very negative perceptions on the suggestion while another 6% of the respondents maintained neutral perceptions.

From these findings, majority of the respondents were positive on their perceptions on the integration of the concepts of pre- and post- harvest crop management into the secondary school agriculture syllabus. These concepts are applicable to the agriculture education domain of knowledge. Therefore, with regard to this applicability, the concepts are deemed ideal to be facilitated by the use of the locally available agriculture teaching resources if integrated into the agriculture syllabus.

k) Overall perceptions

When the perceptions from all the categories on "adaptation strategy sub-topics to climate change in relation to the Agriculture teaching resources" were computed on average, it was found that, the positive or very positive verdicts combined had the highest rating. An overwhelming 82.3% of the respondents confirmed the topic as appropriate for integration in the syllabus, implying its relevance for facilitation using the conventional agriculture teaching resources. On the contrary, 6.7% of the respondents had a different view and negatively or very negatively perceived of the suggestion, while another 11% of the respondents returned neutral verdict as their perceptions.

4.3.3 Adaptation sub-topics on climate change in relation to the teaching methods

Data on the perceptions of teachers toward integration of adaptation strategy sub-topics on climate change into secondary school agriculture syllabus with regard to agriculture teaching methods are presented in Table 8, followed by interpretations and brief discussions on each sub-topic.

Table 8

Adaptation Sub-topics on Climate Change in Relation to Teaching Methods

	Category of scores in Frequencies (F) & Percentages (%)											
	VN		**N**		**U**		**P**		**VP**		**TOTAL**	
Sub-topic	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
a) The meaning of adaptations to climate change	5	5	2	2	11	11	34	34	48	48	100	100
b) Adoption of adaptable crops and livestock	2	2	2	2	7	7	40	40	49	49	100	100
c) Adoption of agro-technologies in agriculture	1	1	2	2	14	14	35	35	48	48	100	100
d) Adoption of bio-tech crops and livestock	4	4	8	8	23	23	33	33	32	32	100	100
e) Flexible approaches to agricultural production	2	2	5	5	17	17	33	33	43	43	100	100
f) Alternative sources of food	2	2	7	7	14	14	34	34	43	43	100	100
g) Diversification of farm enterprises	2	2	2	2	9	9	28	28	59	59	100	100
h) The concept of insurance schemes on crops and livestock	6	6	5	5	22	22	36	36	31	31	100	100
i) The concept of mixed farming, mixed cropping and intercropping	1	1	3	3	8	8	38	38	50	50	100	100
j) The concept of pre and post-harvest crop management	2	2	1	1	11	11	33	33	53	53	100	100
Average scores per category	**2.7**	**2.7**	**3.7**	**3.7**	**13.6**	**13.6**	**34.4**	**34.4**	**45.6**	**45.6**	**100.0**	**100.0**

a) The Meaning of adaptations to climate change

The results in Table 8 on this sub-topic indicated that, the highest proportion of the respondents, 82%, either positively or very positively perceived of the sub-topic as relevant

for incorporation into, and for being taught using the agriculture teaching methods. However, 7% of them appeared to hold unfavourable perceptions to the suggestion. Eleven percent of the respondents held neutral perceptions on statements on this research item.

From these findings, most respondents positively or very positively perceived the idea to integrate the sub-topic on meaning of adaptations to climate change into secondary school agriculture syllabus. This idea concurs with the current agriculture syllabus as some climatic aspects influencing agricultural production are already covered in the principles of crops production though to a limited scope. The fact that, these climatic variables are taught through the conventional agriculture teaching methodologies reveal that, adaptation measures to climate change and variability if integrated into the agriculture syllabus, it conveniently will be taught using the available agriculture teaching methodologies.

b) Adoption of adaptable crops and livestock

The results in Table 8 regarding this sub-topic revealed that 89% of the respondents endorsed either positive or very positive perceptions regarding the sub-topic as relevant to be taught by use of the familiar agriculture teaching methods. On the other hand however, 4% of them confirmed negative or very negative perceptions on the submission, while another 7% of the respondents registered neutral perceptions.

From the findings, majority of the respondents perceived the idea to integrate the sub-topic on adoption of adaptable crops and livestock into secondary school agriculture syllabus positively. The concept is within the agricultural education domain as different crop varieties and livestock breeds prefer different ecological requirements to produce optimally. This sub-topic therefore, if integrated into the agriculture syllabus may conveniently be taught using the available agriculture teaching methodologies.

c) Adoption of innovative agro-technologies in agriculture

The results in Table 8 on this sub-topic revealed that 83% of the respondents held either positive or very positive perceptions on the idea regarding the sub-topic as viable for delivery using the conventional Agriculture teaching methods. Only 3% of them held either negative or very negative perceptions on the statements on this item; and 14% of the respondents maintained neutral perceptions.

From these findings, majority of the respondents held positive perceptions on the idea to integrate the sub-topic on adoption of modern technologies on farming into secondary school

agriculture syllabus. The sub-topic is relevant to agricultural education field of knowledge since a robust knowledge and innovative ideas from the Kenya Agricultural Research Centres (KARI) need to be disseminated to the farming communities. Therefore, if these agro-innovative technologies were integrated into secondary school agriculture syllabus, it is perceived they would conveniently be included and facilitated using the available agriculture teaching methodologies.

d) Adoption of bio-tech crops and livestock

The results in Table 8 on this sub-heading indicated that 65% of the respondents held either positive or very positive perceptions in view of facilitating the sub-topic using the agriculture teaching methodologies; 12% of them were either negatively or very negatively predisposed to this item while 23% of the respondents held neutral perceptions.

Majority of the respondents perceived the idea to integrate the sub-topic on adoption of bio-tech crops and livestock into secondary school agriculture syllabus positively. This variable is correlated to another in the present agriculture syllabus that recommends farmers to embrace planting of certified seeds other than obtaining seeds from the previous season's harvest. Consequently, in livestock production, the recommended practice is out-breeding other than in-breeding which has chances of transmitting heritable diseases or defects to the off-springs. Therefore, the concept on adoption of bio-tech crops and livestock on rearing is deemed ideal for incorporation and delivery using of the locally available agriculture teaching methodologies if integrated into the agriculture syllabus.

e) Flexible approaches to agricultural production

The results in Table 8 on this sub-topic indicated that 66% of the respondents registered either positive or very positive perceptions regarding the proposal. On the other hand though, only 7% of them either endorsed negative or very negative perceptions on the proposal, while 17% of the respondents held neutral perceptions on this item.

From these findings, majority of the respondents upheld positive perceptions on the idea to integrate the sub-topic on flexible approaches on farm production methods into secondary school agriculture syllabus. The finding concurs with a variable also addressed in the present agriculture syllabus particularly on adjusting to risks and uncertainties in farming, though to a limited extent. In this view, therefore, this concept was perceived fit for implementation within available Agriculture curriculum regime.

f) Alternative sources of food

The results in Table 8 on this sub-heading indicated that 77% of the respondents held either positive or very positive perceptions on the appropriateness of the sub-topic in relation to the current teaching methodologies in the agriculture subject. Nine percent of them registered negative or very negative perceptions on the suggestion; and 14% of the respondents endorsed neutral perceptions.

On the basis of these findings, most of the respondents perceived the idea to integrate the sub-topic on alternative food sources into secondary school agriculture syllabus positively. This finding was in tandem with the specific objectives of agricultural education particularly on provision of food to the people which is underpinned by economic importance of agriculture to the nation. Therefore, with regard to this importance, the concept on alternative food sources is deemed feasible to be taught by the use of the available agriculture teaching methodologies if integrated into the agriculture syllabus.

g) Diversification of farm enterprises

The results in Table 8 regarding this sub-topic indicated that, a high proportion of the respondents adding up to 87% held positive or very positive perceptions regarding the sub-topic as relevant for facilitation using the agriculture teaching methodologies. Only 2% endorsed negative or very negative perceptions on the suggestion, while 9% of the respondents confirmed neutral perceptions.

Majority of the respondents perceived the idea to integrate the sub-topic on diversification of farm enterprises into secondary school agriculture syllabus positively. This finding is in agreement to ways of adjusting to risks and uncertainties found in the present agriculture syllabus, though to a limited extent. In this view, therefore, this concept was perceived to fit facilitation by the use of the locally available agriculture teaching methodologies.

h) The concept of insurance schemes on crops and livestock

The results in Table 8 on this variable confirmed that 67% of the respondents held positive or very positive perceptions of the sub-topic as appropriate to be taught using ordinary agriculture methods. Eleven percent of them endorsed negative or very negative perceptions on the scheme, and 22% of the respondents were neutral in their perceptions regarding this item.

As per these findings, majority of the respondents endorsed positive perceptions regarding the idea to integrate the sub-topic on the concept of insurance schemes on crops and livestock

into secondary school agriculture syllabus. This is in agreement with a similar variable covered in the present agriculture syllabus though to a less limit and not in line with adaptations to climate change. On this basis therefore, the sub-topic if integrated into the agriculture syllabus will be taught using the same agriculture teaching methodologies.

i) The concepts of mixed farming, mixed cropping and intercropping

The results in Table 8 from this sub-topic established that 88% of the respondents registered either positive or very positive perceptions confirming the sub-topic appropriate to be taught through the agriculture instructional methodologies. Four percent of them had a different opinion and perceived the proposition either negatively or very negatively while 8% of the respondents registered neutral perceptions.

The findings revealed that, a majority of the respondents perceived the idea to integrate the sub-topic on concepts of mixed-farming, mixed cropping, and intercropping into secondary school agriculture syllabus positively. This finding is in tandem with similar ideas also covered in the agriculture syllabus on the ideal agronomic field practices though not in relation of adapting to climate change. Therefore, the perception was that the sub-topic if integrated into the agriculture syllabus would befit facilitation using the conventional agriculture teaching methodologies.

j) The concepts of pre and post-harvest crop management

The results in Table 8 on this sub-topic revealed that, 86% of the respondents either positively or very positively perceived the sub-topic as relevant to be handled using the available agriculture teaching methodologies. However, 3% of them registered a different opinion by endorsing either negative or very negative perceptions to the suggestion, while another 11% of the respondents registered neutral perceptions.

From these findings, majority of the respondents held positive perceptions on the idea to integrate the sub-topic on the concepts of pre- and post- harvest crop management into secondary school agriculture syllabus. The concept is applicable to the agriculture education field of knowledge as the best practices on realization and preservation of agriculture products. Therefore, with regard to this applicability, the concepts are deemed ideal to be taught by the use of the available agriculture teaching methodologies if integrated into the agriculture syllabus.

k) Overall perceptions

After all data on "adaptation strategy sub-topics to climate change in relation to agriculture teaching methods" were computed, the average perceptions on all categories confirmed most respondents that is 80% registered either positive or very positive perceptions on the proposal. This validated the relevance of the topic to be taught using the conventional agriculture teaching methodologies. However, 6.4% of the respondents had different perceptions and thought of the proposal negatively or very negatively, and 13% of the respondent's recorded neutral perceptions.

4.4 Mitigation Strategy Sub-topics against Climate Change

The sub-topics on mitigation measures against climate change were selected by the researcher in consultation with the supervisors and other subject specialists in the department of Agricultural Education and Extension of Egerton University. The major concern was suitability and relevance of these sub-topics for integration into secondary school agriculture syllabus. Three aspects of the existing agriculture syllabus were examined in line with integration of adaptation sub-topics of climate change. These were; the syllabus content, teaching resources, and teaching methodologies.

The mitigation strategy sub-topics on climate change included:

a) Meaning of mitigations against climate change;

b) Carbon sink/disposal creation in farming;

c) Environmental conservation and sustainability;

d) Land reclamation and remediation;

e) Allocation of land to alternative uses e.g. estate development;

f) Soil and water conservation;

g) Water supply, irrigation and drainage;

h) The concept of agro-forestry;

i) The concept of organic farming; and

j) The concept of green economy.

These sub-topics were studied for their suitability for incorporation into secondary school agriculture syllabus with a view to synchronise their coverage within the context of three aspects of the agriculture syllabus. These are: the syllabus content; the available teaching resources; and the conventional agriculture teaching methods.

Objective 2: The perceptions of agriculture teachers toward integrating mitigation strategy topics against climate change in secondary school Agriculture syllabus

This objective sought to determine whether the agriculture teacher's perceptions were positive or negative on the identified climate change mitigation sub-topics proposed for integration into secondary school agriculture syllabus.

The respondents were subjected to a score scale rating questionnaire where they were required to responded by ticking (√) the appropriate degree to which the sub-topic was relevant for positive, neutral or negative perceptions to secondary agriculture syllabus content, teaching resources, and delivery methods. Their perceptions were presumed to have been influenced by the present agriculture syllabus. Scoring was done in accordance to the rating scale ranging between 1 to 5, where; 1 represented Very negative (V.N), 2 - Negative (N), 3 – Neutral (U); 4 – Positive (P) and 5 – Very Positive (V.P).

4.4.1 Mitigation sub-topics on climate change in relation to syllabus content

Data on the perceptions of teachers toward integration of mitigation strategy sub-topics against climate change into secondary school agriculture syllabus with regard to its relevancy to agriculture content are presented in Table 9, followed by interpretations and brief discussions on each sub-topic. Score on 'negative and very negative' were collectively considered as 'negative' perceptions, while those on 'positive and very positive' were likewise collectively referred to as 'positive' perceptions throughout the discussions.

Table 9

Mitigation Sub-topics on Climate Change in Relation to Syllabus Content

Sub-topic	Category of scores in Frequencies (F) & Percentages (%)											
	VN		N		U		P		VN		TOTAL	
	F	%	F	%	F	%	F	%	F	%	F	%
a) Meaning of mitigations against climate change	4	4	4	4	14	14	30	30	48	48	100	100
b) Carbon sink/disposal through farming	1	1	15	15	16	16	40	40	28	28	100	100
c) Environmental conservation and sustainability	3	3	3	3	7	7	37	37	50	50	100	100
d) Land reclamation and remediation	4	4	4	4	7	7	34	34	51	51	100	100
e) Allocation of farm land to other alternative uses e.g. estate development	13	13	17	17	21	21	24	24	25	25	100	100
f) Soil and water conservation	5	5	5	5	5	5	33	33	52	52	100	100
g) Water supply, irrigation and drainage	2	2	7	7	2	2	34	34	55	55	100	100
h) The concept of agro-forestry	5	5	4	4	3	3	38	38	50	50	100	100
i) The concept of organic farming	5	5	2	2	6	6	33	33	54	54	100	100
J) The concept of green economy	8	8	5	5	14	14	33	33	40	40	100	100
Average score per category	**5.0**	**5.0**	**6.6**	**6.6**	**9.5**	**9.5**	**33.6**	**33.6**	**45.3**	**45.3**	**100.0**	**100.0**

a) Meaning of mitigations against climate change

After the data concerning this sub-topic were analysed, the results in Table 9 pointed out that as high as 78% of the respondents who participated in the research exercise either positively or very positively perceived the sub-topic relevant to the agriculture syllabus content. However, 8% of them differed by endorsing negative or very negative perceptions on the suggestion, while 14% of the respondents confirmed neutral perceptions.

Most of the respondents positively perceived the proposition to integrate the sub-topic on the meaning of mitigations against climate change into secondary school agriculture syllabus. The findings were consistent with Chapter Two of the present Form One Agriculture syllabus on "climatic factors influencing agriculture" where some climatic aspects including rainfall, temperature, light, wind, relative humidity have been highlighted (KIE, 2008). However, the coverage of these climatic aspects is brief in scope and breadth, and does not highlight pertinent information on the importance of mitigating climate change impacts on the environment. The positive perception, therefore, to integrate 'mitigation measures against climate change and variability' into agriculture syllabus would enrich this aspect.

b) Carbon sink/disposal through farming

In reference to this sub-topic, the results in Table 9 indicate a high proportion of the respondents, 68%, held either positive or very positive perceptions about the relevance of the sub-topic. Sixteen percent of them endorsed either negative or very negative perceptions on the suggestion; and 16% of the respondents confirmed neutral perceptions.

These findings suggest the largest proportion of respondents positively perceived the idea to integrate the sub-topic on the knowledge of carbon sink/disposal into secondary school agriculture syllabus content. Although no idea on this sub-topic has been highlighted in the present agriculture syllabus, it appears pertinent to agricultural education knowledge. This concurs with FAO's (2010) report that the agriculture sector has the potential to reduce GHGs through incorporation of crop residues into the soil instead of burning, embracing good management of livestock manure to reduce methane emissions, and proper management of nitrogenous fertilizers in rice and upland agricultural soils to reduce nitrous oxide emissions. Therefore, in view of the relevance of the sub-topic to agricultural education's domain of knowledge, it is hoped to significantly contribute enormous gains in mitigating climate change impacts on the agriculture production if integrated to the syllabus.

c) Environmental conservation and sustainability

The results in Table 9 on this sub-heading indicated that a large proportion of the respondents, 87%, registered either positive or very positive perceptions on the sub-topic as viable in relation integrating it to the Agriculture syllabus content. A low 3% of them endorsed negative or very negative perceptions on the proposition, and 7% of the respondents confirmed neutral perceptions.

Based on these findings, many respondents endorsed positive perceptions regarding the idea to integrate the sub-topic on the environmental conservation and sustainability into secondary school agriculture syllabus content. This is in line with a fundamental objective of the secondary school agriculture syllabus that advocates promotion of positive attitudes toward good health and environmental protection. It further concurs with the second broad objective of secondary school agriculture syllabus that emphasises promotion of agricultural activities which enhance environmental conservation (KIE, 2008). In as much as the idea on environmental conservation is highlighted in the current agriculture syllabus, it is deficient in content and construct valid as relevant mitigation measures against climate change impacts.

d) Land reclamation and remediation

The results in Table 9 on the sub-topic revealed that 85% of the respondents registered either a positive or very positive perceptions to the idea that, the sub-topic was suitable in view to integrating it into agriculture syllabus content. Four percent of them held a negative or very negative perception while 7% of the respondents held a neutral perception regarding this item on the questionnaire.

Based on these findings, a high proportion of the respondents perceived the idea to integrate land reclamation and remediation sub-topic in the secondary school agriculture syllabus content positively. Since climate change is impacting negatively on most agricultural land, making it less suitable for farming activities, such wasted lands need to be reconverted back to agricultural production through measures such as soil conservation, irrigation, desalinisation, drainage, fertilizer application, afforestation, and re-afforestation among others. Therefore, the topic if integrated into secondary school agriculture education knowledge may be vital in mitigating climate change and variability impacts.

e) Allocation of farm land to other alternative uses

Concerning this sub-topic, the results in Table 9 revealed that 49% of the respondents held either positive or very positive perceptions on the sub-topic confirming it as appropriate for integration into the agriculture syllabus content. A significant 30% of the respondents held either negative or very negative perceptions while 21% of the respondents held neutral perceptions regarding this item.

From these findings, slightly less than a half of the respondents held positive perception on the notion to integrate the sub-topic on the allocation of land to other uses such as estate development, into secondary school agriculture syllabus. However, more than a quarter of the respondents endorsed negative perceptions on the scheme, and slightly less than a quarter of the respondent's maintained neutral perceptions on the proposal. This implied this concept did not sound logical enough for the respondents to perceive it positively for inclusion to the agriculture syllabus.

f) Soil and water conservation

In view of this sub-topic, the results in Table 9 indicated that, 85% of the respondents either positively or very positively perceived the sub-topic as relevant to the agriculture syllabus content. Ten percent of them either registered negative or very negative perceptions on the suggestion, while 5% of the respondents returned a neutral perception.

As per these findings, a big proportion of the respondents seemed positive to the proposal to integrate soil and water conservation into agriculture syllabus content. Although this topic exists in Chapter Five of the present Form Three secondary school agriculture syllabus, it does not comprehensively articulate significant details on mitigations against climate change and variability. It is hoped if it were reorganised and expounded further in the light of addressing mitigation strategies against climate change and variability, it could be more appropriate and significant than it is in the present context.

g) Water supply, irrigation, and drainage

As revealed in Table 9 on this sub-topic 89% of the respondents held either a positive or very positive perceptions regarding this sub-topic as relevant to the agriculture syllabus content. Nine percent of them differed by endorsing either negative or very negative perceptions while another 2% of the respondents returned a neutral perception.

An overwhelming proportion of respondents seemed to favour the idea to integrate water supply, irrigation and drainage into agriculture syllabus. This was perceived offer a solution to the constrained rain-fed agriculture which currently faces greatest vulnerability from climate change and variability. Although the topic is discussed in the present secondary school agriculture syllabus content, particularly in Chapter Six of Form One syllabus, it does not articulate much significance as a mitigation strategy against climate change and variability. Similar views have also been shared by Saka (2008) who advocated for intensive and extensive use of irrigation water and improved fertilizer use efficiency to counter the effects of droughts, periodic water stress and low soil fertility conditions, improvements in soil management practices to reduce surface runoff and soil erosion and diversifying species as well as intercropping crops with trees to benefit from improved micro-climate and tree products and services.

h) The concept of agro-forestry

The results in Table 9 on this sub-topic pointed out that 88% of respondents held either positive or very positive perceptions on the sub-topic as suitable for infusion into the agriculture syllabus content. Nine percent of them differed by holding negative or very negative perceptions to it while 3% of the respondents held neutral perceptions.

A big proportion of the respondents seemed to score in favour of the proposed sub-topic validating the need for integration of the concept of agro-forestry into agriculture syllabus content. This was perceived to have been influenced by a similar topic already in the current agriculture syllabus, Chapter Thirteen, Form Four syllabus content, even though it does not comprehensively articulate significant details on mitigations against climate change and variability. Similar sentiments were shared by Schneider (2008) who also advocated for planting of tree species in woodlots, forestry plantations, on-farm boundary planting and other agro-forestry systems.

The key climate change mitigation strategies here include biomass-based technologies such as use of wood fuel in improved mud stoves and ceramics, biogas fuel from bio-wastes to produce biogas for cooking and heating, and briquettes for cooking instead of wood. The non-biomass based strategies would include: rural electrification through grid extension; mini-hydropower; compact fluorescent lamps for lighting; and renewable energy sources (solar cookers and heaters) and wind power for pumping water. It is perceived if agro-forestry sub-topic could be reorganised and expounded further in the light of addressing

mitigation strategies against climate change and variability, it would be more appropriate and significant than it is at the present context.

i) The concept of organic farming

The results in Table 9 on this sub-topic indicated that a large proportion of respondents, 87%, reported either positive or very positive perceptions regarding the sub-topic as applicable to the agriculture education domain. Seven percent of them held negative or very negative perceptions while 6% of the respondent's maintained neutral perceptions.

Based on these findings, the highest proportion of respondents held positive perceptions on the idea to integrate the concept of organic farming into agriculture syllabus content. Although this variable was perceived relevant to the secondary school agriculture domain of knowledge, it is scarcely discussed in the present secondary school agriculture syllabus to assume significance in mitigating the environment against climate change and variability. It is perceived if it were expounded on and given prominence in the light of addressing mitigation strategies against climate change and variability, it would present much significance information than in the present context.

j) The concept of green economy

In reference to the results in Table 9 on this sub-topic 73% of respondents held either positive or very positive perceptions regarding the sub-topic in terms of relevance to the agriculture syllabus content. Thirteen percent of them were negative or very negative in their perceptions while another 14% of the respondents held neutral perceptions regarding this item of research.

From these findings, most of the respondents held positive perceptions regarding the notion to integrate the concept of green economy into secondary school agriculture syllabus content. This idea has not been highlighted in the syllabus content, though it is perceived pertinent in the light of the climate change and variability domain of knowledge. Food Agriculture Organization (FAO's (2010) report defines the concept of green economy as the interaction between the environment and economy, which attracts payments for environmental services (PES) including both financial rewards and non-financial incentives such as capacity building and knowledge sharing.

Increased access to information on capacity building and knowledge development and/or funding mechanisms such as Global Environmental Facility (GEF) makes it possible for

efforts that contribute to sustainable environmental development. The sub-topic, therefore, needs to be integrated into secondary school agriculture content as a mitigation strategy against climate change and variability.

k) Overall perceptions

Once the scores from all the categories on "mitigation strategy sub-topics against climate change in relation to agriculture syllabus content" were computed, on average, the findings confirmed high rating for positive perceptions. A 78% of the respondents' positive perceptions make a strong case for the topic's integration in the syllabus. Eleven point six percent of the respondents negatively perceived of the notion while 9.5% of the respondents scored neutral in their perceptions of this variable.

4.4.2 Mitigation sub-topics on climate change in relation to the teaching resources

Data on the perceptions of teachers towards integration of mitigation strategy sub-topics against climate change into secondary school agriculture syllabus with reference to its relevance on the existing agriculture teaching resources are presented in Table 10, followed by interpretations and brief discussions on each sub-topic.

Table 10

Mitigation Sub-topics on Climate Change in Relation to Teaching Resources

	Category of scores in Frequencies (F) & Percentages (%)											
	VN		**N**		**U**		**P**		**VP**		**TOTAL**	
Sub-topic	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
a) Meaning of mitigations against climate change	6	6	3	3	12	12	38	38	41	41	100	100
b) Carbon sink/disposal through farming	2	2	11	11	24	24	36	36	27	27	100	100
c) Environmental conservation and sustainability	3	3	3	3	13	13	31	31	50	50	100	100
d) Land reclamation and remediation	5	5	2	2	11	11	37	37	45	45	100	100
e) Allocation of farm land to other alternative uses e.g. estate development	13	13	15	15	20	20	31	31	21	21	100	100
f) Soil and water conservation	2	2	5	5	10	10	32	32	51	51	100	100
g) Water supply, irrigation and drainage	4	4	5	5	5	5	33	33	53	53	100	100
h) The concept of agro-forestry	2	2	4	4	6	6	38	38	50	50	100	100
i) The concept of organic farming	2	2	3	3	8	8	36	36	51	51	100	100
j) The concept of green economy	3	3	9	9	15	15	27	27	46	46	100	100
Average score per category	**4.2**	**4.2**	**6.0**	**6.0**	**12.4**	**12.4**	**33.9**	**33.9**	**43.5**	**43.5**	**100.0**	**100.0**

a) Meaning of mitigations against climate change

The results in Table 10 on this sub-topic point out that 79% of the respondents endorsed either a positive or very positive perceptions regarding the sub-topic as relevant for teaching via use of the agriculture instructional resources. Nine percent of them endorsed negative or very negative perceptions to the proposal, while another 12% of the respondents held neutral perceptions as their verdict.

A good proportion of the respondents positively perceived the idea as valid for the integration of the sub-topic on meaning of mitigations against climate change into secondary school agriculture syllabus. The presence of some climatic aspects highlighted in the present secondary school syllabus may have influenced this perception. Though the variable is covered to a limited scope, the fact that these climatic aspects are taught through the conventional agriculture teaching resources may automatically have influenced these perceptions. Mitigation measures against climate change and variability, therefore, if integrated into the agriculture syllabus are perceived to be able to be conveniently taught using the available agriculture teaching resources.

b) Carbon sink/disposal through farming

The results in Table 10 on the sub-topic indicated that, 63% of the respondents endorsed either a positive or very positive perceptions terming the sub-topic as relevant, 13% held negative or very negative perceptions, and on the suggestion, 24% of the respondents scored neutral perceptions.

Quite a good number of the respondents gave positive perceptions on the idea to integrate the sub-topic on the carbon sink or disposal through farming into secondary school agriculture syllabus. They confirmed the idea to be relevant to agriculture education knowledge. Therefore, the sub-topic was perceived teachable using the conventional agriculture teaching resources if it were to be integrated into the agriculture syllabus as a mitigation measure against climate change.

c) Environmental conservation and sustainability

The results in Table 10 appertaining this sub-heading indicated that 81% of the respondents held either positive or very positive perceptions regarding the sub-topic as viable for instruction via the available agriculture teaching resources. Three percent of them differed by either endorsed negative or very negative perceptions to the proposition, while 13% of the respondents reported neutral perceptions.

From the findings, majority of the respondents held positive perceptions in support of the idea to integrate the sub-topic on the environmental conservation and sustainability into secondary school agriculture syllabus. The existing secondary school agriculture syllabus may have influenced this perception since the concept is contained in the broad objectives of education as well as secondary school agriculture syllabus. Based on the relevance of the concept in both the educational curriculum as well as in the agriculture syllabus, the sub-topic renders it-self viable to instruction using the available agriculture teaching resources if integrated into the agriculture syllabus as a remedy for climate change impact on the environment.

d) Land reclamation and remediation

The results in Table 10 on this sub-topic revealed that 82% of the respondents upheld either positive or very positive perceptions concerning the idea that the sub-topic was appropriate to be facilitated using the available agriculture instructional resources. On the other hand, 7% of them scored negative or very negative perceptions on the scheme while 11% of the respondents held neutral perceptions.

From the findings, majority of the respondents held positive perceptions in support of the idea to integrate the sub-topic on land reclamation and remediation into secondary school agriculture syllabus. The idea is quite within the agriculture education domain. Therefore, on the basis of this relevancy, the integration of the concept on land reclamation and remediation into secondary school agriculture syllabus is feasible as content may be delivered by the use of the locally available agriculture teaching resources.

e) Allocation of farm land to other alternative uses

The results in Table 10 revealed that, 52% of the agriculture teachers scored positive or very positive perceptions on this sub-topic. Twenty eight percent of them either scored negative or very negative perceptions on the suggestion, and 20% of the respondents held neutral perceptions as their verdict.

Based on these findings, majority of the respondents confirmed positive perceptions in support of the idea to integrate the sub-topic on allocation of farm land to other alternative uses like estate development among others, into secondary school agriculture education knowledge. This finding was anticipated by the researcher as the idea is applicable in the agriculture field of knowledge. Based on this applicability, therefore, the concept on allocation of farm land to other alternative uses like estate development among others was

perceived appropriate to be imparted using the locally available agriculture teaching resources if integrated into the agriculture syllabus.

f) Soil and water conservation

The results in Table 10 on this sub-topic illustrated an overwhelming majority of the respondents, 83%, positively or very positively perceived the sub-topic as relevant within the agriculture domain. Seven percent of them held divergent opinions, negative to very negative or very negative perceptions; and 10% of the respondents held neutral perceptions.

Majority of the respondents endorsed positive perceptions on the idea to integrate the sub-topic on soil and water conservation into secondary school agriculture syllabus. The idea is also discussed in the present agriculture syllabus though not in the light to mitigating climate change phenomena. Based on this view therefore, the concept was perceived as feasible for teaching by use of the locally available agriculture teaching resources.

g) Water supply, irrigation and drainage

The results in Table 10 on this sub-topic were scored in favour for by 86% of the respondents involved in the study, who held positive or very positive perceptions toward the relevance of the sub-topic. Nine percent held negative or very negative perceptions to the suggestion, and 5% of the respondents returned neutral perceptions as their judgment.

From these findings, majority of the respondents positively perceived the plan to integrate the sub-topic on water supply, irrigation and drainage into secondary school agriculture syllabus. This topic is also discussed in the present agriculture syllabus though in a different context other than mitigating the impacts on climate change. Based on the fact that the concept is facilitated using the locally available agriculture teaching resources, it follows that, the proposed sub-topic if integrated into the agriculture syllabus in the light to mitigate climate change impacts, it would conveniently be handled using the same agriculture teaching resources.

h) The concept of agro-forestry

The results in Table 10 on this sub-heading indicated that, 88% of the respondents conducted for the study either positively or very positively perceived the sub-topic as valid to teach it using the conventional agriculture teaching materials. Though, 6% of them registered negative or very negative perceptions to the scheme, while another 6% of the respondents held neutral perceptions.

From these findings, majority of the respondents positively perceived the idea to integrate the sub-topic on the concept of agro-forestry into secondary school agriculture syllabus. This was thought to have been influenced by the present agriculture syllabus since the topic is also discussed though on a different context. It is therefore perceived if the topic were integrated into the agriculture syllabus in view to mitigate climate change impacts on the environment, it would comfortably be handled using the agriculture teaching materials available in secondary schools.

i) The concept of organic farming

The results in Table 10 on this sub-topic indicated that, 87% of the respondents involved in the study either held positive or very positive perceptions terming the sub-topic viable for facilitation using the available agriculture instructional materials. Five percent of them either held negative or very negative perceptions on the proposition, as yet another 8% of the respondents scored neutral perceptions as their decision.

From the findings, most respondents held positive perceptions in support of the idea to integrate the sub-topic on the concept of organic farming into secondary school agriculture syllabus. A similar concept is also discussed in the present agriculture syllabus though to a limited extent. Based on the fact that the concept in the presently taught by the use of the available agriculture teaching resources, it is on the same strength that, if integrated into the agriculture syllabus with the motive to mitigate climate change impacts on the environment, the sub-topic was perceived to be handled using the conventional agriculture teaching resources.

j) The concept of green economy

The data analysis in Table 10 on this sub-topic illustrated 73% of the respondents either registered positive or very positive perceptions terming the sub-topic as pertinent for integration into agriculture syllabus and for facilitation using the existing Agriculture teaching resources. Twelve percent of them held negative or very negative perceptions to the suggestion, while another 15% of the respondents scored neutral perceptions as their verdict.

k) Overall perceptions

Majority of the respondents perceived the idea to integrate the sub-topic on the concept of green economy into secondary school agriculture syllabus positively. This concept is new though it is applicable in the agriculture education discipline. This applicability therefore

implies that, the sub-topic can be taught using the conventional agriculture teaching resources if integrated into the Agriculture syllabus as a mitigation measure against climate change.

When the scores from all the categories on "mitigation strategy sub-topics against climate change in relation to agriculture teaching resources" were computed on average, the positive or very positive perceptions had the highest rating of 77.4%. Ten point two percent of the respondents scored negative or very negative perceptions to the suggestion, while another 12.4% of the respondents held neutral perceptions, implying they were unbiased on the suggestion.

4.4.3 Mitigation sub-topics to climate change in relation to teaching methods

Data on the perceptions of teachers toward integration of mitigation strategy sub-topics against climate change into secondary school agriculture syllabus with regard to facilitate it using the agriculture teaching methodologies are presented in Table 11.

Table 11

Mitigation Sub-topics on Climate Change in Relation to Teaching Methods

	Category of scores in Frequencies (F) & Percentages (%)											
	VN		**N**		**U**		**P**		**VP**		**TOTAL**	
Sub-topic	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
a) Meaning of mitigations against climate change	4	4	5	5	10	10	34	34	47	47	100	100
b) Carbon sink/disposal through farming	2	2	9	9	19	19	46	46	24	24	100	100
c) Environmental conservation and sustainability	3	3	3	3	11	11	37	37	46	46	100	100
d) Land reclamation and remediation	4	4	2	2	14	14	34	34	46	46	100	100
e) Allocation of farm land to other alternative uses e.g. estate development	14	14	15	15	18	18	28	28	25	25	100	100
f) Soil and water conservation	1	1	8	8	7	7	35	35	49	49	100	100
g) Water supply, irrigation and drainage	2	2	7	7	6	6	32	32	53	53	100	100
h) The concept of agro-forestry	1	1	5	5	12	12	29	29	53	53	100	10
i) The concept of organic farming	3	3	3	3	7	7	36	36	51	51	100	1000
j) The concept of green economy	2	2	8	8	10	10	38	38	42	42	100	100
Average score per category	**3.6**	**3.6**	**6.5**	**6.5**	**11.4**	**11.4**	**34.9**	**34.9**	**43.6**	**43.6**	**100.0**	**100.0**

a) Meaning of mitigations against climate change

The results from this sub-topic in Table 11 pointed out that, out of one hundred respondents involved in the study, 81% either held positive or very positive perceptions as their verdict. This confirmed the sub-topic as relevant for teaching via use of the agriculture instructional methods. Nine percent of them scored negative or very negative perceptions on the proposal, while 10% of them held neutral perceptions.

From these findings, majority of the respondents held positive perceptions in support of the idea to integrate the sub-topic on the meaning of mitigations against climate change into secondary school agriculture syllabus. The idea was perceived noble and relevant to the agriculture field of knowledge. Therefore with regard to this relevancy, the sub-topic is considered fit to be taught by the use of the conventional agriculture teaching methodologies if integrated into the agriculture syllabus.

b) Carbon sink/disposal through farming

The results in Table 11 on this idea confirmed 70% of the respondents who participated in the study either held positive or very positive perceptions regarding the sub-topic as relevant. Eleven percent of them scored negative or very negative perceptions on the suggestion, while another 19% of the respondents held neutral perceptions to the idea.

A greater proportion of the respondents perceived the idea to integrate the sub-topic on the carbon sink or disposal through farming into secondary school agriculture syllabus positively. The concept was perceived pertinent to the agricultural education domain of knowledge. Therefore on the basis of this pertinence, the concept on the carbon sink or disposal through farming was thought appropriate for training using the agriculture teaching methodologies if integrated into the agriculture syllabus.

c) Environmental conservation and sustainability

The results in Table 11 on this sub-heading illustrated that, 83% of the respondents either held positive or very positive perceptions on the proposal, confirming the sub-topic is feasible in relation to teaching it through use of agriculture teaching methodologies. Three percent of them either scored negative or very negative perceptions on the proposition, while another 11% of the respondents held neutral perceptions.

From these findings, most of the respondents perceived the suggestion to integrate the sub-topic on environmental conservation and sustainability into secondary school agriculture

syllabus positively. The concept is correlated to the agricultural education knowledge. Therefore, on the basis of this association, the sub-topic on environmental conservation and sustainability was perceived viable to be taught by the use of the common agriculture teaching methodologies if integrated into the agriculture syllabus.

d) Land reclamation and remediation

The outcome concerning this sub-heading in Table 11 confirmed 80% of the respondents to have either held positive or very positive perceptions regarding the sub-topic as suitable to be taught using the agriculture instructional methods. Six percent of them either scored negative or very negative perceptions to the scheme, while 14% of the respondents held neutral perceptions.

A good proportion of the respondents perceived the idea on integrating the sub-topic on land reclamation and remediation into secondary school agriculture syllabus positively. This idea also was perceived applicable to the agriculture domain of knowledge. Therefore, on the basis of this perception, the sub-topic on land reclamation and remediation was deemed ideal to be taught by the use of the conventional agriculture teaching methodologies if integrated into the agriculture syllabus.

e) Allocation of farm land to other alternative uses

The results in Table 11 based on this sub-heading showed 53% of the respondents involved in the study either scored positive or very positive perceptions. This revealed the sub-topic as appropriate in view to facilitate it using the existing agriculture teaching methodologies. Contrary to their view, 29% of them either held negative or very negative perceptions on the opinion, while another 18% held neutral perceptions.

Majority of the respondents perceived the idea to integrate the sub-topic on allocation of farm land to other alternative uses like estate development among others, into secondary school agriculture syllabus positively. The concept was also perceived to be in line with the allocation of natural resources into best utility, which is applicable in the agricultural practices. Therefore, this implied that, the concept on allocation of farm land to other alternative uses like estate development among others was perceived appropriate to be imparted using the common agriculture teaching methodologies if integrated into the agriculture syllabus.

f) Soil and water conservation

Based on Table 11 the results on this sub-topic showed that, 84% of the respondents either scored positive or very positive perceptions confirming the sub-topic relevant to be handled using the agriculture teaching methodologies. Nine percent of them held negative or very negative perceptions on the suggestion, while 7% of the respondents scored neutral perceptions.

In regard to these findings, therefore, majority of the respondents gave positive perceptions in support of the idea to integrate the sub-topic on soil and water conservation into secondary school agriculture syllabus. This finding was also perceived to be in line with a similar topic also discussed in the present agriculture syllabus, though focused on different ideas other than on mitigations against climatic changes. In this regard therefore, the concept was perceived to be fit for facilitation via use of the regular agriculture teaching methodologies if integrated into the agriculture syllabus.

g) Water supply, irrigation and drainage

The results in Table 11 on this sub-heading revealed that, 85% of the respondents either held positive or very positive perceptions terming the sub-topic as relevant in view to teaching it using the common agriculture instructional methodologies. Nine percent of them scored negative or very negative perceptions on the suggestion, while 6% of the respondents conferred neutral perceptions.

A greater proportion of respondents confirmed positive perceptions on the opinion to integrate the sub-topic on soil and water conservation into secondary school agriculture syllabus. This finding may have been influenced by a similar topic in the present agriculture syllabus though it communicates a different opinion from climate change mitigation measures. On this basis therefore, the concept was perceived valid to be taught by use of the commonly practiced agriculture teaching methodologies if integrated into the agriculture syllabus.

h) The concept of agro-forestry

The results in Table 11 on this sub-topic indicated 82% of the respondents either scored positive or very positive perceptions regarding to the idea that, the sub-topic was fit to be taught by use of the universal agriculture teaching methodologies. Six percent of them challenged the opinion by holding negative or very negative perceptions on the scheme, while 12% of the respondents held neutral perceptions as their verdict.

Majority of the respondents perceived the idea to integrate the sub-topic on the concept of agro-forestry into secondary school agriculture syllabus positively. This finding may have been influenced by a similar topic in the present agriculture syllabus though focused on different ideologies other than mitigating climate change. Therefore, based on this, the concept qualified to be taught by the use of the ordinary agriculture teaching methodologies to communicate climate mitigation ideas.

i) The concept of organic farming

The results in Table 11 on this concept revealed that, 87% of the respondents either held positive or very positive perceptions that, the sub-topic befitted being taught using the ordinary agriculture instructional methods. Six percent of the respondents held negative or very negative perceptions to the proposition, while another 7% of them maintained neutral perceptions.

A greater percentage of respondents held positive perceptions in support of the motive to integrate the sub-topic on the concept of organic farming into secondary school agriculture syllabus. This perception may have been influenced by availability of a similar idea in the present chapter two of form one agriculture course outline, though it does not put emphasis on mitigation of climate change. Therefore it was perceived if the sub-topic was integrated into the agriculture syllabus it would befit facilitation using the available agriculture teaching methods.

j) The concept of green economy

The results in Table 11 on this idea indicated that, 80% of the respondents involved in the study either held positive or very positive perceptions that, the sub-topic was relevant. Ten percent of them held negative or very negative perceptions on the suggestion, as another 10% of the respondents held neutral perceptions.

Majority of the respondents held positive perceptions in support of the idea to integrate the sub-topic on the concept of green economy into secondary school agriculture syllabus. The concept was also perceived relevant to the agricultural field of knowledge. This relevancy therefore implied that, the sub-topic befits facilitation using the conventional agriculture teaching methodologies if integrated into the agriculture syllabus as a mitigation measure against climate change.

k) Overall perceptions

Upon computing the average scores from all the categories on "mitigation strategy sub-topics against climate change in relation to agriculture teaching methodologies", the findings revealed either positive or very positive perceptions added up to 78.5%. Those who held negative or very negative perceptions to the suggestion added up to 10.1% on average, while the other 11.4% of the respondents held neutral perceptions.

4.5 Cost-Reduction and Sustainability Strategy Sub-topics from Climate Change

The sub-topics on cost-reduction and sustainability strategy topics on climate change were selected by the researcher in consultation with the supervisors and other subject specialists in the department of Agricultural Education and Extension of Egerton University. The major concern was their suitability and relevance for integration into secondary school agriculture syllabus. Three aspects of the existing agriculture syllabus were examined in line with integration of adaptation sub-topics of climate change. These were; the syllabus content, teaching resources and teaching methodologies.

The cost-reduction and sustainability strategy sub-topics on climate change included:

a) Implications of climate change to the environment;
b) Non-farm ventures e.g. brick-making, sand/stone harvesting;
c) Renewable energy sources from climate change e.g. solar / wind / biogas;
d) Adoption of agro-forestry tree cultivars with multiple uses;
e) Adoption of perennial crops with multiple edible parts;
f) Acquisition of market oriented skills to diversify incomes from farming;
g) Concept of agro-tourism (tourist activity in rural based agricultural communities);
h) Concept of agro-biodiversity (variations of organisms in agricultural ecosystems);
i) The concept of bio-energy production (fuel products from biomass); and
j) The concept of geo-engineering (capturing and recycling co_2 into useful products).

These sub-topics were studied for their suitability for integration into secondary school agriculture syllabus with a view to synchronise their coverage within the context of three aspects of the agriculture programme of study that is; the syllabus content, the available teaching resources and the conventional agriculture teaching methods.

Objective 3: The perceptions of agriculture teachers toward integration of cost-reduction and sustainability strategy topics from climate change in secondary school agriculture syllabus

This objective determined whether the agriculture teacher's perceptions were positive or negative on the identified climate change cost-reduction and sustainability sub-topics proposed for integration into secondary school agriculture syllabus.

The respondents were subjected to a score scale rating questionnaire where they were required to responded by ticking (√) the appropriate degree to which the sub-topic was relevant for positive, neutral or negative perceptions to secondary agriculture syllabus content, teaching resources, and delivery methods. Their Perceptions were alleged to have been influenced by the present agriculture syllabus. Scoring was done in accordance to the Likert's rating scale ranging between 1 to 5, where; 1 represented Very negative (V.N), 2 - Negative (N), 3 – Neutral (U); 4 – Positive (P) and 5 – Very Positive (V.P).

4.5.1 Cost-reduction and sustainability sub-topics on climate change in relation to syllabus content

Data on the perceptions of teachers toward integration of cost-reduction and sustainability strategy sub-topics on climate change into secondary school agriculture syllabus with regard to their relevancy to the agriculture syllabus content are presented in Table 12, followed by interpretations and brief discussions on each sub-topic. Although, score on (negative and very negative) were collectively considered as negative perceptions, while those on (positive and very positive) were referred to as positive perceptions in the discussions.

Table 12

Cost-reduction and Sustainability Sub-topics on Climate Change in Relation to Syllabus Content

	Category of scores in Frequencies (F) & Percentages (%)											
	VN		**N**		**U**		**P**		**VP**		**TOTAL**	
Sub-topic	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
a) Implications of climate change to environment and economy	2	2	5	5	8	8	38	38	47	47	100	100
b) Non-farm ventures e.g. brick making, sand and stone harvesting	9	9	16	16	14	14	32	32	29	29	100	100
c) Renewable energy sources from climate change	3	3	3	3	12	12	36	36	46	46	100	100
d) Adoption of agro-forestry tree species with multiple uses	0	0	4	4	8	8	30	30	58	58	100	100
e) Adoption of crops with multiple edible parts	0	0	8	8	11	11	26	26	55	55	100	100
f) The concept of agro-tourism	1	1	2	2	8	8	35	35	54	54	100	100
g) Acquisition of market oriented skills to diversify incomes from farming	1	1	5	5	18	18	35	35	41	41	100	100
h) The concept of agro-biodiversity	1	1	6	6	15	15	31	31	47	47	100	100
i) The concept of bio-energy production	1	1	7	7	7	7	39	39	46	46	100	100
j) The concept of geo-engineering	4	4	10	10	10	10	30	30	46	46	100	100
Average score per category	**2.2**	**2.2**	**6.6**	**6.6**	**11.1**	**11.1**	**33.2**	**33.2**	**46.9**	**46.9**	**100.0**	**100.0**

a) Implications of climate change to the environment

The results in Table 12 on this idea revealed that, 85% of respondents either held positive or very positive perceptions confirming the sub-topic as correlated to the agriculture knowledge. Six percent of them scored negative or very negative perceptions on the sub-topic, while another 8% of the respondents held neutral perceptions.

From these findings, most of the respondents confirmed positive perceptions toward the view to integrate the sub-topic on the implications of climate change to the environment into secondary school agriculture syllabus content. The sub-topic has similarity to another concept discussed in Chapter Three of the present Form Four agriculture syllabus "sources of power in the farm" where some beneficial avenues to generate energy from climate change impacts including harnessing energy from wind, solar radiation, biomass and water among others have been highlighted (KIE, 2008). However, the coverage of these sources of energy is brief and not correlated to reduction of real-life farm cost it is perceived if further expounded on in the light of cost-reduction and sustainability context, it could improve the farm environment and economy as well.

Similar sentiments were also shared by FAO, (2010) report that, agriculture sector and its support services can be responsive in enhancing carbon sink functions of agricultural soils through zero tillage, soil and water conservation and mixed farming. This translates that, farmers in attempt to reduce climate change impacts on the environment and sustainability of habitable conditions may also attract donor funds such as; carbon credit trade funds, global environmental facility funds and payments for ecosystem services that cushion their economies. This, therefore, implied that, the syllabus needs to be reviewed in order to address cost-reduction and sustainability strategies from climate change impacts.

b) Non-farm ventures

The results in Table 12 show that, 61% of respondents either scored positive or very positive perceptions on the relevancy of the sub-topic to agriculture syllabus perspective. Twenty five percent of them held negative or very negative perceptions to the suggestion, while another 14% of the respondents held neutral perceptions.

From these findings, most respondents scored positive perceptions in support of the idea to integrate the sub-topic on engagement in non-farm ventures such as brick making, sand/stone harvesting among others, into secondary school agriculture syllabus content. Climate change and variability increases the risks and uncertainties involved in farming further from what is tolerable. Therefore, it was perceived farmers who cannot find alternative avenues of livelihoods, but have land, could try quarrying to trade with the resource at their disposal in an attempt to diversify income. The sub-topic was therefore perceived if integrated in the agriculture syllabus content could significantly enlighten farmers on income diversification as a cost-reduction and sustainability strategy from climate change and variability.

c) Renewable energy sources from climate change

Based on Table 12 the respondents' perceptions to incorporate renewable energy sources from climate change the results indicated that, 82% either scored positive or very positive verdicts confirming the sub-topic pertinent to the agriculture syllabus content. Three percent of them either held negative or very negative perceptions to the proposition, while another 12% of the respondents held neutral perceptions.

The findings that most of the respondents confirmed positive perceptions in support of the view to integrate the sub-topic into secondary school agriculture syllabus were consistent with the agricultural education policy to improve and sustain lives of rural dwellers. The idea also concurred with Chapter Three of the present Form Four agriculture syllabus, particularly on "sources of power in the farm" where aspects of harnessing energy from wind, solar radiation, biomass and water among others have been highlighted (KIE, 2008).

Since greenhouse gas emissions (GHGs) into the atmosphere are responsible for global warming and subsequent changes in the climate system, there is a need to identify measures for limiting GHGs into the atmosphere. The solution to this lies in the use of renewable energy from solar, wind and biomass. However, the coverage of these ideas have no bearing on renewable energy sources from climate change, it was perceived if they were further expounded on as alternative sources of energy from climate change phenomena in the light of cost-reduction and sustainability strategy from climate change, it would make a significant improvement to the agriculture syllabus.

d) Adoption of agro-forestry tree species with multiple uses

The outcome in Table 12 on this concept revealed that, a majority of respondents that is 88% either held positive or very positive perceptions to the idea that, the sub-topic was suitable in view to integrate it to the agriculture syllabus content. Four percent of them recorded a different opinion by confirming negative or very negative verdicts on the suggestion, while another 8% of the respondents held neutral perceptions as their judgement.

These findings also concurred with similar information on agro-forestry in the present Form Four Agriculture course outline (KIE, 2008). However, the coverage of this unit is deficient on the matter pertaining to cost-reduction and sustainability. The concept on agro-forestry trees with multiple uses including medicinal value, food, livestock feeds, timber, fuel, shelter, beauty among others therefore, offer pertinent information relevant to agricultural policies and requirements of the rural communities. It therefore, calls for review in order to address

this sub-topic exhaustively as a cost-reduction and sustainability strategy from climate change and variability.

e) Adoption of crops with multiple edible parts

In response to the results in Table 12 on this sub-topic, 81% of respondents either held positive or very positive perceptions that, the sub-topic was appropriate in view to integrate it to the agriculture syllabus content. However, contrary to this view, 8% of them scored negative or very negative perceptions regarding the idea, while another 11% of the respondents scored neutral perceptions.

The findings revealed most of the respondent's perceptions were in support of the view to integrate the sub-topic on adoption of crops with multiple edible parts into secondary school agriculture syllabus. This view was also consistent with one of the secondary school agricultural education importance on provision of food (KIE, 2008). Although the coverage of crops in the present agriculture context has dwelled on production procedures, technology such as grafting, budding and layering application on crops to establish crop species with multiple edible parts. An example is the grafting of tomato and potato where the roots bear potatoes and the shoots bear tomatoes. Therefore, the syllabus was perceived fit for adjustments in order to address such a sub-topic exhaustively as a cost-reduction and sustainability strategy from climate change and variability impacts.

f) Concept of agro-tourism

The results in Table 12 on this sub-heading indicated that, 89% of the respondents involved in the study either scored positive or very positive perceptions confirming the sub-topic relevant to the agriculture syllabus content. However, 3% of them either scored negative or very negative verdicts on perception to the suggestion, while another 8% of the respondents held neutral perceptions.

Majority of the respondents perceived the idea to integrate the sub-topic on concept of agro-tourism into agriculture syllabus content positively. Although this concept is new in the agricultural sector, it was perceived to have been gaining popularity. Consequently, it confers economic relevance in terms of earning the country foreign currency, since one role of agriculture in the economy is to provide foreign exchange through export of agricultural products (KIE, 2008). Agro-tourism simply refers to tourism activity in rural based agricultural communities. Tourism activities include: outdoor activities like fishing, hunting

and horse riding; educational experiences like cannery, tours and cooking classes; entertainment like harvest festivals or barn dances; hospitality services like farm stays and guided tours or outfitter services; as well as on-farm direct sales such as u-pick operations or roadside stands. It was perceived if the sub-topic is expounded and given prominence in the light of cost-reduction and sustainability strategy from climate change and variability, it could present much significance to the agriculture syllabus content.

g) Acquisition of market oriented skills to diversify incomes from farming

The results in Table 12 on response to this sub-topic indicated that, 76% of the respondents either scored positive or very positive perceptions regarding the relevance of the sub-topic to the agricultural education field of knowledge. Six percent of them held negative or very negative perceptions on the suggestion, while another 18% of the respondents scored neutral perceptions.

Most respondents perceived the idea positive in favour to integrate the sub-topic on acquisition of market oriented skills to diversify incomes from farming into agriculture syllabus content. However, such skills are also mentioned in the secondary school agriculture syllabus content particularly in principles of agricultural economics, they are not well articulated in view to addressing cost-reduction and sustainability strategies from climate change impacts. It was therefore perceived if the sub-topic was expounded and given prominence in this light, it could confer much significance than in the present context.

h) The concept of agro-biodiversity

The results in Table 12 on this concept revealed 78% of the respondents to have either perceived the sub-topic positively or very positively in view to include it into the agriculture syllabus content. Seven percent of them scored negative or very negative perceptions on the idea, as yet another 15% of the respondents held neutral perceptions.

Most of the respondents perceived the suggestion on integration of the concept of agro-biodiversity into secondary school agriculture syllabus positively. This was consistent with the agricultural policy to increase animals and plants species to meet people's nutritional requirements. According to Conservation of Biological Diversity (CBD, 2000), agro-biodiversity refers to the variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels, which are necessary to sustain key functions of an agricultural ecosystem.

FAO's (2010) report suggested that measures promoting agro-biodiversity includes improved grasslands, forests and marine ecosystem management. According to some estimates, the potential biodiversity of grasslands is only slightly less than that of forests. Currently, there is evidence that the number of animal and plant species and soil micro-organisms resident in grazing lands grasslands is declining alarmingly due to mismanagement like, land-use change and, more recently, climate change and variability. Besides climate change mitigation, such efforts would also contribute to climate change adaptation and to improved livelihoods for pastoral and agro-pastoral peoples (FAO, 2010). The sub-topic on agro-biodiversity was perceived relevant to agriculture syllabus content. Therefore, based on this relevancy, the sub-topic befitted integration into the syllabus in the light to address cost-reduction and sustainability strategies to climate change and variability.

i) The concept of bio-energy production

The results in Table 12 on this sub-heading indicated that, as many as 85% of the respondents contacted for the survey either held positive or very positive perceptions regarding the sub-topic's applicability to the agriculture syllabus content. Even though, 8% of them scored negative or very negative perceptions on the proposition, as yet another 7% of the respondents indicated neutral perceptions.

The findings confirmed that, most of the respondents perceived the idea positively in view to integrate the sub-topic on the concept of bio-energy production into secondary school agriculture syllabus. This confirmed it was consistency with the principles of agricultural economics in the present agriculture syllabus. The agricultural economic principle puts emphasis on use of scarce and limited resources of land, capital, labour and management to meet unlimited human wants (KIE, 2008). According to Vanzyl *et al.*, (2008), bio-energy refers to sources of energy other than fossil fuels that have reduced carbon emissions. They are derived directly from crops and agriculture, agro-industrial and animal by-products such as dung, maize and soya. This sub-topic was perceived pertinent to an agricultural education policy that advocated on recycling of waste materials for reuse. Therefore, based on this fact, the sub-topic befitted integration into the syllabus in the light to address cost-reduction and sustainability strategies to climate change and variability.

j) The concept of geo-engineering

The results in Table 12 concerning this sub-topic revealed that, 76% of respondents either held positive or very positive perceptions confirming the sub-topic relevant to the agricultural

education field of knowledge. Nonetheless, 14% of them negatively or very negatively perceived of the suggestion, as another 10% of the respondents held neutral perceptions.

From the findings analysis, most of the respondents supported the view on integration of the sub-topic on the concept of geo-engineering into secondary school agriculture syllabus. According to Schneider (2008), geo-engineering refers to philosophical translations being investigated for possible creations of low-carbon economies, such as enhancing removal of excess CO_2 from the atmosphere, reducing the amount of sunlight reaching the ground, recycling CO_2 into fuel through reaction with H_2 or ejecting it from the atmosphere using the planet's magnetic field and deliberately polluting the stratosphere with sulphate in order to reflect solar heat into space. This sub-topic was perceived as pertinent to agriculture syllabus content. Therefore based on this fact, the sub-topic befitted integration into the syllabus in the light to address cost-reduction and sustainability strategies to climate change and variability.

k) Overall perceptions

When the scores from all the categories on "cost-reduction and sustainability strategy sub-topics on climate change in relation to agriculture syllabus content" were computed on average, the results revealed that, 79.1% of the respondents registered positive perceptions. Nevertheless, 8.8% of the respondents held negative perceptions on the idea, as another 11.1% scored neutral perceptions.

4.5.2 Cost-reduction and sustainability sub-topics on climate change in relation to teaching resources

Data on the perceptions of teachers toward integration of cost-reduction and sustainability strategy sub-topics on climate change into secondary school agriculture syllabus with consideration to the existing agriculture teaching resources are presented in Table 13, followed by interpretations and brief discussions on each sub-topic.

Table 13

Cost-reduction and Sustainability Sub-topics on Climate Change in Relation to Teaching Resources

	Category of scores in Frequencies (F) & Percentages (%)											
	VN		**N**		**U**		**P**		**VP**		**TOTAL**	
Sub-topic	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
a) Implications of climate change to environment	4	4	7	7	9	9	36	36	44	44	100	100
b) Non-farm ventures e.g. brick making, sand and stone harvesting	11	11	11	11	19	19	31	31	28	28	100	100
c) Renewable energy sources from climate change	3	3	7	7	9	9	41	41	40	40	100	100
d) Adoption of agro-forestry tree species with multiple uses	2	2	6	6	8	8	38	38	46	46	100	100
e) Adoption of crops with multiple edible parts	3	3	2	2	10	10	42	42	43	43	100	100
f) The concept of agro-tourism	2	2	7	7	8	8	40	40	43	43	100	100
g) Acquisition of market oriented skills to diversify incomes from farming	3	3	10	10	15	15	32	32	40	40	100	100
h) The concept of agro-biodiversity	5	5	6	6	17	17	34	34	38	38	100	100
i) The concept of bio-energy production	4	4	9	9	16	16	30	30	41	41	100	100
j) The concept of geo-engineering	7	7	10	10	18	18	23	23	42	42	100	100
Average score per category	**4.4**	**4.4**	**7.5**	**7.5**	**12.9**	**12.9**	**34.7**	**34.7**	**40.5**	**40.5**	**100.0**	**100.0**

a) Implications of climate change on environment

The results from this sub-topic in Table 13 indicated that, 80% of the respondents either held positive or very positive perceptions to the suggestion. Eleven percent of them had a different opinion and scored negative or very negative perceptions on the suggestion, while another 9% of the respondents registered neutral perceptions.

From the findings, majority of the respondents perceived the suggestion to integrate the sub-topic on the implications of climate change on environment into secondary school agriculture syllabus positively. The idea was thought relevant to the agriculture education field of knowledge. Therefore, with regard to this relevancy, the sub-topic on the implications of climate change on environment was also positively perceived appropriate to be taught by the use of the locally available agriculture teaching resources if integrated into the agriculture syllabus.

b) Engaging in non-farm ventures

The results in Table 13 on this sub-topic indicated that, 59%, slightly more than a half of the respondents either held positive or very positive perceptions. Eleven percent of them had a different opinion and registered negative or very negative perceptions on the suggestion, while another 19% of the respondents scored neutral perceptions.

With respect to the findings, most respondents perceived the idea to integrate the sub-topic on engaging in non-farm ventures such as brick making, sand and or stone harvesting among others into secondary school agriculture syllabus positively. Since farming business is currently faced by numerous risks and uncertainties particularly on climate change and variability. It was thought imperative that farmers who cannot find alternative avenues of livelihoods, but have land, may try quarrying to trade with the resource at their disposal in order to diversify their incomes. The sub-topic therefore, was perceived if integrated in the agriculture syllabus content would befit to be instructed using the usual agriculture instructional resources in secondary schools.

c) Renewable energy sources from climate change

The results in Table 13 on this sub-topic revealed that, 81% of the respondents involved in the study either held positive or very positive perceptions. Ten percent of them either scored negative or very negative perceptions on the proposition, while 9% of the respondents registered neutral perceptions.

The findings that most of the respondents perceived the view on integrating the sub-topic on renewable sources of energy from climate change into secondary school agriculture syllabus positively. This was consistent with agricultural economic policy on minimizing the cost of production to maximize returns. This is alleged to be achievable through use of renewable energies from solar, wind and biogas which don't accrue monthly bills compared to electric and fossil fuel energies.

Besides, fossil fuels also pose significant threat to environmental pollution and ozone layer destruction enhancing GHGs emissions hence global warming that trigger climate change. A similar concept is also mentioned in Chapter Three of Form Four Agriculture syllabus 'sources of power in the farm' where aspects of harnessing energy from wind, solar radiation, biomass and water among others have been highlighted (KIE, 2008). However, the concept does not highlight significant information in relation to climatic adaptation measures. It was therefore perceived positively that, the sub-topic could befit training if integrated into the syllabus on account to cost-reduction and sustainability from climate change, using the common agriculture teaching resources.

d) Adoption of agro-forestry tree species with multiple uses

The results in Table 13 on this concept indicated that, 84% of the respondents either recorded positive or very positive perceptions. On the contrary, 8% of them held negative or very negative perceptions to the suggestion, while another 8% of the respondents registered neutral perceptions.

Based on the findings, a great proportion of the respondents perceived the plan to integrate the sub-topic on adoption of agro-forestry trees with multiple uses into secondary school agriculture syllabus positively. The sub-topic is also in line with a unit on agro-forestry in the present agriculture syllabus (KIE, 2008). Therefore on that basis, integration of agro-forestry trees with multiple uses sub-topic into secondary school agriculture syllabus was perceived fit for instruction using the agriculture teaching resources in secondary schools agriculture departments.

e) Adoption of crops with multiple edible parts

The results in Table 13 on this sub-heading indicated that, 85% of the respondents either scored positive or very positive perceptions. However, 5% of them either, negatively or very negatively perceived of the proposal, while another 10% of the respondents held neutral perceptions.

From these findings, most of the respondents held positive perceptions on the view to integrate the sub-topic on adoption of crops with multiple edible parts into secondary school agriculture syllabus. This is also in line with the principles of crops production practices like grafting and budding discussed in the present agriculture syllabus (KIE, 2008). It was on that basis the sub-topic was perceived appropriate for facilitation using the common agriculture teaching materials if integrated into secondary school agriculture syllabus.

f) The concept of agro-tourism

The results from this concept in Table 13 indicated that, 83% of the respondents either held positive or very positive perceptions. Nine percent of them either recorded negative or very negative perceptions on the suggestion, while 8% of the respondents registered neutral perceptions.

Majority of the respondents perceived the idea to integrate the sub-topic on the concept of agro-tourism into agriculture syllabus content positively. This idea though new in the agriculture education domain, it is beginning to gain popularity as a tourist activity, where agriculturally based operations or activities attracts visitors who may buy products directly from the farm stand, feed and milk livestock, or reside in farm sites. Therefore, it is hoped the sub-topic fits to be conveniently taught using the usual agriculture teaching materials.

g) Acquisition of market oriented skills to diversify incomes from farming

The results from this sub-topic in Table 13 show that, 72% either held positive or very positive perceptions. Nevertheless, 13% of them recorded negative or very negative perceptions on the suggestion, while another 15% of the respondents held neutral perceptions.

Most respondent's perceptions were in favour of the idea to integrate the sub-topic on acquisition of market oriented skills to diversify incomes from farming into agriculture syllabus. Similar skills are mentioned in the present secondary school agriculture syllabus particularly in the unit on agricultural economics, though not in reference to cost-reduction and sustainability from climate change. On this basis therefore, the sub-topic on acquisition of market oriented skills to diversify incomes from farming if integrated into secondary school agriculture syllabus was perceived to fit facilitation using the common agriculture instructional materials.

h) The concept of agro-biodiversity

The results from this concept in Table 13 indicated that, 72% of the respondents involved in the study either held positive perceptions in favour of the sub-topic as appropriate in reference to train it using agriculture teaching resources. Eleven percent of them held negative or very negative perceptions on the scheme, as another 17% of the respondents scored neutral perceptions.

From the findings analysis, most of the respondents confirmed positive perceptions in support of integrating the sub-topic on the concept of agro-biodiversity into secondary school agriculture syllabus. The proposal is consistent with agricultural policy on improvement of the existing species of beneficial plant and animals, as well as breeding new ones. The motive being, to enhance peoples endeavour to meet their unlimited needs by manipulating the limited resources of land, capital, labour and management. This sub-topic was thought relevant in agricultural education field of knowledge. Therefore based on this relevancy, the sub-topic if integration into the secondary school agriculture syllabus in the light to address cost-reduction and sustainability strategies to climate change and variability, was perceived to get facilitation using the agriculture instructional materials available.

i) The concept of bio-energy production

The results in Table 13 on this concept indicated that, 71% of the respondents either scored positive or very positive perceptions. Thirteen percent of them held negative or very negative perceptions on the proposition, as yet another 16% of the respondents recorded neutral perceptions.

The findings revealed most of the respondents perceived the opinion on integration of the sub-topic on the concept of bio-energy production into secondary school agriculture syllabus positively. They thought of it as consistent with the agricultural economic policy that aims at minimising cost at the expense of maximising outputs. The sub-topic is also pertinent to agriculture education knowledge. Therefore, on that basis the sub-topic if integrated into the secondary school agriculture syllabus in the light to address cost-reduction and sustainability strategies to climate change, would conveniently be taught by using agriculture instructional materials available.

j) The concept of geo-engineering

The results from this concept in Table 13 revealed that, 65% of the respondents either scored positive or very positive perceptions. Seventeen percent of them held negative or very negative perceptions on the suggestion, while another 18% of the respondents recorded neutral perceptions.

The findings indicated that, most of the respondents had a positive view on integrating the sub-topic on geo-engineering into secondary school agriculture syllabus. This was consistent with agricultural policy on recycling finite resources for reuse. The concept was in tandem with an economic principle to meet the infinite human needs overtime. The sub-topic therefore was pertinent to the agriculture domain of knowledge. On this basis, the sub-topic if integration into the syllabus in the light to address cost-reduction and sustainability strategies to climate change and variability would qualify to be facilitated using the conventional agriculture instructional materials.

k) Overall perceptions

Finally, the scores from all the categories on "cost-reduction and sustainability strategy sub-topics on climate change in relation to agriculture teaching resources" were computed on average. The results indicated that, the positive or very positive perceptions added up to 75.2%. Eleven point nine percent of the respondents differed with the opinion and scored negative or very negative perceptions on the suggestion, while 12.9% of the respondents held neutral perceptions.

4.5.3 Cost-reduction and sustainability sub-topics on climate change in relation to teaching methods

Data on the perceptions of teachers toward integration of cost-reduction and sustainability strategy sub-topics on climate change into secondary school agriculture syllabus with regard to their relevancy to be facilitated using the conventional agriculture teaching methodologies are presented in Table 14, followed by interpretations and brief discussions on each sub-topic.

Table 14

Cost-reduction and Sustainability Sub-topics on Climate Change in Relation to Teaching Methods

Sub-topic	Category of scores in Frequencies (F) & Percentages (%)											
	VN		N		U		P		VP		TOTAL	
	F	%	F	%	F	%	F	%	F	%	F	%
a) Implications of climate change to environment	2	2	7	7	7	7	39	39	45	45	100	100
b) Non-farm ventures e.g. brick making, sand and stone harvesting	9	9	2	12	18	18	31	31	30	30	100	100
c) Renewable energy sources from climate change	2	2	6	6	10	10	40	40	42	42	100	100
d) Adoption of agro-forestry tree species with multiple uses	0	0	4	4	5	5	37	37	54	54	100	100
e) Adoption of crops with multiple edible parts	1	1	3	3	10	10	30	30	56	56	100	100
f) The concept of agro-tourism	1	1	5	5	7	7	38	38	49	49	100	100
g) Acquisition of market oriented skills to diversify incomes from farming	2	2	9	9	19	19	29	29	41	41	100	100
h) The concept of agro-biodiversity	2	2	8	8	15	15	31	31	44	44	100	100
i) The concept of bio-energy production	3	3	5	5	17	17	32	32	43	43	100	100
j) The concept of geo-engineering	3	3	11	11	18	18	28	28	40	40	100	100
Average score per category	**2.5**	**2.5**	**7.0**	**7.0**	**12.6**	**12.6**	**33.5**	**33.5**	**44.4**	**44.4**	**100.0**	**100.0**

a) Implications of climate change to environment

The results in Table 14 indicated that, 84% of the respondents in the study either registered positive or very positive perceptions. Nine percent of them scored negative or very negative perceptions on the suggestion, while another 7% of the respondents held neutral perceptions.

From these findings, majority of the respondents perceived the idea to integrate the sub-topic on the implications of climate change on environment into secondary school agriculture syllabus positively. The idea is also relevant to the agriculture syllabus since agricultural practices and activities are dependent on prevailing climatic conditions. Therefore, on this basis the sub-topic on the implications of climate change on environment was perceived positive to be taught by the use of the agriculture teaching methodologies.

b) Engagement in non-farm ventures

The results in Table 14 on this proposal indicated that, 61% of the respondents either held positive or very positive perceptions in view to teaching the sub-topic using the Agriculture teaching methodologies. Twenty one percent of them had a different opinion and scored negative or very negative perceptions on the suggestion, while another 18% of the respondents held neutral perceptions.

Based on these finding, most respondents registered positive perceptions in support of the idea to integrate the sub-topic on engaging in non-farm ventures such as brick making, sand and or stone harvesting among others into secondary school agriculture syllabus. Since farming business is faced by numerous risks and uncertainties particularly on climate change and variability. It is expected that, farmers who cannot find alternative avenues of livelihoods, but have land, may try these suggested alternatives in order to diversify their incomes.

c) Renewable energy sources from climate change

The results in Table 14 on this sub-topic indicated that, 82% of the respondents involved in the survey either held positive or very positive perceptions confirming the sub-topic viable in relation to facilitate it using the various agriculture teaching methodologies. Whereas 18% of them either scored negative or very negative perceptions on the proposition, as another 10% of the respondents held neutral perceptions.

The findings that most of the respondents registered positive perceptions in favour of integrating the sub-topic on alternative sources of clean energy from climate change

phenomena into secondary school agriculture syllabus were consistent with the unit on farm power and machinery in the present syllabus. The unit highlights aspects of harnessing energy from wind, solar radiation, biomass and water among others (KIE, 2008). Therefore, based on this relevancy, the sub-topic was perceived to fit facilitation using the conventional agriculture teaching methodologies.

d) Adoption of agro-forestry tree species with multiple uses

The results in Table 14 on this particular sub-topic indicated that, 91% of the respondents either held positive or very positive perceptions confirming the sub-topic suitable in regarding imparting it using the conventional agriculture teaching methodologies. Four percent of them scored negative or very negative perceptions, as yet another 5% of the respondents held neutral perceptions.

From these findings, most of the respondents confirmed their positive perceptions on integrating the sub-topic on adoption of agro-forestry trees with multiple uses into secondary school agriculture syllabus. This was consistent with a unit on agro-forestry in the present secondary agriculture syllabus (KIE, 2008). Therefore on this basis, integration of agro-forestry trees with multiple uses sub-topic into secondary school agriculture syllabus was thought to befit instructing it using the agriculture teaching methodologies.

e) Adoption of crops with multiple edible parts

The results in Table 14 on this sub-heading pointed out that, 86% of respondents either recorded positive or very positive perceptions. However, 4% of them either, scored negative or very negative perceptions on the plan, while another 10% of the respondents held neutral perceptions.

Most of the respondents held positive perceptions in support of the view on integrate the sub-topic on adoption of plants with multiple edible parts into secondary school agriculture syllabus. This was thought consistent with an agricultural principle of adequate food production and sustainability. It is on this basis, therefore, that the sub-topic would befit using the available agriculture teaching methodologies to facilitate it if it were integrated into secondary school agriculture syllabus.

f) The concept of agro-tourism

The results in Table 14 on this sub-topic confirmed 87% of the respondents involved in the survey to either held positive or very positive perceptions qualifying the sub-topic as relevant

for facilitation using the conventional agriculture teaching methods. However, 6% of them either scored negative or very negative perceptions to the suggestion, while another 7% of the respondents held neutral perceptions.

Majority of the respondents positively perceived the idea to integrate the sub-topic on agro-tourism into agriculture syllabus as relevant to agricultural education. This idea could open the minds of rural farmers to not only aim at producing agricultural commodities but also to attract tourists to the farming sites. It was hoped tourists would enjoy adventuring as well as buying fresh agricultural goods directly from the farms and boost farm businesses. Therefore, if the sub-topic were integrated into secondary school agriculture syllabus it was perceived would appropriately accommodate facilitation using the usual agriculture teaching methods.

g) Acquisition of market oriented skills to diversify incomes from farming

The results in Table 14 on this sub-topic indicated that, 70% of the respondents used in the survey either scored positive or very positive perceptions qualifying the sub-topic as relevant in terms of facilitating it using the agriculture convectional teaching methods. Nevertheless, 11% of them registered negative or very negative perceptions on the suggestion, while another 19% of the scored neutral perceptions.

A majority of the respondents perceived the idea to integrate the sub-topic on acquisition of market oriented skills to diversify incomes from farming into agriculture syllabus content positively. Similar skills are mentioned in the present secondary school agriculture syllabus particularly in 'the principles of agricultural economics' though inadequately. On this basis therefore, the sub-topic if integrated into secondary school agriculture syllabus was perceived to fit facilitation using the usual agriculture instructional methods.

h) The concept of agro-biodiversity

The results in Table 14 on this sub-topic indicated that, 75% of the respondents either held positive or very positive perceptions confirming the sub-topic suitable in view to tackle it via the conventional agriculture teaching techniques. Though, 10% of them registered negative or very negative perceptions on the suggestion, as yet another 15% of the respondents held neutral perceptions.

From the findings, most of the respondents favoured the suggestion to integrate the sub-topic on the concept of agro-biodiversity into secondary school agriculture syllabus in their perceptions. This sub-topic is relevant to an agricultural principle that advocates on diversity

of plants species and animal breeds of high economic quality. Therefore, based on this relevancy, the sub-topic if integration into the secondary school syllabus in the light to address cost-reduction and sustainability strategies to climate change and variability, it would befit facilitation using the agriculture instructional methods.

i) The concept of bio-energy production

The results in Table 14 on this sub-heading indicated that, 75% of the respondents used in the survey either scored positive or very positive perceptions terming the sub-topic viable for handling using agriculture teaching methodologies. Even though, 8% of them either held negative or very negative perceptions on the proposition, while 17% of the respondents' registered neutral perceptions.

Most of the respondents perceived the proposal on integrating the sub-topic on the concept of bio-energy production into secondary school agriculture syllabus positively. This concurred with the present agricultural economic concepts on diversification of farm products (KIE, 2008). The advocacy is on production of as many goods and services as there are human needs. Therefore, on that basis the sub-topic if integrated into the secondary school agriculture syllabus in the light to address cost-reduction and sustainability strategies to climate change, would conveniently be taught using agriculture instructional methodologies.

j) The concept of geo-engineering

The results in Table 14 on this sub-heading confirmed that, 68% of the respondents involved in the survey either held positive or very positive perceptions confirming the sub-topic relevant in terms of teaching it using the conventional agriculture teaching methods. Whereas, 14% of them either scored negative or very negative perceptions on the suggestion, while another 18% of the respondents indicated neutral perceptions.

On the basis of the findings, most of the respondents held positive perceptions in view to integrating the sub-topic on the concept of geo-engineering into secondary school agriculture syllabus. This sub-topic is pertinent to agricultural education. Therefore, based on this fact the sub-topic befits integration into the syllabus to address cost-reduction and sustainability strategies on climate change and variability through facilitation using agriculture instructional methodologies.

k) Overall perceptions

Upon computing the average scores from all the categories on "cost-reduction and

sustainability sub-topics from climate change in relation to agriculture teaching methodologies", the results revealed positive or very positive perceptions had the highest rating of 77.9% on average. On the other hand those who held negative perceptions on the suggestion were 9.5% while another 12.6% of them on average scored neutral perceptions.

4.6 Cumulative Perceptions on Integration of Climate Change Topics into the Syllabus

After scoring on the three topics that is adaptations, mitigations and cost-reduction and sustainability on climate change was done, the cumulative perceptions were pooled together and ranked. The ranks were on the basis of; positive, negative or neutral perceptions. The results on this variable are presented in Table 15 followed by briefly discussions.

Table 15

Cumulative Perceptions on Integration of Climate Change Topics into the Syllabus

Rank	**No. of Respondents (n=100)**	**Percent (%)**
Positive	79	79
Negative	10	10
Neutral	11	11
Total	**100**	**100**

When all the scores from the three climate change topics were cumulatively analysed on the basis of their relevance for integration into the agriculture syllabus, the results indicated that, on average 79% of the respondents perceived the proposal positively. Ten percent of the respondents on average had different view and scored negative perceptions on the proposal; as yet another 11% of them indicated neutral perceptions to the suggestion, implying that they had reservations about the proposal.

From the overall findings, the cumulative perceptions by respondents revealed that, an overwhelming majority of the respondents involved in the survey registered positive perceptions on the suggestion to integrate the selected climate change and variability topics into secondary school agriculture syllabus.

This concurred with a major contemporary issue on climate change, currently influencing sustainable agricultural development and a food secure world. Climate change is a significant concern not only in Kenya but globally. According to FAOs (2008) report, the world cannot safeguard its food supplies if it is unable to adapt to climate change and variability, and it

may not adapt to the climate change unless agricultural education is allowed to play a central role. Therefore, integration of the proposed topics into secondary school agriculture syllabus if implemented are perceived to be an achievement toward secondary school agriculture syllabus review to conform to the changing climate and create peoples resilience against the negative impacts.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMEDATIONS

5.1 Introduction

The chapter presents the summary of the key findings, conclusions and recommendations for the study. The summary captures the problem, the research methodology of the study and the study outcome. The conclusion section presents the major conclusions drawn from the findings of the study. Lastly, the recommendation presented was for implementation and further research.

5.2 Summary

Agriculture sector is a major contributor to the economic development in Sub-Sahara Africa. Over the past few decades, however, the sector's contribution to the Gross Domestic Product has been on the decline. A number of factors seem to trigger this decline. These factors are assumed to include; human factors, biotic factors, soil factors and climate change and variability. In the wake of the last quarter of the 20^{th} Century, climate change is documented as the single most challenge to the worlds' agriculture and allied sectors, Sub-Sahara Africa being the most vulnerable. This is because Africa exclusively depends on natural resources for livelihoods including fisheries, wildlife, forestry and farming.

There can be no meaningful agricultural development unless climate change and variability is brought under control, and climate change cannot be brought under control unless agriculture is allowed to play a central role in removal of the greenhouse gas emissions from the atmosphere. To tackle the escalating climate change, therefore, each country ought to find appropriate solutions pertinent to its socio-economic endowments to secure and sustain agricultural production. Socio-economic endowments encompass the proportionate allocation of resources with respect to community's everyday life, integrated to educational curricula.

Education is critical in preparing individuals to become functional and productive members of the society in which they live. Education is a link between people's lives and the contemporary societal challenges. To address climate change and variability, therefore, the education system must be cross examined in relation to contemporary issues. Further, the subjects / disciplines constituting the curricula should be cross-examined for their relevance with contemporary issues in the society. In this line of thought, climate change and variability vulnerability to agricultural development was focused in this study. Agricultural education is

presumed to be a precursor to the agricultural development. The inception of agriculture curriculum in secondary school aimed at developing the agriculture sector through equipping learners with skills and knowledge on the basic principles of farming.

Farming provides people with; food, employment, market for industrial goods, raw materials for industries and foreign exchange. To meet these goals, however, agriculture syllabus ought to conform to contemporary issues by curtailing the soaring climate change and variability. Inadequacy of the agriculture syllabus to adapt, mitigate and make use of the opportunities from climate change bars the agriculture curriculum from meeting its key objectives. This in turn translates to inconsistencies in responding to the farmers' needs. The problem this study sought to solve therefore was the lack of capacity by the existing secondary school agriculture syllabus to transmit relevant skills and knowledge in response to climate change and variability effects. The purpose of the study was to determine the perceptions of agriculture teachers toward the integration of selected climate change topics in secondary school agriculture syllabus, in order to control its effects on agricultural production.

The study focused on the agriculture teachers under the Teachers Service Commission employment since they were 'information rich' in relation to the study objectives. To create resilience to the rural people whose livelihoods exclusively depends on farming. Pertinent climate issues need to be considered in line with integrating them into the agriculture curriculum. Climate change is responsible for the intensifying global warming resulting to declining agricultural, forestry, wildlife, and fisheries productivity.

The intensifying climate change and variability is increasingly threatening to undercut the gains so far contributed by secondary school agriculture syllabus by adding up the risks and uncertainties on agricultural productivity. This in turn has translated to increased food insecurity and over dependency on donor countries for food and non-food agricultural commodities. If the knowledge from the robust growing literature on climate change is well understood and integrated into the present agriculture syllabus, it could make the syllabus deal with the contemporary issues pertinent to the changing climate. The selected climate change topics studied in this context included; adaptations, mitigations and cost-reduction and sustainability strategies from climate change.

The study was on opinion review that used a descriptive survey research design convey the findings. The target population consisted of secondary school agriculture teachers under TSC employment. They were preferred for their expertise on the present secondary school

agriculture curriculum which was assumed to influence their perceptions on the subject matter under study. A sample size of 100 respondents was obtained through a non-probability sampling method known as purposeful or subjective sampling technique.

The major findings of the study were as follows:

i) Majority of the respondents that is, 80% registered positive perceptions toward integration of adaptation topic on climate change into agriculture syllabus, authenticating the use of the common agriculture teaching resources and methodologies to facilitate it.

ii) Similarly, a high proportion of the respondents adding up to 78.5% perceived the idea to adopt mitigation topic against climate change into agriculture syllabus positively also validating the relevance of agriculture teaching materials and methodologies to impart it.

iii) Subsequently, most respondents amounting to 77.9% recorded positive perceptions on integration of the suggested cost-reduction and sustainability topic on climate change into agriculture syllabus, endorsing the reliability of teaching resources and delivery methods to teach it.

Cumulatively, a major segment of the respondents that is 79% registered positive perceptions pertaining to incorporation of the three climate change topics into secondary school agriculture syllabus, qualifying the current agriculture teaching resources and methodologies to impart them.

5.3 Conclusions

The main conclusions drawn from the key findings of the study indicated that:

i) The selected climate change topics were relevant to the current secondary school agriculture content.

ii) The existing agriculture teaching resources to facilitate climate change topics are relevant.

ii) The contemporary agriculture teaching methodologies for climate change topics are suitable.

The integration of the three climate change topics (adaptations, mitigations and cost-reduction and sustainability) into the agriculture syllabus need to be considered for implementation in line with the study findings. This is hoped to enhance its ability to confer

knowledge necessary to revitalize the agriculture sector from the escalating climate change impacts. Consequently, it is hoped to enable farmers to utilize the robust knowledge in agro-technologies to improve farm productivity. This also creates resilience by opening a window for business opportunities for farmers to diversify their incomes by adjusting farm practices to the inevitable climatic changes.

5.4 Recommendation

The recommendation drawn from the conclusions of the study was that, the agriculture teachers should strengthen use of agriculture teaching methodologies for climate change related topics.

5.5 Recommendations for Further Research

i) This study should be replicated in other regions to examine the perceptions of agriculture teachers toward integration of climate change topics in secondary school agriculture syllabus.

ii) There is a need to conduct another study to establish the economic (financial) implications toward integrating the climate change topics into secondary school agriculture syllabus.

iii) There is need for a study on the extend of integration of climate change topics at primary and tertiary level institutions.

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APPENDICES

APPENDIX A

SYNOPSIS OF SECONDARY SCHOOL AGRICULTURE SYLLABUS

FORM ONE

1.0.0 Introduction to Agriculture

1.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Define agriculture;
b) State the main branches of agriculture;
c) Describe farming systems;
d) Explain the role of agriculture in the economy and demonstrate an appreciation of its importance to the country; and
e) Demonstrate an appreciation for the wide and varied opportunities in agriculture.

2.0.0 Factors Influencing Agriculture

2.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Explain the human factors influencing agriculture;
b) Explain biotic factors influencing agriculture;
c) Explain how climatic factors influencing agriculture;
d) Define soil;
e) Describe the process of soil formation;
f) Describe soil profile;
g) Determine soil constituents;
h) Classify soils by physical characteristics;
i) Explain chemical properties of soils; and
j) Relate crop and livestock distribution to soils in different regions.

3.0.0 Farm Tools and Equipment

3.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Identify various farm tools and equipment;
b) Name parts of various farm tools and equipment;
c) Describe the use of various tools and equipment;
d) Carry out maintenance practices on tools and equipment; and
e) Demonstrate an appreciation for care and maintenance of tools.

4.0.0 Crop Production I (Land Preparation)

4.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Explain the importance of land preparation;
b) Describe the various types of cultivation;
c) Relate cultivation operation to correct tools and implements; and
d) Prepare a piece of land ready for crop production.

5.0.0 Water Supply, Irrigation and Drainage

5.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) State the sources of water for the farm;
b) Describe collection, storage, pumping and conveyance of water;
c) Describe water treatment and explain its importance;
d) Define irrigation;
e) Explain the importance of irrigation;
f) Describe methods of irrigating land;
g) List the equipment used in irrigation;
h) Grow a crop through irrigation;
i) Carry out maintenance on irrigation equipment and facilities;
j) Define drainage;
k) Explain the importance of drainage;
l) Describe the methods of drainage;
m) Explain how agriculture activities pollute water and how this can be prevented; and
n) Demonstrate an appreciation for clean water in farming and life in general.

6.0.0 Soil Fertility 1 (Organic Manures)

6.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Define soil fertility;
b) Explain how soil fertility can be maintained;
c) Describe how soil loses fertility;
d) Define and distinguish organic matter, manure and humus;
e) Explain the importance of organic matter in the soil;
f) Describe the different organic manures;

g) Prepare compost manure; and
h) Demonstrate a caring attitude towards soils.

7.0.0 Livestock production I (Common Breeds)

7.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Name the various livestock species;
b) Define the terms livestock, breed and type;
c) Describe the various breed characteristics;
d) State the origin of various livestock breeds;
e) Classify the various breeds into types;
f) Name the external parts of the various livestock species; and
g) Demonstrate an appreciation of the socio-economic value of livestock.

8.0.0 Agricultural Economics I (Basic Concepts and Farm Records)

8.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Define economics and agricultural economics;
b) Explain basic concepts of economics;
c) Describe the importance of agricultural economics;
d) Explain the importance of farm records;
e) Describe the different types of farm records; and
f) Keep farm records.

FORM TWO

9.0.0 Soil Fertility II (Inorganic Fertilizers)

9.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) List the essential elements;
b) Classify the essential elements;
c) State the role of each macro-nutrient;
d) Describe the deficiency symptoms of the macro-nutrients;
e) Identify and classify fertilizers;
f) Describe the properties of various fertilizers;
g) Describe soil sampling and testing procedures;

h) Use appropriate methods of fertilizer application;
i) Calculate fertilizer application rates; and
j) Explain how soil acidity and alkalinity affect crop production.

10.0.0 Crop Production II (Planting)

10.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) State the correct planting materials for various crops;
b) Select and prepare planting materials;
c) Determine the optimum time of planting;
d) State the factors which determine the depth of planting;
e) Describe the planting procedures for different crops;
f) State the factors that determine seed rate, spacing and plant population;
g) Calculate plant population; and
h) Demonstrate an appreciation for economical use of land.

11.0.0 Crop Production III (Nursery Practices)

11.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Describe a nursery bed;
b) Distinguish between a nursery bed, a seedling bed and a seed bed;
c) State the importance of a nursery bed;
d) Select a suitable site for a nursery bed;
e) Prepare a nursery bed;
f) Manage a nursery bed;
g) Transplant crops from a nursery bed;
h) Bud a seedling;
i) Graft a seedling;
j) Explain the importance of budding, grafting, layering and tissue culture; and
k) Describe damage caused by animals on tree seedlings and how to prevent it.

12.0.0 Crops Production IV (Field Practices)

12.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Define crop rotation;

b) State the importance of crop rotation;
c) Draw a crop rotation programme;
d) Distinguish terms used in crop farming;
e) State the importance of mulching in crops production;
f) Describe the importance of various field practices in crop production;
g) Carry out various field practices;
h) State the correct stage for harvesting various crops; and
i) Describe harvesting practices for various crops.

13.0.0 Crop Production V (Vegetables)

13.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Grow a vegetable crop from nursery establishment to harvesting;
b) Keep crop production records;
c) Market farm produce; and
d) Demonstrate an appreciation of agriculture as an economically lucrative activity.

14.0.0 Livestock Health I (Introduction to Livestock Health)

14.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Define health and disease;
b) Describe signs of sickness in animals;
c) State the predisposing factors of livestock diseases;
d) Categorize animal diseases;
e) Carry out disease control practices;
f) State the importance of maintaining livestock healthy; and
g) Demonstrate a caring attitude towards livestock.

15.0.0 Livestock Health II (Parasites)

15.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Describe the host-parasite relationship;
b) Identify different parasites;
c) Describe the life-cycle of parasites; and
d) Explain methods of parasite control in livestock.

16.0.0 Livestock Production II (Nutrition)

16.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Identify and classify livestock feeds;
b) Describe digestion and digestive systems of cattle, pig and poultry;
c) Define terms used to express feed values;
d) Compute a livestock ration;
e) Prepare balanced ration for various livestock; and
f) Demonstrate a caring attitude towards livestock.

FORM THREE

17.0.0 Livestock Production III (Selection and Breeding)

17.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Describe reproduction and reproductive systems;
b) Selection of breeding stock;
c) Describe breeding systems;
d) Identify signs of health in livestock;
e) Describe methods used in serving livestock; and
f) Demonstrate a caring attitude towards livestock.

18.0.0 Livestock Production IV (Livestock Rearing Practices)

18.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Describe livestock rearing practices;
b) Carry out livestock rearing practices; and
c) Demonstrate a caring attitude towards livestock.

19.0.0 Farm Structures

19.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Describe parts of a building;
b) Identify materials for construction;
c) Describe various farm structures and their uses;
d) Describe siting of various structures; and
e) Construct and maintain farm structures.

20.0.0 Agricultural Economics II (Land Tenure and Land Reform)

20.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Define the term tenure;
b) Describe tenure systems; and
c) Describe land reform.

21.0.0 Soil and Water Conservation

21.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Define soil erosion;
b) Explain the various factors that influence erosion;
c) List the agents of erosion;
d) Describe the various types of erosion;
e) Describe the various methods of erosion control;
f) Demonstrate a caring attitude towards soil and water;
g) Carry out soil control measures;
h) Describe water harvesting and conservation techniques;
i) Describe micro-catchments and their uses; and
j) Design and construct a micro-catchment.

22.0.0 Weeds and Weed Control

22.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Define a weed;
b) Identify weeds;
c) Classify weeds;
d) Explain the characteristics which make the weeds competitive;
e) Describe ways of controlling weeds;
f) State harmful effects of weeds;
g) Control weeds; and
h) Exercise safety measures to oneself, to crops and to the environment while controlling weeds.

23.0.0 Crop Pests and Diseases

23.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Define pest and disease;
b) State the main causes of crop diseases;
c) Describe the harmful effects of crop pests and diseases;
d) Identify and classify some of the common pests and diseases;
e) Carry out general disease and pest control measures; and
f) Demonstrate a caring attitude towards the environment while controlling pests and diseases.

24.0.0 Crop Production VI (Field Practices)

24.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Describe management practices for a given crop production;
b) Carry out management practices for a given crop; and
c) Demonstrate an appreciation of agriculture as an economically lucrative activity.

25.0.0 Forage Crops

25.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Define and classify pastures;
b) Identify forage crops;
c) Describe the ecological requirements of forage crops;
d) Describe the establishment and management of pastures and fodder; and
e) Describe forage utilization and conservation.

26.0.0 Livestock Health III (Diseases)

26.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Describe causes and vectors of main livestock diseases;
b) State the incubation period ;
c) Describe the signs of each disease;
d) State the predisposing factors where applicable;
e) Carry out simple control measures of livestock diseases; and

f) Demonstrate a caring attitude towards livestock.

FORM FOUR

27.0.0 Livestock Production V (Poultry)

27.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Identify parts of an egg;
b) Select eggs for incubation;
c) Identify suitable sources of chicks;
d) Describe broodiness and natural brooding;
e) Describe brooder and brooder management;
f) Describe conditions necessary for artificial incubation;
g) Describe rearing systems;
h) Describe the feeding for each age and category of poultry;
i) Identify stress and vices;
j) State the causes of stress and vices in poultry;
k) State the effects of vices and stress in poultry;
l) State control measures of vices and stress;
m) Describe marketing of eggs and poultry meat;
n) Select, sort and grade eggs for marketing; and
o) Demonstrate an appreciation of poultry production as an economically lucrative activity.

28.0.0 Livestock Productive VI (Cattle)

28.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Raising young stock;
b) Demonstrate a caring attitude towards livestock;
c) Describe milk by its components;
d) Describe milk secretion and let-down;
e) Milk using correct procedure and technique;
f) Describe marketing of beef cattle and milk; and
g) Demonstrate an appreciation of cattle production as an economically lucrative activity.

29.0.0 Farm Power and Machinery

29.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Describe various sources of power in the farm;
b) Describe various systems of tractor;
c) Describe the various tractor implements, their uses and maintenance;
d) Describe the various animal drawn implements, their uses and maintenance; and
e) Describe tractor service and maintenance practices.

30.0.0 Agricultural Economics III (Production Economics)

30.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Explain various parameters of national development;
b) Relate national development to agricultural production;
c) State the factors of production and explain how each affects production;
d) Describe how the law of diminishing returns relates to agricultural production;
e) Describe agricultural planning and budgeting in a farm business.
f) State sources of agricultural support services; and
g) Describe risks and uncertainties in farming and explain ways of adjusting to risks and uncertainties.

31.0.0 Agricultural Economics IV (Farm Accounts)

31.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) State the importance of farm accounts;
b) Distinguish and describe the various financial documents and their uses;
c) Prepare and analyze financial statements; and
d) Identify various books of accounts and their uses.

32.0.0 Agricultural Economics V (Agricultural Marketing and Organizations)

32.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Define market and marketing;
b) Describe the various types of markets;
c) Describe how the law of supply and demand affects the prices of agricultural products;

d) State various marketing functions, agents and institutions;
e) Identify problems in marketing of agricultural products;
f) List various agricultural organizations; and
g) Describe the role of each of the agricultural organizations.

33.0.0 Agroforestry

33.1.0 Specific objectives

By the end of the topic, the learner should be able to:

a) Define agroforestry;
b) State the importance of agroforestry;
c) Describe various forms of agroforestry;
d) Explain the importance of trees;
e) Select appropriate trees for different uses;
f) Describe tree nursery management and transplanting;
g) Explain routine tree management;
h) Select appropriate sites for trees in the farm and other areas; and
i) Describe various methods of tree harvesting (KIE, 2008).

APPENDIX B

PROPOSED CLIMATE CHANGE TOPICS

FORM ONE

Climate Change I (Introduction to Climate Change and Variability)

Specific objectives

By the end of the topic, the learner should be able to:

a) Define climate change;
b) Explain the components of climate change;
c) Describe the implications of climate change to agriculture;
d) Explain the implications of climate change on the economy;
e) Describe global warming;
f) Identify the impacts of climate change on the environment;
g) State the effects of climate change on agriculture;
h) List the aspects of climate change;
i) Distinguish between climate change and climatology; and
j) Explain how climatic factors influence agriculture.

FORM TWO

Climate Change II (Adaptations to Climate Change)

Specific objectives

By the end of the topic, the learner should be able to:

a) Explain adaptations to climate change;
b) Identify adaptable crops and livestock to the school environment;
c) Explain bio-tech crops and livestock;
d) State innovative agro-technologies in agriculture;
e) State flexible approaches to agricultural production;
f) Identify alternative sources of food;
g) Explain the diversification of farm enterprises;
h) State insurance policies available to farmers;
i) Explain mixed farming; and
j) State pre and post-harvest crop management practices.

FORM THREE

Climate Change III (Mitigations against Climate Change)

Specific objectives

By the end of the topic, the learner should be able to:

a) Explain mitigations against climate change;
b) Explain how farming creates carbon sinks;
c) State environmental conservation and sustainability measures:;
d) Describe land reclamation and remediation;
e) Explain ways in which land can be put into alternative uses;
f) Demonstrate caring attitude towards soil and water resources;
g) Describe collection, storage, pumping and conveyance of water;
h) Identify the significance of agroforestry;
i) Explain organic farming; and
j) Explain the importance of green economy.

FORM FOUR

Climate Change IV (Cost-reduction and Sustainability)

Specific objectives

By the end of the topic, the learner should be able to:

a) State the implications of climate change to the environment;
b) List ways in which land can be put under non-farming ventures;
c) Identify sources of renewable energy from climate change impacts;
d) Identify agroforestry trees with multiple uses;
e) State perennial crops with multiple edible parts;
f) Identify sources of water in the farm;
g) State ways in which people can adjust to diversify incomes from farming;
h) Describe agro-tourism;
i) Explain agro-diversity; and
j) Describe geo-engineering.

APPENDIX C

QUESTIONNAIRE FOR AGRICULTURE TEACHERS

Introduction

The bearer of this questionnaire is a Ph.D. student in the Department of Agricultural Education and Extension (AGED/AGEX), Faculty of Education and Community Studies (FEDCOS), Egerton University. The questionnaire seeks to gather information from secondary school Agriculture teachers.

Instructions

The purpose of this questionnaire is to gather information on the perceptions of teachers towards the implications of integrating selected climate change topics in secondary school Agriculture syllabus in Machakos County, Kenya. You are kindly requested to study and reflect on the following proposed climate change components in order to give informed perceptions on the subject matter. The proposed unit is hoped to be spread over the four year secondary school cycle that is from form one to form four:

Topic 1: Introduction to climate change and variability (proposed for integration into Form 1 Agriculture syllabus).

Sub-topics: -The meaning of climate change and variability
-The components of climate change
-Significance of climate change to agriculture
-Implications of climate change on the economy
-The concepts of global warming
-Impacts of climate change on environment
-Effects of climate change on agriculture
-Aspects of climate change e.g. floods, droughts, heat and frost etc
-The concept of climatology
-The climatic factors influencing farming

Topic 2: Adaptations to climate change (proposed for integration into Form 2 Agriculture syllabus).

Sub-topics: -The meaning of adaptations to climate change;
-Adoption of adaptable crops and livestock;
-Adoption of bio-tech crops and livestock;
-Adoption innovative agro-technologies in agriculture;

-Flexible approaches to agricultural production;

-Alternative sources of food;

-Diversification of farm enterprises;

-The concept of insuring crops and livestock;

-The concept of mixed farming; and

-The concept of pre and post-harvest crop management.

Topic 3: Mitigations against climate change (proposed for integration into Form 3 Agriculture syllabus).

Sub-topics: -Meaning mitigations against climate change

-Carbon sink/disposal creation in farming

-Environmental conservation and sustainability

-Land reclamation and remediation

-Allocation of land to alternative uses e.g. estate development

-Soil and water conservation

-Water supply, irrigation and drainage

-The concept of agro-forestry

-The concept of organic farming

-The concept of green economy (interaction between environment and economy)

Topic 4: Cost-reduction and sustainability against climate change (proposed for integration into Form 4 Agriculture syllabus).

Sub-topics: -Implications of climate change to the environment

-Non-farm ventures e.g. brick-making, sand/stone harvesting

-Renewable energy sources from climate change e.g. solar/wind/biogas

-Adoption of agro-forestry tree cultivars with multiple uses

-Adoption of perennial crops with multiple edible parts

-Acquisition of market oriented skills to diversify incomes from farming

-Concept of agro-tourism (tourist activity in rural based Agricultural communities)

-Concept of agro-biodiversity (variations of organisms in Agricultural ecosystems)

-The concept of bio-energy production (fuel products from biomass)

-The concept of geo-engineering (capturing and recycling co_2 into useful products)

The projected amendments are that; some units like soil fertility (organic manures and inorganic fertilizers), and water supply, irrigation and drainage both covered in Form One and Two; and soil and water conservation, and agro-forestry both taught in Form Three and Four respectively, will form integral parts of the main climate change and variability unit.

You are kindly required to answer all the questions in this questionnaire as honestly as possible, for your contribution may be of great value to Agriculture syllabus improvement for secondary schools in Kenya. Your identity will remain confidential. Your assistance will be highly appreciated.

a) Background information of the respondent

1. Please indicate by ticking (√) in the box provided the needed information in the section below:

i) Name of the Sub-county in which the school is located.....

ii) Age category? ≤30 years [ ]; 30-40 years [ ]; ≥40 years [ ]

iii) Gender? Male [ ]; Female [ ]

iv) Teaching experience? ≤5 years [ ]; 5-10 years [ ]; ≥10 years [ ]

b) Adaptation strategy topic on climate change

2. Please indicate by ticking (√) in the blank spaces provided, your degree of perception on the integration of the adjacent adaptation strategy sub-topics on climate change into Agriculture **syllabus content**, using the following rating scale:

1=VN (Very Negative); 2=N (Negative); 3=U (Neutral); 4=P (Positive); 5=VN (Very Negative)

Sub-topic	**Rating score**				
	5	**4**	**3**	**2**	**1**
The meaning adaptations to climate change					
Adoption of adaptable crops and livestock					
Adoption of innovative agro-technologies in agriculture					
Adoption of bio-tech crops and livestock					
Flexible approaches to agricultural production					
Alternative sources of food					
Diversification of farm enterprises					

The concept of insurance schemes on crops and livestock					
The concept of mixed farming, mixed cropping and intercropping					
The concept of pre and post-harvest crop management					

3. Please indicate by ticking (√) in the blank spaces provided, your degree of perception on the integration of the adjacent adaptation strategy sub-topics on climate change into Agriculture **syllabus teaching resources**, using the following rating scale:

1=VN (Very Negative); 2=N (Negative); 3=U (Neutral); 4=P (Positive); 5=VN (Very Negative)

Sub-topic	**Rating score**				
	5	**4**	**3**	**2**	**1**
The meaning of adaptations to climate change					
Adoption of adaptable crops and livestock					
Adoption of innovative agro-technologies in agriculture					
Adoption of bio-tech crops and livestock					
Flexible approaches to agricultural production					
Alternative sources of food					
Diversification of farm enterprises					
The concept of insurance schemes on crops and livestock					
The concept of mixed farming, mixed cropping and intercropping					
The concept of pre and post-harvest crop management					

4. Please indicate by ticking (√) in the blank spaces provided, your degree of perception on the integration of the adjacent adaptation strategy sub-topics on climate change into Agriculture **syllabus teaching methods**, using the following rating scale:

1=VN (Very Negative); 2=N (Negative); 3=U (Neutral); 4=P (Positive); 5=VN (Very Negative)

Sub-topic	**Rating score**				
	5	**4**	**3**	**2**	**1**
The meaning adaptations to climate change					
Adoption of adaptable crops and livestock					
Adoption of innovative agro-technologies in agriculture					
Adoption of bio-tech crops and livestock					
Flexible approaches to agricultural production					
Alternative sources of food					

Diversification of farm enterprises					
The concept of insurance schemes on crops and livestock					
The concept of mixed farming, mixed cropping and intercropping					
The concept of pre and post-harvest crop management					

c) Mitigation strategy topic

5. Please indicate by ticking (√) in the blank spaces provided, your degree of perception on the integration of the adjacent mitigation strategy sub-topics on climate change into Agriculture **syllabus content**, using the following rating scale:

   1=VN (Very Negative); 2=N (Negative); 3=U (Neutral); 4=P (Positive); 5=VN (Very Negative)

Sub-topic	**Rating score:**				
	5	**4**	**3**	**2**	**1**
Meaning of mitigations against climate change					
Carbon sink/disposal through farming					
Environmental conservation and sustainability					
Land reclamation and remediation					
Allocation of farm land to other alternative uses e.g. estate development					
Soil and water conservation					
Water supply, irrigation and drainage					
The concept of agro-forestry					
The concept of organic farming					
The concept of green economy					

6. Please indicate by ticking (√) in the blank spaces provided, your degree of perception on the integration of the adjacent mitigation strategy sub-topics on climate change into Agriculture **syllabus teaching resources**, using the following rating scale:

   1=VN (Very Negative); 2=N (Negative); 3=U (Neutral); 4=P (Positive); 5=VN (Very Negative)

Sub-topic	**Rating score:**				
	5	**4**	**3**	**2**	**1**
Meaning of mitigations against climate change					
Carbon sink/disposal through farming					
Environmental conservation and sustainability					
Land reclamation and remediation					

Allocation of farm land to other alternative uses e.g. estate development					
Soil and water conservation					
Water supply, irrigation and drainage					
The concept of agro-forestry					
The concept of organic farming					
The concept of green economy					

7. Please indicate by ticking (√) in the blank spaces provided, your degree of perception on the integration of the adjacent mitigation strategy sub-topics on climate change into Agriculture **syllabus teaching methods**, using the following rating scale:

   1=VN (Very Negative); 2=N (Negative); 3=U (Neutral); 4=P (Positive); 5=VN (Very Negative)

Sub-topic	**Rating score:**				
	5	**4**	**3**	**2**	**1**
Meaning of mitigations against climate change					
Carbon sink/disposal through farming					
Environmental conservation and sustainability					
Land reclamation and remediation					
Allocation of farm land to other alternative uses e.g. estate development					
Soil and water conservation					
Water supply, irrigation and drainage					
The concept of agro-forestry					
The concept of organic farming					
The concept of green economy					

d) Cost-reduction and sustainability strategy topic

8. Please indicate by ticking (√) in the blank spaces provided, your degree of perception on the integration of the adjacent cost-reducing and sustainable strategy sub-topics on climate change into Agriculture **syllabus content**, using the following rating scale:

   1=VN (Very Negative); 2=N (Negative); 3=U (Neutral); 4=P (Positive); 5=VN (Very Negative)

Sub-topic	**Rating score**				
	5	**4**	**3**	**2**	**1**
Implications of climate change to environment					
Non-farm ventures e.g. brick making, sand and stone harvesting					
Renewable energy sources from climate change e.g. solar/wind/biogas					

Adoption of agro-forestry tree species with multiple uses					
Adoption of perennial crops with multiple edible parts					
The concept of agro-tourism					
Acquisition of market oriented skills to diversify incomes from farming					
The concept of agro-biodiversity					
The concept of bio-energy production					
The concept of geo-engineering					

9. Please indicate by ticking (√) in the blank spaces provided, your degree of perceptions on the integration of the adjacent cost-reducing and sustainable strategy sub-topics on climate change into Agriculture **syllabus teaching resources**, using the following rating scale: 1=VN (Very Negative); 2=N (Negative); 3=U (Neutral); 4=P (Positive); 5=VN (Very Negative)

Sub-topic	**Rating score**				
	5	**4**	**3**	**2**	**1**
Implications of climate change to environment					
Non-farm ventures e.g. brick making, sand and stone harvesting					
Renewable energy sources from climate change e.g. solar/wind/biogas					
Adoption of agro-forestry tree species with multiple uses					
Adoption of perennial crops with multiple edible parts					
The concept of agro-tourism					
Acquisition of market oriented skills to diversify incomes from farming					
The concept of agro-biodiversity					
The concept of bio-energy production					
The concept of geo-engineering					

10. Please indicate by ticking (√) in the blank spaces provided, your degree of perceptions on the integration of the adjacent cost-reducing and sustainable strategy sub-topics on climate change into Agriculture **syllabus teaching methods**, using the following rating scale: 1=VN (Very Negative); 2=N (Negative); 3=U (Neutral); 4=P (Positive); 5=VN (Very Negative)

Sub-topic	**Rating score**				
	5	**4**	**3**	**2**	**1**
Implications of climate change to environment					
Non-farm ventures e.g. brick making, sand and stone harvesting					
Renewable energy sources from climate change e.g. solar/wind/biogas					
Adoption of agro-forestry tree species with multiple uses					

Adoption of perennial crops with multiple edible parts					
The concept of agro-tourism					
Acquisition of market oriented skills to diversify incomes from farming					
The concept of agro-biodiversity					
The concept of bio-energy production					
The concept of geo-engineering					

APPENDIX D

REQUEST LETTER FOR RESEARCH PERMIT

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254-020-2213471, 2241349, 254-020-2673550
Mobile: 0713 788 787 , 0735 404 245
Fax: 254-020-2213215
When replying please quote
secretary@ncst.go.ke

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: **NCST/RCD/14/013/1615**

Date **13th September, 2013**

Stephen Kyalo Mutiso
Egerton University
P.O Box 536
Egerton

RE: RESEARCH AUTHORIZATION

Following your application dated ***30th August, 2013*** for authority to carry out research on "***Perceptions of Teachers towards the Implications of integrating selected climate change topics in secondary school Agriculture syllabus in Machakos County, Kenya.***" I am pleased to inform you that you have been authorized to undertake research in **Machakos County** for a period ending **30th November, 2014.**

You are advised to report to **the County Commissioner and County Director of Education, Machakos County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

SAID HUSSEIN
FOR: SECRETARY/CEO
NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Copy to:

The County Commissioner
The County Director of Education
Machakos County.

"The National Council for Science and Technology is Committed to the Promotion of Science and Technology for National Development".

APPENDIX E

RESEARCH AUTHORIZATION LETTER FROM NACOSTI

00EGERTON UNIVERSITY
Tel: Pilot: 254-51-2217620
254-51-2217877
254-51-2217631
Dir.line/Fax: 254-51-2217847
Cell Phone

P.O. Box 536 - 20115
Egerton, Njoro, Kenya
Email: bpgs@egerton.ac.ke
www.egerton.ac.ke

OFFICE OF THE DIRECTOR GRADUATE SCHOOL

Ref: ED11/0384/12 Date: 22nd August, 2013

The Secretary,
National Council of Science and Technology,
P. O. Box 30623-00100
NAIROBI.

Dear Sir,

RE: REQUEST FOR RESEARCH PERMIT – MR. STEPHEN KYALO MUTISO – REG. NO. ED11/0384/12

This is to introduce and confirm to you that the above named student is in the Department Agricultural Education and Extension, Faculty of Education and Community studies, Egerton University.

He is a bona-fide registered PhD student in this University. His research topic is "**Perceptions of Teachers Towards the implications of Integrating Selected Climate Change Topics in Secondary School Agriculture Syllabus in Machakos County, Kenya".**

He is at the stage of collecting field data. Please issue him with a research permit to enable him undertake the studies.

We have enclosed all the necessary documentation required for your necessary action.

Yours faithfully,

for **Prof. M.A. Okiror**
DIRECTOR, BOARD OF POSTGRADUATE STUDIES

DIRECTOR, BOARD OF POST GRADUATE STUDIES
22 AUG 2013
EGERTON UNIVERSITY P. O. Box 536, EGERTON

Encl.

MAO/cwk

Egerton University is ISO 9001:2008 Certified

APPENDIX F

RESEARCHER'S IDENTIFICATION

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 00185

CONDITIONS: see back page

PAGE 2

THIS IS TO CERTIFY THAT:
Prof./Dr./Mr./Mrs./Miss/Institution
Stephen Kyalo Mutiso
of (Address) Egerton University
P.O Box 536, Egerton.
has been permitted to conduct research in

Location
Machakos District
County

on the topic: Perceptions of Teachers towards the Implications of integrating selected climate change topics in secondary school Agriculture syllabus in Machakos County, Kenya.

for a period ending: 30th November, 2014.

PAGE 3

Research Permit No. *NCST/RCD/14/013/1615*
Date of issue *13th September, 2013*
Fee received *KSH. 2000*

Applicant's Signature

For: Secretary
National Commission for Science
Technology & Innovation

APPENDIX G

RESAERCH AUTHORIZATION LETTER FROM OFFICE OF THE PRESIDENT

OFFICE OF THE PRESIDENT
MINISTRY OF INTERIOR AND COORDINATION OF NATIONAL GOVERNMENT

Telephone: 21009 and 21983 – 90100
Email Add: countycommasaku@gmail.com
Fax No. 044-21999
When replying please quote

County commissioner
P.O. Box 1 - 90100
MACHAKOS.

Ref. No.ADM 15/31 VOL.V/205

20th September 2013

TO WHOM IT MAY CONCERN

RE: RESEARCH AUTHORIZATION

This office has authorized Stephen Kyalo Mutiso to carry out a research on "***Perceptions of teachers towards the implications of integrating selected climate change topics in secondary school agriculture syllabus in Machakos County, Kenya.***"

The purpose of this letter is therefore to introduce him to and request you to accord him the necessary assistance.

DISTRICT COMMISSIONER
MACHAKOS

J.K. MAGUTA
For: COUNTY COMMISSIONER
MACHAKOS

APPENDIX H

RESEARCH AUTHORIZATION LETTER FROM MOEST

MINISTRY OF EDUCATION, SCIENCE &TECHNOLOGY

Telegrams: "**SCHOOLING**" Machakos
Telephone: Machakos (
Fax: Machakos
Email –cdemachakos@yahoo.com
When replying please quote

OFFICE OF THE
COUNTY DIRECTOR OF
EDUCATION
P.O. BOX 2666-90100,
MACHAKOS

Ref. No . MKS/ED/CD/U/1/16

23rd September,2013

Stephen Kyalo Mutiso
Egerton University
P.O.Box 536
Egerton

RE: RESEARCH AUTHORIZATION

Following your letter dated 13th September,2013 on the above subject, authority is hereby granted to undertake research in Machakos county.

It is important you report to the head teacher of the concerned schools in the area of your research.

COUNTY DIRECTOR OF EDUCATION
MACHAKOS COUNTY
DATE 23/9/2013
P.O. Box 28-90100, MACHAKOS

Hellen Muriuki
For: County Director of Education
Machakos

APPENDIX I

A MAP OF MACHAKOS COUNTY SHOWING THE SUB-COUNTIES/DISTRICTS