INTEGRATION OF CLIMATE SMART AGRICULTURE IN SUPPORTERS IN KIAMBU DAIRY VALUE CHAIN AND IN KNOWLEDGE SUPPORT SYSTEMS.

A Research Project submitted to Van Hall Larenstein University of Applied Science in partial fulfillment of the requirements for the award of a Master's Degree in Agricultural Production Chain Management Specializing in Livestock Chains.

BY CATHERINE NAMBOKO WANGILA

September 2018

This research has been carried out as part of the project "Climate Smart Dairy in Ethiopia and Kenya" of the professorships "Dairy Value Chain" and "Sustainable Agribusiness in Metropolitan Areas".

Velp, The Netherlands

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DEDICATION

To the Almighty God for His sufficient grace, to my children Edwin, Mercy, Enock Emmanuel, family members, dear friend Romano, spiritual leaders and friends for their support, patience, encouragement and unmeasurable assistance offered while struggling to finish my studies. I am proud of you all. God bless all of you

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Acronyms

EQUIVALENTS: 1 Euro equivalent to approximately KShs 114.00 (August 2018)

3R	Robust, Resilient and Reliable
ASDSP	Agricultural Sector Development Support Program of Kenya
BAC	Baraka Agricultural college
CCAFS	Climate Change, Agriculture and Food Security Program
CGIAR	Consultative Group on International Agricultural Research
CIRCLE	Climate impact research capacity and leadership enhancement programme
CREATE	Community Resilience Against Environmental Threats
CSA	Climate smart agriculture
DTI	Dairy Training Institute
FAO	Food Agriculture Organization of United Nations
GDP	Gross domestic product
GHGs	Greenhouse Gas emissions
GIZ	Gesellschaft für Internationale Zusammenarbeit
ICCA	The Institute of Climate Change and Adaptation
ICRAF	World Agroforestry Centre
ILRI	International Livestock Research Institute
KALRO-	Kenya Agriculture and Livestock Research Organization
KCSAPK	Kenya Climate Smart Agriculture Project for Kenya
MoALF	Ministry of Agriculture, Livestock and Fisheries
NAMA	National Adaptation Mitigation Action
SNV	Netherlands Development Organization
TIMPS	Technology innovation management practices.
VCs	Value Chains
VMGs	Vulnerable marginalized groups
WMI	Wangari Maathai Institute of peace and Environmental studies.

ABSTRACT

Climate change is a major hindrance to global sustainable development. The well being of future generations is facing critical environmental challenges. The effect of globalization in terms of economic, social and technological changes have been rapid and have left human beings behind schedule yet hunger is a persistent disaster to millions of human beings. The agriculture sector in Kenya is identified as a significant contributor to the national economic growth, the livestock sector employees over sixty percent of the population. The majority of farmers in the livestock sector are small-scale farmers. The sub-sector is dominated by small-scale farmers estimated at 1.8 million farmers and 500 large scale farmers that are vulnerable to effects of climate change and are huge contributors to climate change. Approximately ninety-eight percent of the agricultural production in Kenya is rain-dependent and are prone to many challenges including greenhouse gas production, population pressure and increased sensitivity to climate change impacts and variability. To mitigate against the effects of climate change and enhance agricultural productivity, the adoption of Climate Smart Agriculture (CSA) has been identified as a practical alternative.

The theme of the study is to determine the contribution of public, private and knowledge supporters in Kiambu county dairy value chain and in knowledge institutions in integrating climate smart Agriculture practices and recommend proper realignment to up- scale it. The study was carried between 28 June 2018 -30 August 2018. 32 respondents were interviewed from knowledge Institutions and one focus group from Githunguri cooperative society and nine developmental partners.

Findings showed that most of the respondents interviewed were aware of climate smart agriculture technologies. Most of the knowledge institutions had no unit/course in the curriculum with courses on climate smart agricultural technologies except Egerton university, Institute of climate change and Baraka college. Dairy training Institute, Ahiti Ndomba, Nairobi University (Animal production) practiced CSA technologies on their livestock farms which included paddocking, manure utilization and carbon sinks.

Among the developmental partners 3 R, and Netherlands developmental organization had done up-scaling activities specifically on fodder production, feed challenges, quality payment procurement and promotion of renewable energy and the study concludes that good work has been done on fodder production especially maize silage, little was achieved on renewable energy -17,000 bio digesters nationally and quality payment has not worked well due to many challenges and fewer incentives for quality milk.

Other developmental organization included ILRI and KALRO with projects on climate smart agricultural practices-low emission analysis, adaptation and mitigation in the formation phase while on fodder and breeding strategies findings indicate successful training of trainers and fodder demonstrations by KALRO Naivasha and improved Sahiwal cows at Naivasha but not in quantitative analysis. KCSAP and NARIGP have climate smart projects that have laid a foundation on climate technologies in 45 counties in Kenya and actual work not installed. Women are in, input supply (sales), quality control testing, Milk ATMs, old women in production while youth are in ICT-cow signal programme, in hubs, roads- shows and consultancy in Performer.

I concluded that much needs to be done on up-scaling, hence concerted efforts from all stakeholders and recommendations are directed to small-scale farmers, knowledge Institution and linkages, studies and Research and extension relationship.

CHAPTER 1: INTRODUCTION

1.1. Background Information

1.1.1 Overview of Climate Change

Climate change is a critical environmental challenge threatening the welfare of the present and future generations. The effect of globalization in terms of economic, social and technological changes have been rapid and have left human beings way advanced yet food insecurity is a persistent disaster to millions of people (Ministry of Agriculture, Livestock and Fisheries and Ministry of Environment and Natural Resources, 2015). According to Williamson (2016), there is an urgent need to reduce global temperature rise to below 2^{o}C .

Globally the livestock sector has been identified as a substantial contributor to GHGs (Leichenko and O'Brien, 2008). Emissions excluding Land-Use Change and Forestry though it can also be a remedy of the required mitigation efforts. Africa as a continent is equally affected as the livestock is internationally connected. Kenya has been under weather extremities in the past fifty years leading to severe impacts on human beings and the livestock sector hence reduction in agricultural productivity. The sector's emissions are evident and greatest in beef and cattle milk production then feed production and processing, enteric fermentation, manure management, and least emitter is animal products processing and transportation.

In Kenya, significant economic growth is projected to come from the agricultural sector. Given that an overwhelming percentage of the agricultural production was rain-fed, it is vulnerable to the harmful effects of climate change which puts in danger the projected economic boom. As noted by MoALF and MoENR (2015) the temperature would rise about 2.3 degrees by 2050 and there would be a 1-degree rise by 2020. These changes will affect the rain-fed agricultural system, especially in arid and semi-arid. This further increases the levels of poverty and food insecurity since the agricultural output from the farms will be significantly reduced. There is a need for new innovative means for combating the effects of climate change.

To mitigate against the effects of climate change and enhance agricultural productivity, the adoption of Climate Smart Agriculture (CSA) has been identified as a practical alternative. Various regional bodies such as DFIF and COMESA are at the forefront of developing programs towards achieving CSA. The programs seek to promote smart agricultural practices that are in line with Kenya's vision 2030. One such program is the "Country CSA Program for 2015-2030" (MoALF & MoENR, 2015). The goal of the program is to increase food security and promote national development. The success of the country programs depends on the dedication of all the stakeholders to ensure improved standards of living for all citizens. There is a need for all the concerned stakeholders to implementation affordable and effective measures in combating the challenges of climate change.

1.1.2. Kenyan Dairy Sector

The dairy industry in Kenya is among the largest in Africa and is most rapidly expanding dairy sub-sectors. The sub-sector is dominated by small-scale farmers keeping exotic dairy breeds and few large-scale farmers (Wambugu, Kirimi, and Opiyo, 2011). The current milk production stands at 7.6 billion kgs (Behnke and Muthami, 2011) from different livestock species and milk consumption is anticipated to increase to 4.7 billion kgs by 2018 (MoALF,

2013). Kenyans are the highest milk consumers in the developing world, an estimated 198 kgs per person per annum (Wambugu, Kirimi, and Opiyo, 2011).

Almost 98% of agricultural systems in Kenya are rain-fed and are susceptible to many challenges including greenhouse gas production, population pressure, inefficient resource, low production capability and increased susceptibility to the effects of climate change and variability (MoALF & MoENR, 2015). There is a need for the sector to critically consider scale up climate smart agriculture to increase food efficiency and productivity and lower the GHG emissions.

1.1.3. Supporters in the Dairy Sector

Kenya has initiated national development strategies that promote productivity and climate resilient projects nationally through the National Dairy Master plan, Vision 2030, National Climate Change Action Plan, the Climate-Smart Agriculture Framework programme and the private sector National Adaptation Mitigation Action working with the government in the dairy industry to enhance productivity, climate resilient and lower emissions. NAMA supports the development of the institutional framework and financing mechanisms, at farm level and extension services and employs scientific technology in monitoring, reporting and verification (MRV) approach in line with international climate agreements. In the implementation of climate-smart business models on the farm, the project checks and promotes increased gender equity in promoting dairy development. The project targets to scale up 1.8 million households but currently, over 600,000 livestock producers have been reached. NAMA works in closer collaboration with ICRAF and UNIQUE leads with other international and Kenyans Institutions targeting to reduce 3.3% of its 2010 emissions and create 180,000 jobs per annum (World Agroforestry Centre (ICRAF) and International Livestock Research Institute (ILRI), 2015). In the study, supporters include knowledge institutes, TVET colleges, government ministries, and 10 developmental organizations: 3 R. Agriprofocus, SNV, KCSAP, NARIGP, ADSP who are engaged in Livestock sector at various levels.

1.2. Scope of the study.

The research was carried out in Kiambu county, in seven knowledge Institution, and in nine developmental partners and it's on integration climate smart agriculture. The sub-county in the study area is Githunguri while the knowledge Institutions include Dairy Training Institute, AHITI-Ndomba, and Baraka college, Universities- Egerton, Nairobi-Animal production, Institute of Climate change adaptation and Wangari Maathai and partners were SNV, SDCP, ILRI, KALRO, Agri-profucus, performer, NARIGP, KCSAP, and ASDSP. The population targeted are supporters in Kiambu, the staff of knowledge institution and staff in developmental partners. The dairy cattle population in Kiambu is estimated at 230,292 dairy cattle producing a 334M kg of milk (County Government Of Kiambu, 2017).

1.3. Justification of the study

The increased activities in the livestock production systems in Kiambu and in the knowledge Institution implies more emissions, results to losses of nitrogen (N), energy and organic matter which is a challenge to efficient production of the sector to achieve to food security, reduce emissions and protect environmental footprint. Though there are efforts by the sector supporters to ensure the existing and promising mitigations are implemented not much success has been achieved. Many studies have been conducted in the livestock sector on GHG emissions in Kenya but little success on up-scale of climate smart agriculture hence a gap that this study intends to fill by identifying alternative strategies through which the sector supporters in Kiambu and in the knowledge system can implement to scale up climate smart agriculture to reduce GHG emissions and create a friendly environment for present and future generations. This proposal is line with the Kenyan constitution of

2010 to achieve food security and protect the natural resources and the 2015 Paris climate agreement (COP21) where 195 nations agreed to address the issue of climate change (Kenya is a signatory).

1.4. Problem Statement

Supporters in the dairy value chain of Kenya promote livestock production to increase food efficiency and productivity especially milk production. These have led to an intensification of livestock production hence increased milk production and is estimated at 7.6 Billion litres. The livestock sector is identified as a significant contributor to greenhouse gas emissions in Kenya (MoALF & MoENR, 2015). More GHG is emitted by the sector leading to losses in Nitrogen, energy and organic matter, which is a challenge to the achievement of food security. Farmers alone are inefficient to reduce GHG due insufficient knowledge on GHG reduction technologies but their collective collaboration with supporters is key to implementation of GHG interventions. The study intends to determine the contribution of public, private and knowledge supporters in integrating climate smart Agriculture practices in Kiambu county dairy value chain and at selected knowledge institutions.

1.5. Significance of the Study

The study will generate important information on the Dairy value chain which is of critical use to Kenyan dairy value chain and to knowledge system and such strategies can be useful for implementation of Agricultural Policy. The study is critical as it's on request of the Climate Smart Dairy NWO-CCAF project which is funding Mr. Macro's PhD study and the research work on knowledge transfer in the Dairy Diamond in Kenya and Ethiopia. it's also key to completion of my master's program at Van Hall University of Applied Science.
The study can also serve as an input to the contribution of the continued debate and research on climate change globally. The primary data generated shall provide important information that may enlighten approaches on the improvement of adoption strategies for fighting climate change and additionally to upgrade the productivity of the small-scale farmers benefiting both female and male.

1.6. Research Objective

To determine the contribution of public, private and knowledge supporters in Kiambu county dairy value chain and in selected institutions in integrating climate smart Agriculture practices and recommend proper realignment to scale up climate smart agriculture.

1.7. Research Questions

Main Research question 1

1.1. What is the current situation of supporters on climate smart agriculture?
Sub-questions

1.1. What are key supporters, their position, and functions towards climate smart agriculture?
1.2 What are the existing interventions done by supporters to promote climate smart agriculture?
1.3. What are the barriers and opportunities for the adoption of climate smart agriculture mitigation practices?
1.4. What is the gender, youth role and inclusiveness and the significance of 3R and how it relates to climate smart agriculture?

Main research question 2
What are the linkages of the knowledge disseminating institutions in climate smart agriculture?

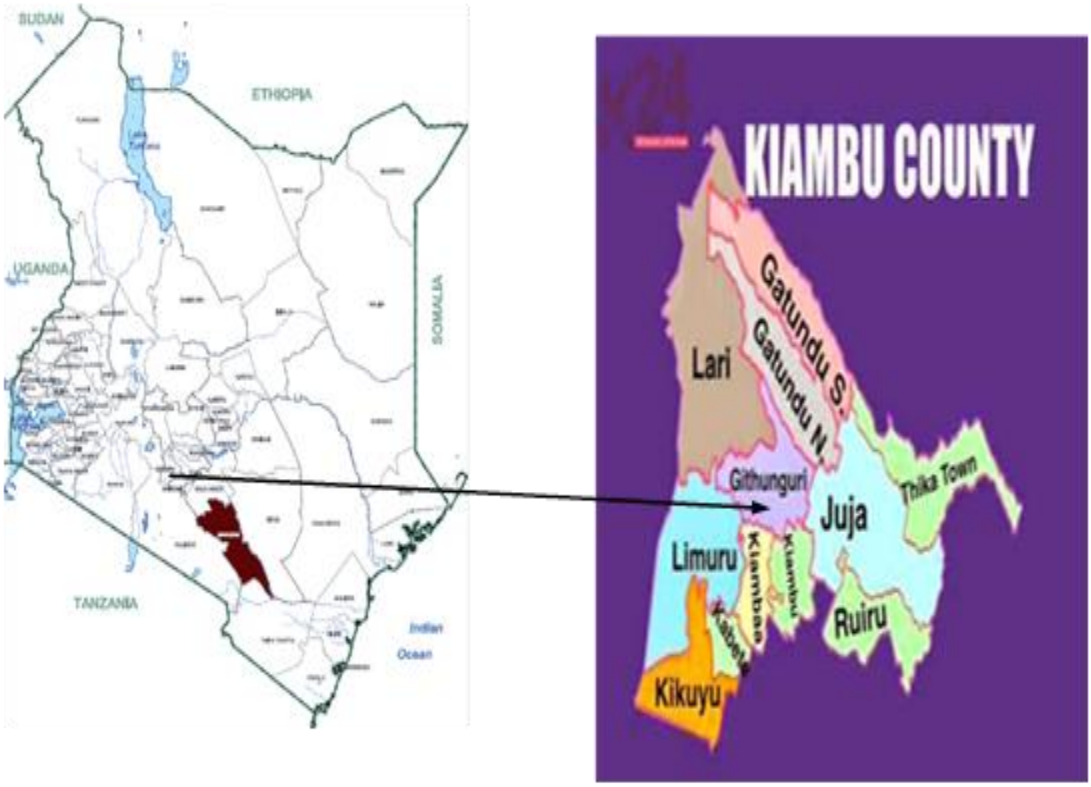
Sub-question

2.1. What is the current climate smart mitigations strategies that the knowledge institutions are implementing at their farm?
2.2. What are the guiding policies to knowledge institutions concerning climate smart agriculture?
2.3. What are the enabling requirements to scale up climate smart agriculture in the study?

1.8. The study regions

The study was conducted in Kiambu Dairy Value Chain, TVET Colleges (Naivasha Dairy Training Institute, Ahiti Ndomba in Kirinyaga and Baraka college in Molo and Universities- Institute of climate change and adaption, Egerton, Wangari Maathai, and Nairobi-Animal production and in nine organizations.

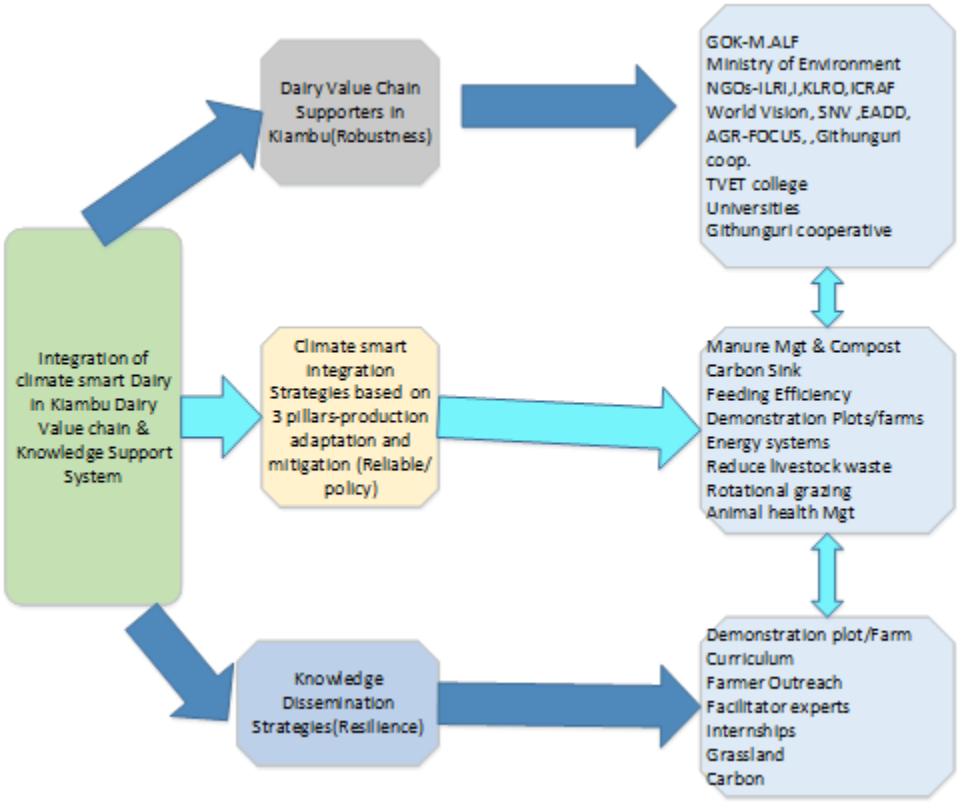
Figure 1: Map of study area



Source: Kiambu County Report (2017)

1.9. Conceptual Framework

Figure 2: Conceptual Framework



Source: (Author)

The conceptual framework was formed as shown in figure 2. The conceptual framework above will act as a guidance during the study of this thesis.

The researcher designed the conceptual research framework where all research theme is on climate smart dairy principally based on its three pillars regarding the dairy sector. The core value of the study is to recognize the supporters in the dairy value chain in Kiambu and knowledge system then evaluate their input to up-scale climate smart agriculture in the livestock sector. First, the conceptual framework relates climate smart agriculture to the dairy sector particularly in Kiambu county and at the selected knowledge system, then how its pillars relate to dairy sustainability, thirdly evaluate the contribution of supporters to climate smart agriculture practices at Kiambu, knowledge institutions and developmental partners.

CHAPTER 2. LITERATURE REVIEW

2.1. Legal Framework on CSA in Kenya

The laws and the programmes the Kenya government has initiated to scale-up climate agriculture include;

- Climate-smart villages in Nyando in Western Kenya and Makueni in Eastern Kenya
- National climate change Response strategy of 2010
- National climate change plan of 2013
- Climate Change Units/Desk Offices in Government institutions-KALRO, KEFRI, and KWS
- 47 County governments with power and function on climate change and
- Key partners- NAMA, ILRI, MoALF, FAO, CCAFS, MoENR.

Legislative frameworks and policies in Kenya linked to CSA are found in national and regional documents. These documents familiarize policy makers on the exposure to climate change, the effects and the need to take action swiftly. The government of Kenya is working towards increasing climate change adaptation to enable farmers to increase productivity and lower greenhouse emissions in the wake of climate change. Table 1 outlines the policy and discusses the function of each of them.

Table 1:Policies relevant to agriculture and climate change (GoK. NCCAP 2012)

Source Document	Relevance to Agriculture and Climate Change Policy
Draft National Climate Change Framework Policy (2014)	Policy declarations to promote climate resilience and adaptive capacity; enhance low carbon growth.
National Climate Change Action Plan 2013-2017 (NCCAP. 2012, and NCCAP, 2013)	To roll out the National Climate Change Response Strategy (NCCRS). CSA urgencies encamps conservation tillage, Agro-forestry and agricultural waste management.
The Climate Change Bill (draft) (2014)	Concerned with mainstreaming climate change within the National policy. Enhances climate resilience and low carbon growth.
The Agriculture, Fisheries, and Food Authority Act 2013	Delivery of policy guidelines on the development, preservation, and utilization of agricultural land
The Farm Forestry Rules (2009)	Enforces establishment and maintenance of farm forestry cover of 10%
Crops Act. 2013	Entails details on the sustainable use of environment friendly land
National Agribusiness Strategy (2012)	Focuses on the need to improve risk mitigation measures, insurance arrangements, and information risk
The National Disaster Management Policy (2012)	Tasked with disaster risk reduction and risk management in Kenya's development initiatives.

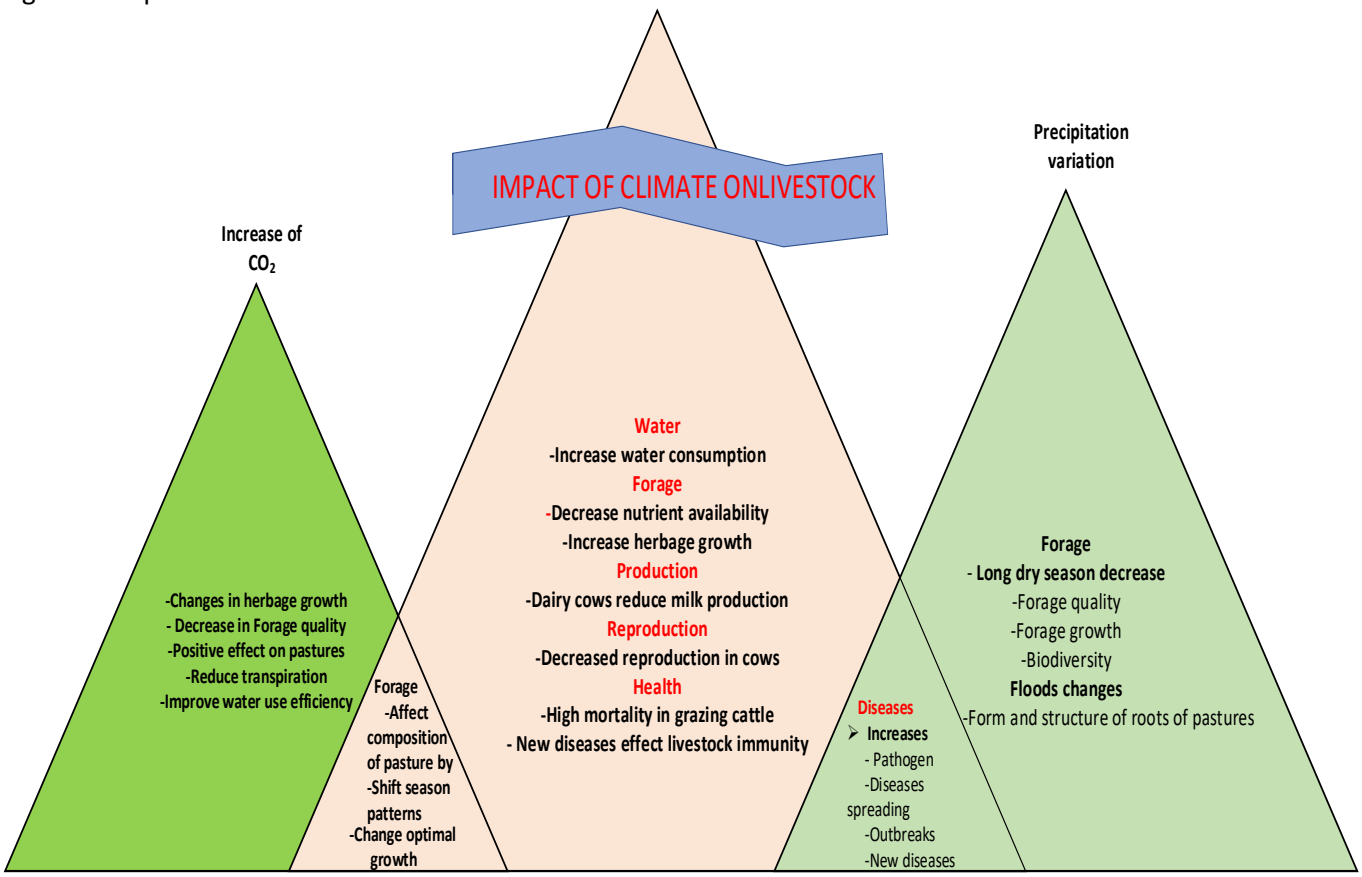
National Food and Nutrition Policy (2011)	Identifies climate change as an emerging issue for food and nutrition security; advocates for adaptation CSA.
The Constitution of Kenya (2010)	Chapter 5 : Land and Environment – For sustainability practices on Natural Resource Management
CAADP Compact of NEPAD	Incorporating CSA into Land and water management; research and technology dissemination, capacity building, food security, and GHG reduction
National Climate Change Response Strategy (NCCRS, 2010)	Identifies Agriculture as weather dependent sector key for Kenyan economy one bearing climate and variability impacts. Work on adaptation and mitigation measures of GHG emissions.
Agricultural Sector Development Strategy (2010-2020)	Tasked with sustainable management of Land and Natural Resources
East African Community Climate Change Policy (2010)	Emphasizes for an integrated and multi-sector framework for responding to Climate Change occurrences in EAC region.
The National Land Policy (2009)	Used in Intensification of high-potential, densely populated areas.
Kenya Vision 2030 (2008)	Broad environmental issues.

It can be observed from the table that policies on Climate--resilient development pathways identified agriculture and environment as the key areas and the CSA are directed to agriculture and agroforestry, water resource management, clean energy solutions and restoration of forest and degraded lands.

2.2. Impact of climate change on the livestock chain

The global average surface temperature has risen by 2100, an increase of between 0.3 °C and 4.8 °C, on account of uncertainties in climate change and variability. The likely impacts on livestock include changes in feed crop and forage production (Polley et al., 2013), animal growth and milk production, reproduction, water availability, diseases, and biodiversity. The above effects are a consequence of increased temperature, precipitation variation, the concentration of atmospheric carbon and a mix of these factors. The impact of climate change on livestock production factors are presented in Fig. 3.

Figure 3: Impact of climate on livestock



(Gerber et al., 2013).

2.2.1. Feed Quantity and Quality

Changes in Carbon dioxide and temperature levels will affect the composition of pastures by altering the species competition changes (Fuhrer et al, 2016). Increased temperatures may increase lignin and cell wall components in plants , which low digestibility and degradation rates , resulting in a decreased nutrient availability . Impacts on forage quantity and quality depend on the region and duration of growing season.

2.2.2. Dairy Production

Livestock keeps a body temperature range of $\pm 0.5^0$ C , but when temperature rises above upper critical temperature limit of varies species animals start suffering heat stress. Decreased production in the dairy industry is mainly caused by heat stress and this has a significant economic impact.

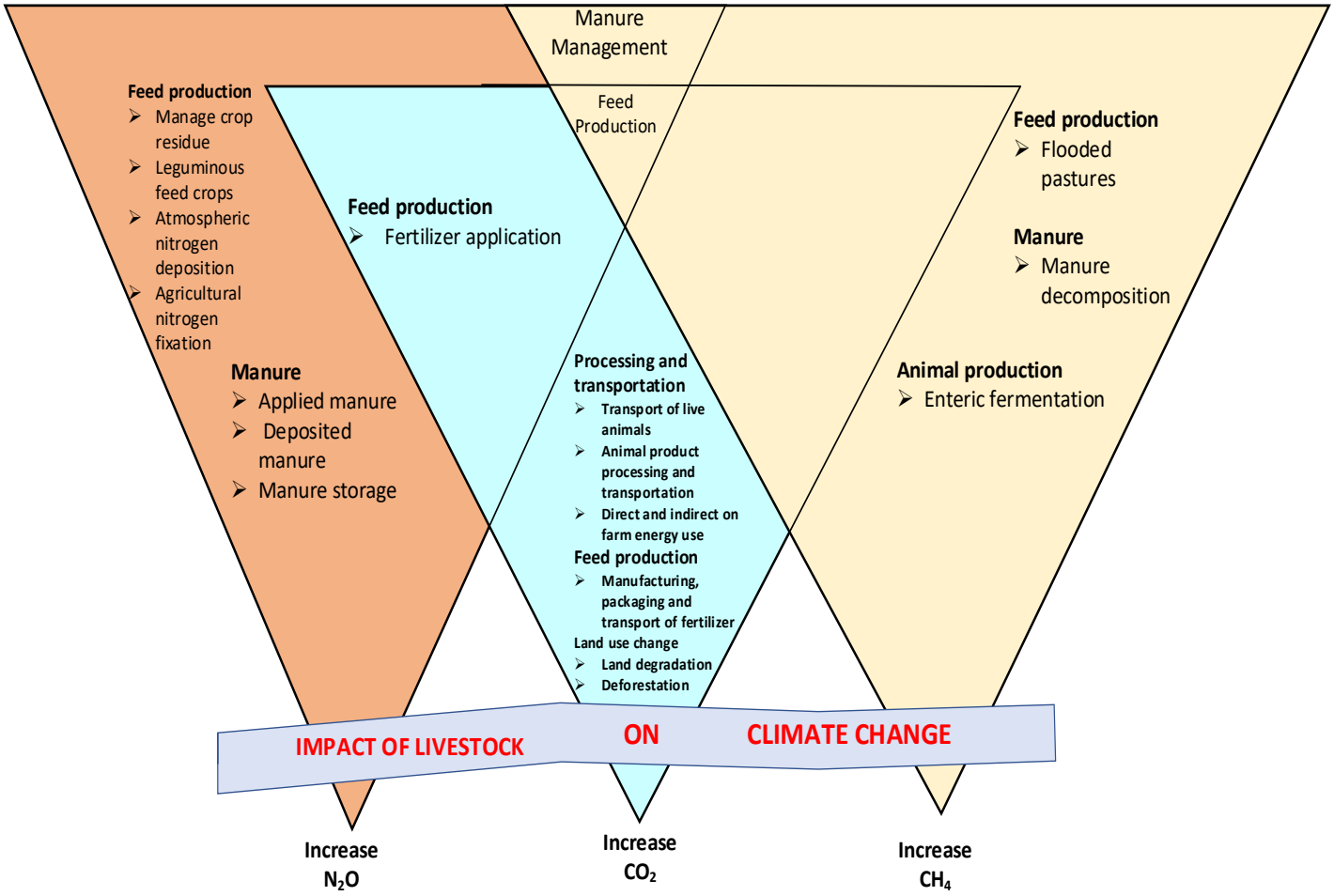
Livestock reproduction efficiency may be affected by heat stress in female cows where it impairs embryo development and low pregnancy rate. Though mitigation measures of sprinklers, shade, or similar management

to cool animals are necessary. Biodiversity contributes to human well-being and when at risk populations decrease, due to climate change (UNEP, 2012).

2.2.3. Impact of Livestock on Climate Change

Livestock globally contributes 14.5% of the total annual anthropogenic GHG emissions (Rojas-Downing et al, 2017). Livestock stimulus climate through land use, animal production, feed production, manure, processing and transport (Fig 4.) Feed production and manure emit CO2, N2O, and CH4, which subsequently affect climate change. Transport and processing of animal products as well as land use promote the increase of CO2 emissions. (Fig.4). The negative environmental impacts associated with the Livestock sector are land degradation, air and water pollution, and biodiversity destruction.

Figure 4:Impacts of livestock on climate change



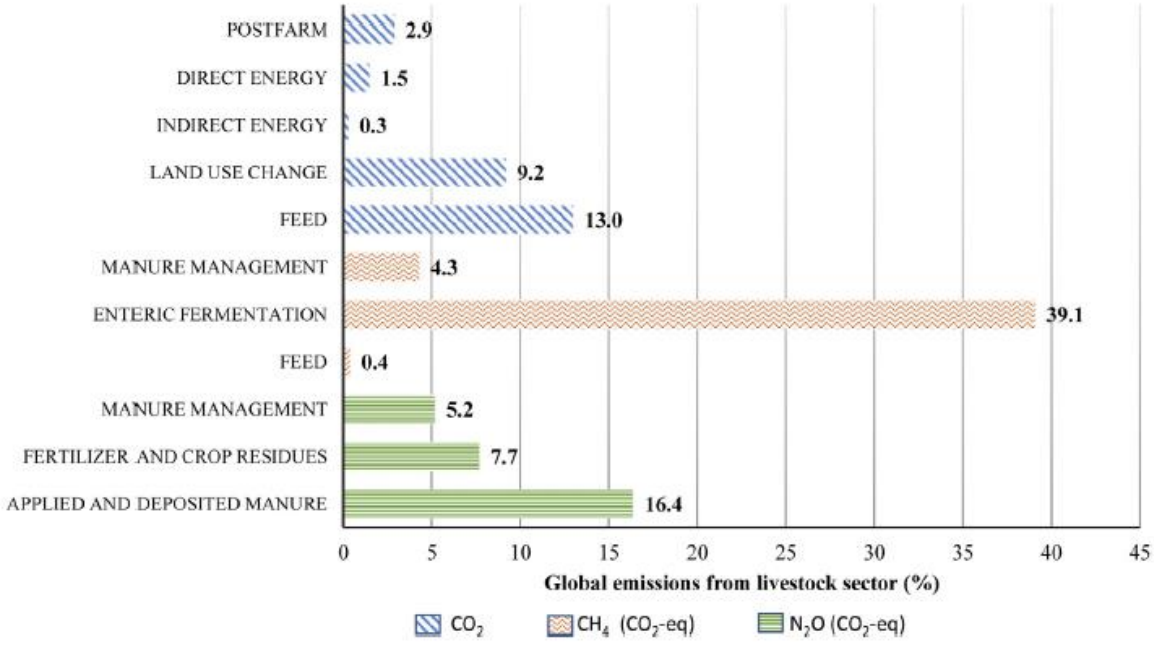
Source: (Gerber et al., 2013).

The primary livestock GHG emissions are CO2, CH4, and N2O, each contribute 27%, 29%, and 44% respectively hence CH4 contributes the most to GHG emissions. The high concentrations of these gases can be attributed to lower productivity efficiency of livestock system due to excess loss of nutrients, energy, and organic matter.

The contributors of the 14.5% of Livestock GHG emissions include enteric fermentation is the highest emitter with 39.1%, manure management, application, and direct deposit 25.9%, feed production 21.1%, land use change 9.2%, post-farm gate 2.9%, and direct and indirect energy 1.8% (Rojas-Downing et al, 2017).

2.2.5. Land Use

Agriculture lands are about 38.5% of the global total land area, consisting of 28.4% arable land and 68.4% permanent meadows and pasture. Natural habitats, mostly forests, sequester more carbon in soil and vegetation than pasture and croplands. About 9.2% is attributed to land use change, whereas 6% is from pasture expansion and 3.2% from feed crop expansion all contributed the total livestock GHG emissions. Grazing management which can increase carbon sequestration are possible where one doesn't exceed pastureland's carrying capacity, rotational grazing, and excluding degraded pasturelands from grazing livestock.



Source: Gerber et al., (2013)

2.2.6. Feed Production.

The production of forage and feed transport are the key contributors of GHG emissions linked to livestock sector, making about 45% of global livestock anthropogenic GHG emissions, comprising of CO2, N2O and NH4 (Gerber et al., 2013). GHG emissions of CO2, are due to fertilizer on feed production, additives in fertilizer manufacture, packaging, transport and application. N2O contributor to GHG emissions is through fertilizer use, agricultural nitrogen fixation, atmospheric nitrogen and leguminous feed crops.

2.2.7. Manure Management

Livestock manure produces CH4 and N2O gas (Fukumoto et al, 2003). The decomposition of the organic materials found in manure under anaerobic conditions releases methane. Apply the use of anaerobic digesters, cover the storage, using a solids separator, and changing the animal diets to shorten the storage duration. Anaerobic digestion can reduce methane emissions and produce biogas. Balancing between protein diets and feed supplements can reduce GHG emissions- reduction in protein intake, will reduce nitrogen excreted by the animal.

2.2.8. Processing and Transport

Energy use depends on the type of livestock system either small or large scale. Significant energy is also utilized for heating, cooling, and ventilation systems. Transportation of livestock products and feeds to retailers contribute to GHG emissions.

2.3. Adaptation

Adaptation strategies can improve the resilience of crop and livestock productivity to climate change. Adaptation and mitigation can make significant impacts if they become part of national and regional policies. Adaptation measures involve production and management system modifications, breeding strategies, institutional and policy changes, science and technology advances, and changing farmers' perception and adaptive capacity.

2.3.1. Livestock Production and Management Systems.

An adaptation may involve the modification of production and management systems via a diversity of livestock animals and crops, integration of livestock systems with forestry and crop production. Agroforestry as a land management approach can help maintain the balance between agricultural production, environmental protection, carbon sequestration to offset emissions from the sector. incorporating agroforestry species in the animal diet, and capacity development of producers in feed production and conservation.

2.3.2. Breeding Strategies

Breeding strategies can help animals adjust to tolerance to heat stress and diseases and improve both reproduction and growth development. Improve policy measures concerned with facilitating the implementation of strategies. Introduce genes of high milk production and advice farmer on good management to have cows with long longevity.

2.4. Mitigation Measures

Reduction of livestock sector GHG emissions is possible through different technologies and Practices like carbon sequestration, improving diets to reduce enteric fermentation, improving manure management, and more efficient use of fertilizers.

2.4.1. Carbon Sequestration.

Lal (2004) states that Carbon sequestration can be achieved by reducing deforestation rates, reversing of deforestation by replanting Plant higher-yielding crops with better climate change adapted varieties, and improve land and water management. Soil organic carbon can be restored through conservation tillage, erosion reduction, soil acidity management, crop rotations, higher crop residues, and mulching. Pasture management improvement leads to carbon sequestration by incorporating trees, improving plant species, inter-seeding legumes, and fertilization. Promote Carbon sequestration by maintaining the right carrying capacity.

2.4.2. Enteric Fermentation.

This a source of methane emissions and reduction can be through practices like improving animal nutrition and genetics like increasing dietary fat content, provision of higher quality forage, increase protein content (Adesogam and Tricarico, 2013). Increasing protein content of feed can also improve digestibility and low methane emissions per unit of product. An increase in milk production leads to fewer animals needed to produce the same amount of milk and fewer emissions produced.

2.4.3. Fertilizer Management

Organic fertilizers application doesn't produce much Nitrogen oxide as the synthetic fertilizers, a combination of legumes with grasses in pasture lands may lower GHG emissions in feed production. In pasture land legumes can be combined with grasses, as the legumes fix nitrogen through Rhizobium bacteria, grasses receive nutrients, and this can be supplemented with reduced quantities of fertilizers.

2.5. Kiambu livestock production and fisheries and climate change

Kiambu county is found in Central Kenya and occupies a total area of 1448 km2. It has 12 sub-counties with a human population of 253,751 persons. Temperatures range from 12.5^0C July/August in the upland zone to 20.4^0C in March/April. In 2010, the County recorded an increase in all the subsectors and these were attributed ready urban market in the sub-counties-Kiambu, Ruiru and Nairobi and accessible processing factories (KNBS, 2009).

2.5.1. Aspects of marketing, producers' organizations credit and value addition.

Marketing and markets are key issues due to increased commercialization of agriculture products.
About 40 percent of agricultural products are lost due to unsuitable storage conditions. The investment environment and business are conductive but farmers as well stakeholders have insufficient knowledge of value addition technologies. A major constrain to agricultural production in Kiambu is access to credit by farmers. The hindering factors include business associated risks, land tenure systems, and infrastructure.

2.5.2. Status of environmental degradation and climate change in Kiambu

In Kiambu county, environmental degradation is significant and magnified through felling trees in Karura forest resulting in soil erosion and desertification. Development of two Industries- tea and coffee are key in the county despite their effect of air pollution together with a high population (County Government Of Kiambu, 2013). Kiambu county being the third largest country in livestock production in Kenya, climate change has greater impacts on the environment specifically from feed production, feeding, transport, and manure handling (CGoK, 2013).

2.6. Gender Inclusiveness in Climate Smart Agriculture

Kenyan workshop analyzed gender differences in awareness and adoption of climate-smart agricultural practices between 375 men and 376 women in two different parts (Bernier et al, 2015). The research was to improve the target and design of interventions to achieve greater and equitable agricultural development in East Africa and any other place. The results recommend awareness of improved agricultural practices that will improve livelihoods, resilience to change and adopt new ways. Researchers by in Senegal, Uganda, and Bangladesh and results showed men and women have differences in the way they perceived climatic changes such as floods. Women also preferred CSA practices related to their role in the household. Women are smallholder farmers, environmental and natural resource managers. Lower rates of CSA practices (improved fodder, agroforestry, manure management) for women than men are reported.

2.6.1. Youth involvement in climate change and agriculture

There is a global challenge as half of the farmers in the US are above 55 years and the average age of farmers in Sub-Saharan Africa is around 60 years old. Fortunately, youth across the world are already turning to farm and the food system as a career option as noted when exploring career options in information and communication technologies, forecasting, marketing, value addition, transport and logistics, quality assurance, urban agriculture projects, food preparation, and environmental sciences.

2.7. Knowledge support system

Universities in Kenya operate under the commission of university. The commission has a duty to regulate, coordinate and assure quality education in the university. The commission ensures standard maintenance, quality, and relevance in programs of university education, training and research. The researcher sampled at 4 universities, WMI, ICCA, Nairobi and Egerton.

2.7.1. Egerton University

Situated 5km^2 from Njoro town. The University has nine (9) faculties and 51 academic departments offering many programmes at diploma, undergraduate, and postgraduate levels. major research projects- include wetland Project, River Njoro Watershed. University has University Botanic Garden. FOA has ensured that all aspects of agricultural training are covered in its 5 Diploma, 10 BSc., 17 MSc., 9 Ph.D. and several tailor made short and executive courses**.** It is an agricultural university but has widened their scope to include other areas except for no climate smart agriculture courses The Agricultural farm activities support climate smart farming-pasture grazing and rotation, manure utilization and in bio-gas production.

2.7.2. The Institute of Climate Change and Adaptation (ICCA)

The Institute of Climate Change and Adaptation. Is within Nairobi university. The Institute's mission is to do capacity building to drive the climate change adaptation agenda of vulnerable communities and action-oriented research, develop innovative technologies, the participation of communities and give advice for National and regional formulation and implementation on climate mitigation strategies. The objective of ICCA is to conduct; formal training on climate change and adaptation at Master and Doctorate level then later undergraduate. (Master and Ph.D. in Climate Change and Adaptation), (ICCA. 2016) professional Short courses for various stakeholders in the public and private sectors. Institutions do fieldwork in the communities, in 2015 ICCA did practices in Oloitokitok pastoral area to pre-test the methodological tools learned in class to boost Adaptation to Climate Variability and Change through Appropriate Dissemination of Climate Products and Services

2.7.3. Technical Vocational Educational Training (TVET)

World-wide, a shift has been observed in TVET moving towards competency-based training by use of modular courses. The role of TVET is to achieve a large number of well-trained manpower to implement programs and identified projects in the vision 2030 of Kenya.

Public and private training institutes which piloted and have developed a curriculum include Dairy Training Institute, Bukura Agricultural College, several polytechnics, Baraka Agricultural College and Faraja Latia Resource Centre (private) and the Kenya School of Agriculture (public). These include Dairy Training Institute, Ahiti Ndomba, Baraka Agricultural college.

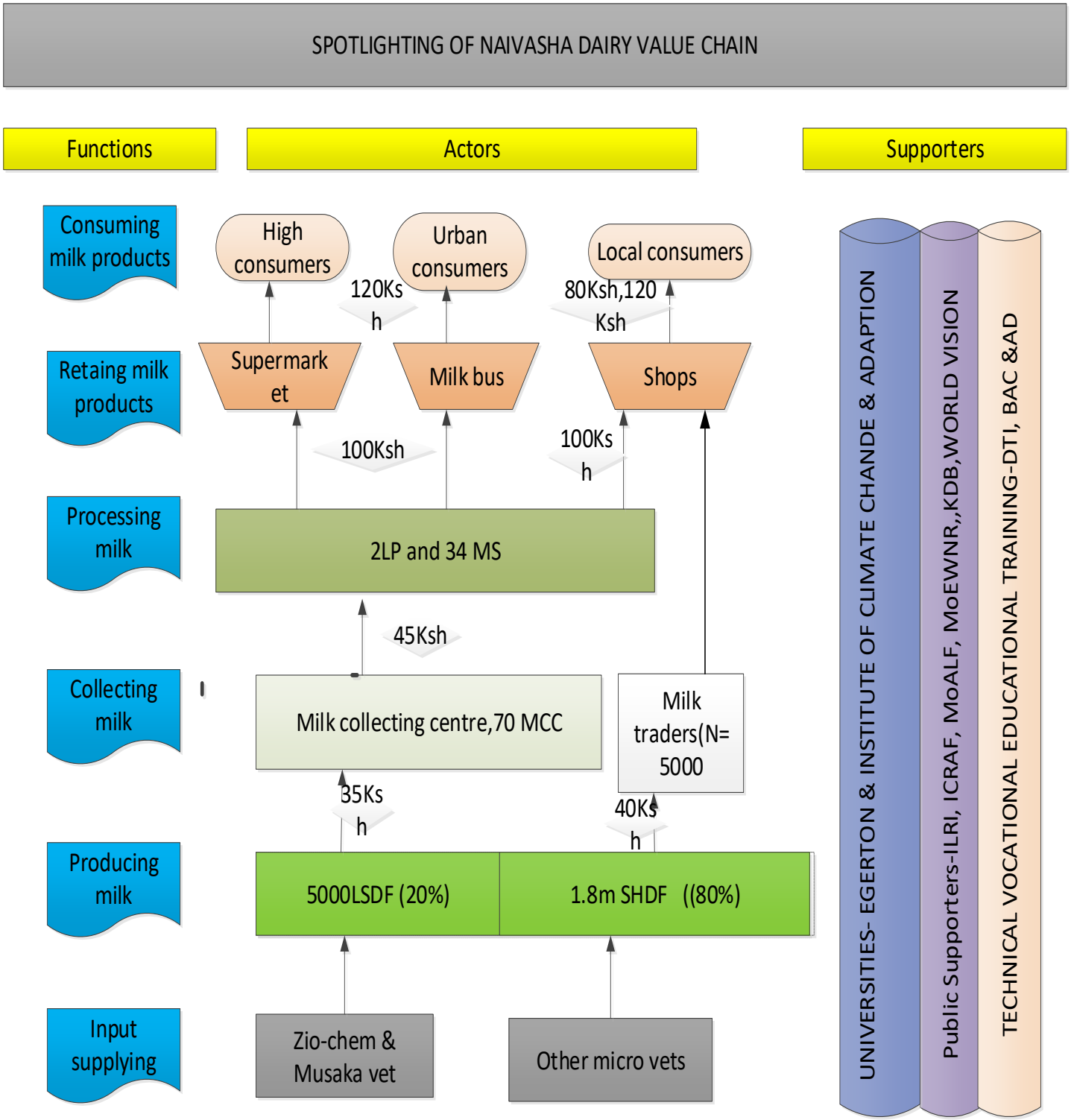
Dairy Training Institute (DTI) is in Nakuru county and located 12 km^2 from Naivasha town. DTI offers three programmes all under TVET which include Diploma in Dairy production and processing and certificates in the same courses with a variety of one week short courses in dairy technology, Animal production, and Animal health. DTI joined TVET colleges in the last 5 years and managed to develop curriculum but unfortunately, it doesn't include climate smart dairy courses though the farm engages activities in support of climate smart agriculture practices. Courses curriculum in Annex 3.

Ahiti-Ndomba is in Kirinyaga county in Central Kenya and 185km^2 from Nairobi. The Institute recently joined the TVET colleges with no climate courses in their curriculum but with comprehensive investigation through case study will reveal more information. Courses offered at Ahiti- Ndomba in Diploma in Animal Health and Production, Certificate in Dairy Management and Diploma in Occupational Health and Safety and no course in CSA.

Baraka Agricultural college

Has a mandate to enhance agricultural knowledge and skills to farmers and other willing clients interested. The college empowers local farmers on food security and offers diploma and certificate courses in Agriculture and Rural Development. Baraka achieves its mission by offering six programmes which focus on rural communities' empowerment in Eastern Africa-Certificate in sustainable Agriculture and Rural Development (CSARD), Diploma Short courses, Day Release courses, Bee-keeping Development, Area Based Programme in Kamara and Tenges Division. The certificate is a sixteen-month course and candidates must be intelligent, hardworking women and men with farming experience and committed in their rural development communities and a minimum of D+ in the KCSE or its equivalent. The curriculum can be viewed in annex 2. In addition, Baraka runs 6 days short courses throughout the year in various agricultural aspects, bee-keeping development course, and a day release course.

Figure 5: Dairy value chain in Kenya



Source: Technoserve report (2008)

2.7.4. Dairy Value Chain

According to (Technoserve, 2008), there are over 1.8million dairy farms in Kenya, the majority being in the Rift valley and the Central province of Kenya. Dairy value chain includes both the formal and informal sector. In the formal value chain, the milk is usually transported to chilling and bulking centers, then to a processing facility. Once the milk is processed, distributors deliver it to a point of marketing. Informal market connects producers to consumers via several brokers.
Input suppliers include agro-vet stores, animal feed suppliers, AI service providers, and animal breeding organizations. Producer cooperatives have expanded their services to include other dairy related services.

Producers
Small Scale farmers

There are over 1.8 million smallholder dairy farmers with 1-5 cows, supplying more than 80 percent of all milk consumed in Kenya (Wambugu et al, 2011). Farmers keep crossbreds and purebred animals. Small-scale dairy farmers usually sell their milk through three channels; directly to consumers in rural areas, mostly neighbors, and low-income urban dwellers; through local traders/hawkers; and, through dairy cooperatives and producer groups.

Medium/Large Scale Dairy Farmers

There are an estimated 5,000 farmers operate medium and large-scale dairy production systems that produce 100 liters of milk per day.

Cooperatives

Collect milk from farmers, bulk and chill it. They later sell it to processors and sometimes to traders or directly to consumers.

Processors

Kenya has about 92 dairy processors; 35 large, 30 Medium, and the remaining are small scale (KNBS, 2009). Majority of the processors produce a variety of products including fresh milk, yoghurt, ghee, cheese, and milk powder. There are six large processors that dominate the processed milk and dairy products segment of the value chain. These are Brookside Dairies, New KCC (NKCC), Githunguri Dairies, Sameer Agriculture, Meru Central Cooperative, and Kinangop Dairies (KNBS, 2009).

Milk Traders and Retailers

Most of the milk is sold through small-scale traders who buy milk in the informal channel
Consumers include households in rural and urban centers

Transporters

The dairy chain has formal transporter using in-build trucks for milk transportation, licensed traders transport milk in open vehicles and trucks and informal traders transport milk on foot, bicycles, and motor-cycles.

2.7.5. Public Supporters

INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE (ILRI)

ILRI has initiated and promoted several projects in collaboration with other partners-FAO, (SDCP), NAMA, MoALF, and MoE. Another project was better grass for better smallholder dairying, where ILRI worked with KLRO and promoted high yielding-disease resistant fodder-Napier grass (*Pennisetum purpureum*) to over 10,000 dairy farmers.

ILRI has supported more projects including KALRO agricultural innovations for young business farmers, payment for environmental services through productivity gains. Mitigation Intervention areas included enteric fermentation of methane, methane and nitrous oxide from manure.

The Ministry of Environment and Natural Resources (MoENR)
The Ministry provides policy direction, legal framework and capacity building and utilization of natural resources for national development.

2.7.6. 3R- Kenya Resilient, Robust, and Reliable Project in Kenya

As part of the Dutch transition strategy from aid to trade in Kenya. The project investigates whether lessons learned from the aid era can be transformed and scaled up in the approaching trade era and be better anchored within Kenya. Three principles apply:

-Resilient Innovation System: knowledge exchange and co-innovation networks; Robust Supply Chain Integration: and Reliable Institutional Governance: public-private cooperation, co-innovation and public economic policy framework that is supportive for private investments. (Mierlo, 2018). The 3R project on dairy will target the fodder production, evaluate the production cost and feed challenges. The project's research areas in the dairy sector are the cost of production, commercialization of fodder access and milk quality and testing (3R Kenya Project: Dairy Sector", n.d.).

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

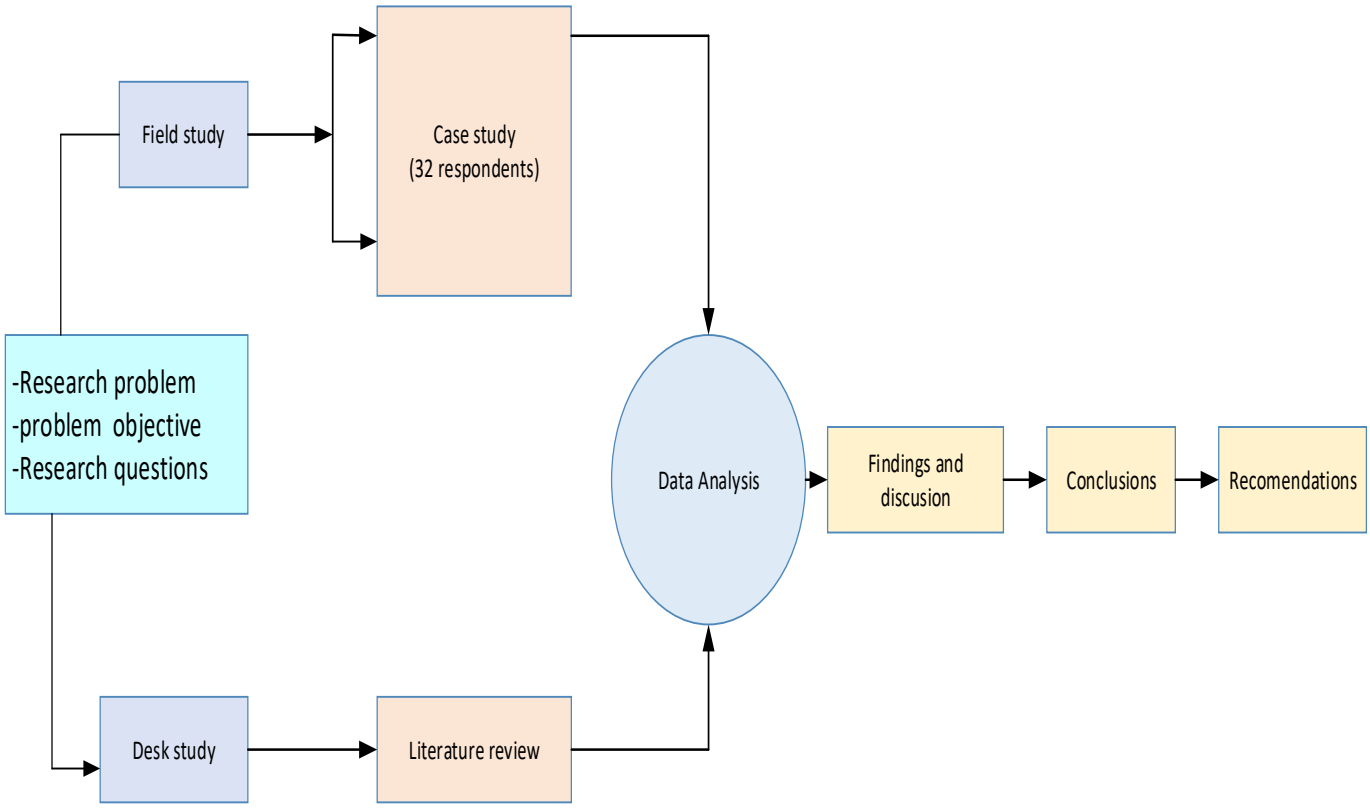
3:1. The study area

The study was conducted in Kiambu Dairy Value Chain. The study was carried out in Githunguri but more information was gathered in Kiambu county from MoALFD, Dairy Value Chain (DVC), Ministry Environment and Natural Resources (MoENR) seven knowledge Institutions and in nine developmental partners.

3.2. Research strategy

Based on the research objective and the research questions, the research framework formed as shown in Fig. 8. This framework is used as guidance throughout this thesis project. The study is found on this research framework which gives a detailed description of the relation between independent and dependent variables leading the concept of integration of climate smart agriculture in KDVC and knowledge supporter system.

Figure 6:: Research framework



Source: (Author.2018)

3:3. Method of Data Collection.

The use of primary and secondary data was used to collect data in the study. Different techniques were combined and applied including case study, and key informant interviews (KII) in primary data collection. Secondary data

will be obtained from supporters at Kiambu offices, in nine developmental organization and important documents were reviewed to give theoretic information on curriculum and up-scaling climate smart agriculture activities at the knowledge Institutions. Kiambu Dairy value chain and the nine organizations. A purposive sample was used.

3:3.1 Key Informant Interviews

The researcher adopted Key Informant Interviews and one Focus group from Githunguri to collect information The key informants recognized in Kiambu and the knowledge system were identified and are listed, Farm managers, livestock experts in extension both from Kiambu county and Githunguri Factory, extension coordinator, his assistant, farmers, livestock researchers, ILRI staff, MoERN officer, researchers from KLRO, Director of Studies (DOS), Livestock trainers, senior Agricultural officers, totaling to a sample of 32 Key informants. Key Informant interviews are important as the respondents gave detailed information on climate smart Agricultural practices. The Research designed a key informant guide to administer interviews to supporters in the study area. These were conducted to map both supporters in Dairy Value Chain and knowledge support system and organizations. The value chain map will be used to map the supporters in the study area. The interviews involved were structured, semi-structured, open-ended questions as well as closed questions and checklist to prompt views and opinions of key supporters. The interviews were conducted face to face with the respondents from Kiambu Dairy value chain at the selected knowledge Institutions and the organization.

FOCUS GROUP MEETING

Two focus meeting were held one at the beginning to introduce the research idea to Githunguri cooperative and as an entry point for collecting data from the field and second was to present the findings to stakeholders. The two meetings were held at Githunguri and in the first meeting we discussed the various training held and challenges and opportunities for the farmers and the cooperative.

3.3.2. Method of Data Analysis

The source of the data was mainly Key informants and Focus group discussion. Qualitative data was analyzed using descriptive statistical analysis techniques to show an overview-scenario of scale-up of climate smart Agriculture in KDVC, in the Knowledge support system and nine organizations. On recording the data had to go through ground theory method (Baarda and Hidajattoellah, 2014), recorded in the transcript, organized in fragments (labels/units), labels were sorted out for any irrelevant and reedited information and then removed. Open coding to refine the information and axial coding was done where related labels and detailed properties and dimension were clustered in subcategories. Then all subcategories (selective coding) were clustered around the core categories linked to the research dimension.

Data analysis was grouped in in five categories; knowledge institutes, TVET colleges, NGOs and consultants organizations, Research Institution and Government Ministries and a comparison was done between the categories based on up-scaling services in CSA. Power and interest grid were used to analyze the power and interest of dairy value chain supporters, supporter matrix used to categorize supporters and their role. SWOT and PESTEC analyzed the opportunities for supporters CSA. 3R model was used to describe the dairy value chain supporter activities and a business model was used to cluster supporters in seven groups as per the services they offered analytical tools such as excel sheet, SPSS and descriptive statistics-value chain map stakeholder matrix, gender analysis was used.

Table 2: Research methods, data collection, and data analysis matrix.

Research Questions	Methods of data collection	Tools for data collection	Tool for data analysis	Source of Information /Data
1.What are key supporters and their function in the climate smart agriculture?	Desk research Interview	Literature review Checklist	Stakeholder matrix	Interviews with the supporters at KDVC and Knowledge Institutions
2.What are the existing measures done by supporters to promote climate smart agriculture?	Supporters interview Desk research	Checklist Literature review	Business Model	Interviews with Supporters-Farmer leaders, Key informants at the study areas
3. What are the barriers and opportunities for the adoption of climate smart agriculture mitigation practices in areas?	Interview Desk research	Check list Literature review	SWOT and PESTEC	Interviews with the supporters from KDVC and at Knowledge institutions. Information collected from Desk research
4. What is the gender role and involvement as well as the 3 Robust, Resilient, Reliable (RRR) in the dairy value chain?	Interviews Desk research	Check list Literature review	Gender Analysis	Information from Desk Research. Interviews from Livestock officers, lecturers from KDVC and at the Institutions
What are the mitigation supporters use toward to climate smart agriculture?	Interviews Desk Research	Check list Literature review	3 R model	Supporters-Key informants Interviews and Desk research
2.2. What linkage can be adopted between by supporters to scale up climate smart agriculture in the dairy value chain?	Interviews Desk Research	Check list Literature review	Business Model	Secondary data Interviews from Livestock officers and other officers from Kiambu county and at selected institutions
3. What are the requirements to scale up climate smart agriculture in the study area?	Interviews Desk Research	Check list Literature review	Business Model	Desk Research to collect information. Interviews of what supporters plan to implement

Source: (Author)

CHAPTER 4: RESULTS

This chapter presents data from the study and an analysis using methods and tools like tables, figures, graphs, tables, pie charts, bar charts, stakeholder matrix, interest and power grid, and business model

4.1 Dairy value chain supporters

4.1.1. Overview of Dairy value chain supporters

The data was collected from the dairy value chain supporters totaling 32 respondents from four knowledge institutions where 11 were interviewed, three TVET colleges where 6 were interviewed, two government

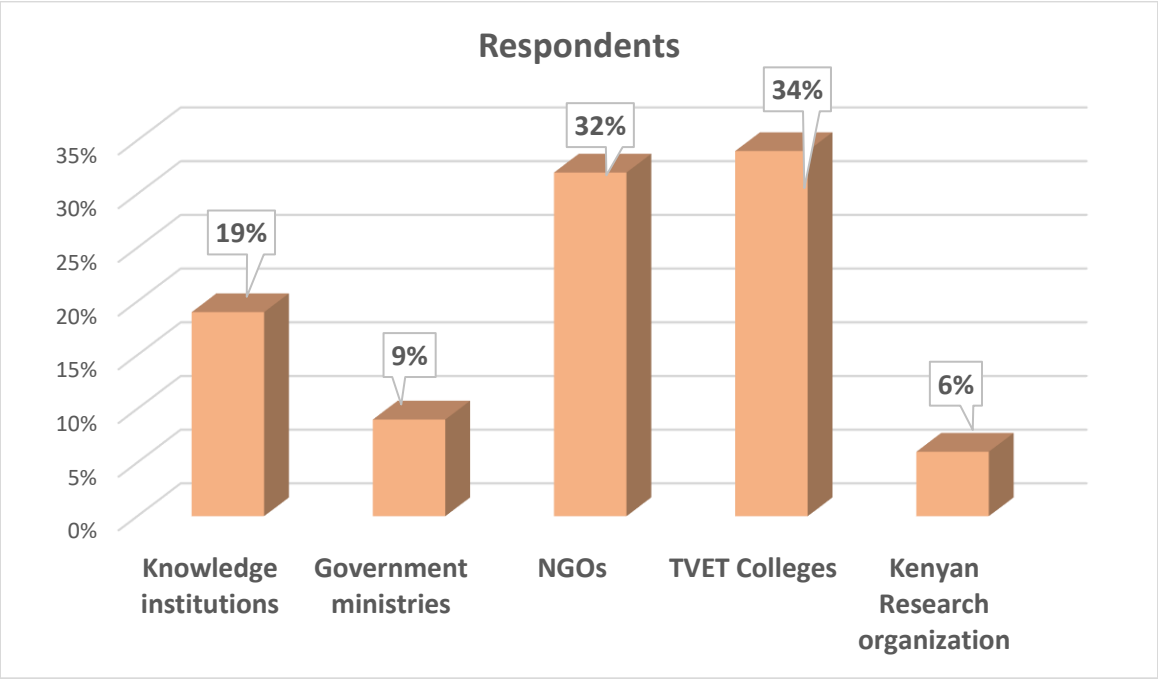
Ministries where 3 officers were interviewed and nine Non-governmental organizations as shown in table 3 and further classified in figure 7.

Table 3:Dairy value chain supporters

Dairy value chain Clusters	**No. of Respondents**
TVET COLLEGES	**34%**
Ahiti Ndomba	4
Baraka agricultural College	4
Dairy Training Institute	3
KNOWLEDGE INSTITUTIONS	**19%**
Egerton University	2
Wangari Maathai Institute of peace and Environmental studies	1
Institute of Climate Change and Adaptation	1
Nairobi University-Animal production	**2**
GOVERNMENT MINISTRY	**9%**
Ministry of Livestock production	2
Climate and Environment unit in Ministry of E&NR	1
NON-GOVERNMENTAL ORGANIZATIONS	**38%**
Netherlands Development Organization (SNV)	**1**
3 Robust, Reliable Resilient	1
Agri-profocus	1
International Livestock Research Institute	1
Agricultural dairy Development support programme	2
National Agricultural Inclusive Growth Project	1
Kenya Climate Smart Agricultural project	2
Kenyan Research Organization	**6%**
Kenya Agricultural Livestock Research Organization	2
Total	**32**

Source: (Author 2018)

Figure 7: Cluster of respondents (Dairy value chain supporters)



Source: (Author 2018)

4.1.2. Gender of respondents

The respondent was classified into gender, where 23 males and 9 females were interviewed representing 78% and 28% of the respondent and the data is shown in table 4. The data shows a majority of the respondents were men, accounting for 78 % of the sample.

Table 4:Gender of respondents

Sex	Frequency	Percentage
Male	23	72%
Female	9	28%
Total	32	100%

Source: (Author, 2018)

The data on gender was further analyzed to determine whether there was a significant difference between the male and female among the respondents as shown in figure 5. The P value is equal to 0.13 from the Levene's test, therefore we reject the Ho and conclude that there is a significant difference between males and females interviewed.

Table 5: Gender analysis of the respondents.

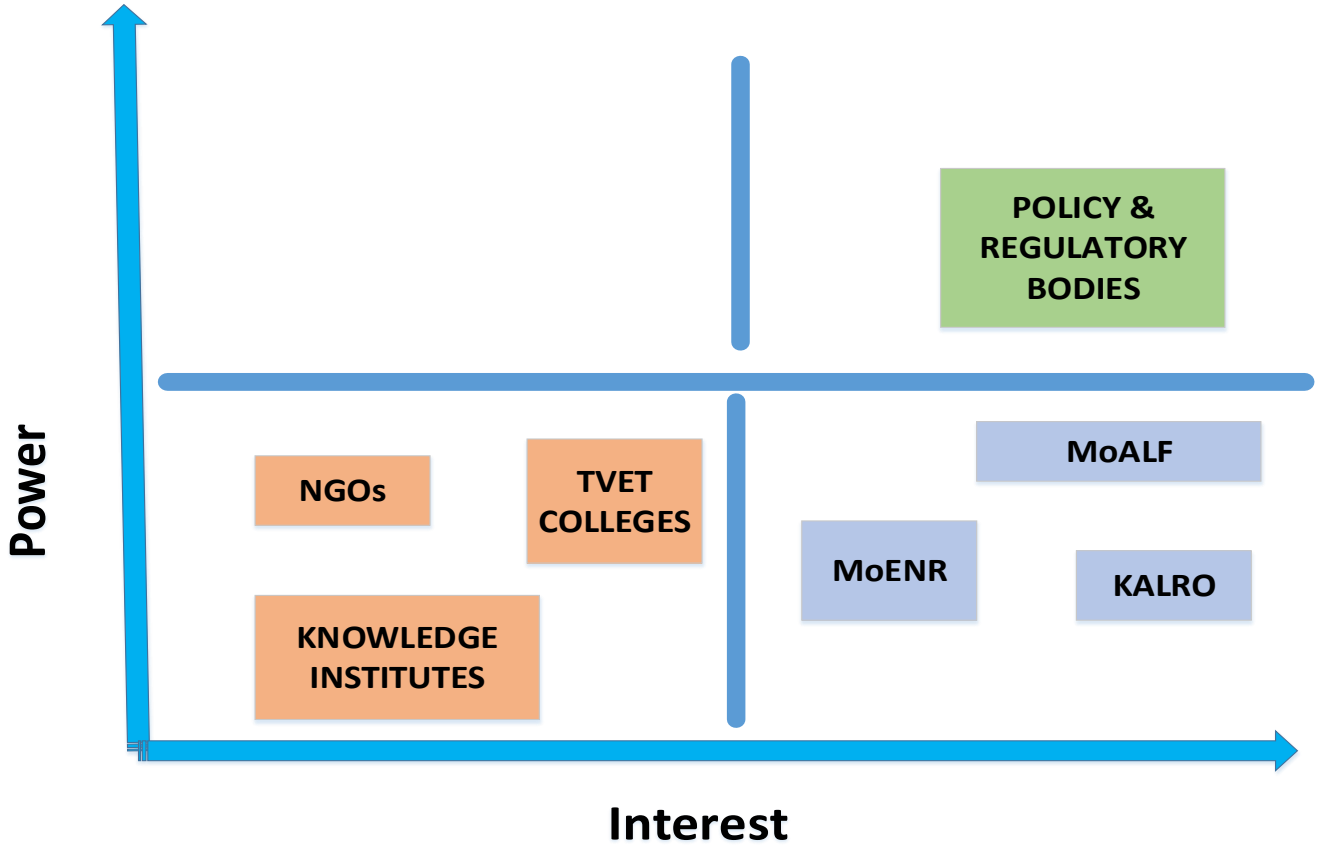
	Levene's Tests		
		P value	Conclusion
Table 4	Gender of respondent	0.13	There is a significant difference between males and females interviewed.

NB. Levene's results are in the annex 10

4.1.3. Power and interest grid of Supporters in the dairy sector

Concerning the climate smart agriculture practices, we consider analyzing the Dairy value chain supporters through the power/influence and interest grid in figure 8. The NGOs, knowledge Institutions and TVET colleges are concerned with CSA awareness, poverty alleviation, productivity and profitability increase at household level (trainees) while the policy makers, regulatory bodies, (Includes the members of parliament in Kenya and representatives from key stake holders in the livestock sector) Ministries, and KALRO are interested in administering policies on CSA and increase food security and reduce GHGs from the livestock sector. The players are key in CSA integration and should be put into consideration.

Figure 8: Power and Interest of Supporters

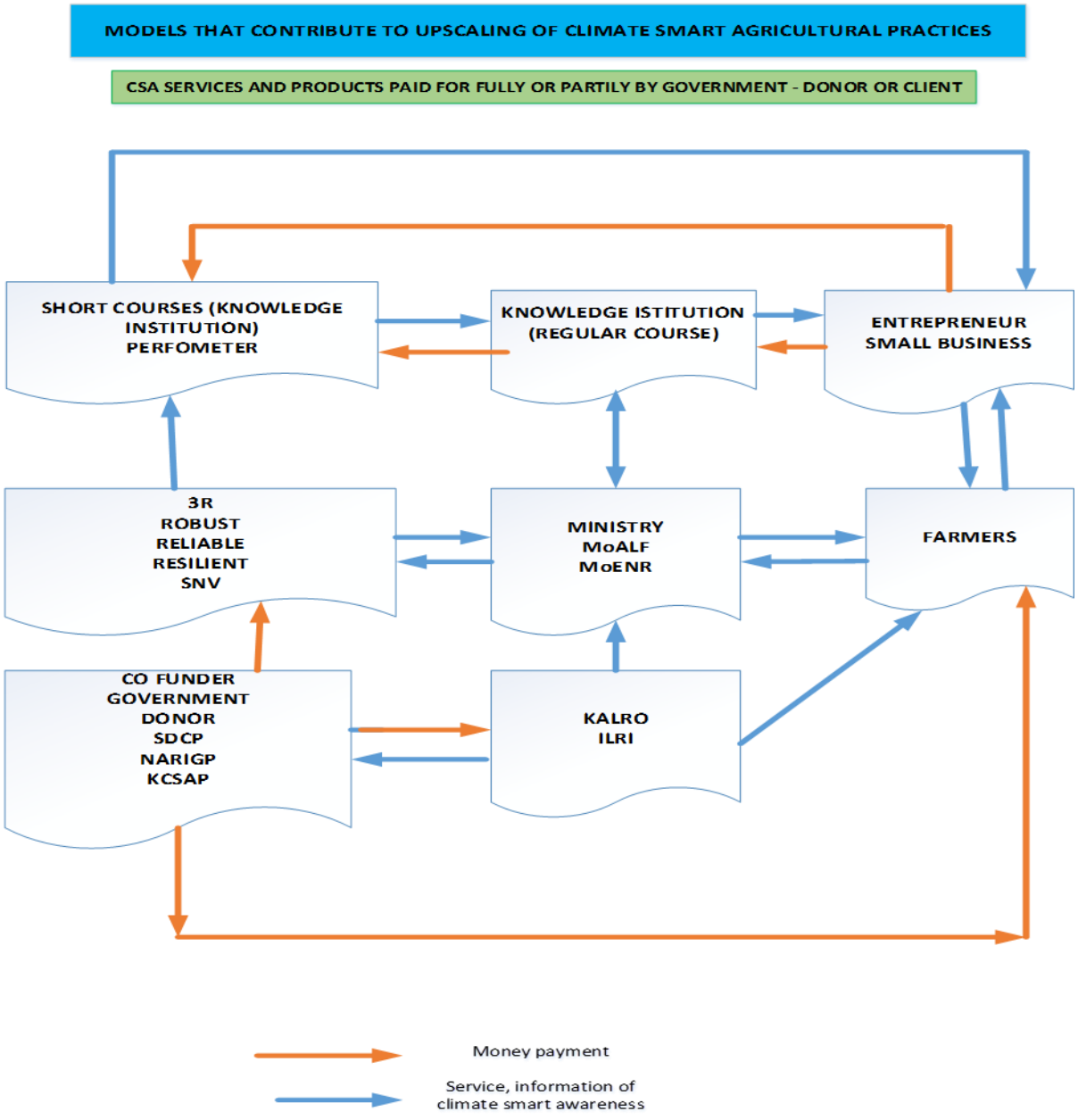


Source: (Author, 2018)

4.1.4. Business Model

The Business model in figure 9 illustrates the CSA services the Dairy value chain supporters are doing to disseminate the knowledge and skills to farmers and entrepreneurs**.** As shown in table 6 Supporters offering free services include NARIGP, KCSAP, SDCP, KALRO, ILRI, and government ministries. Subsidized include SNV, and Agriprofocus while full paid services are Preformeter and short courses from all knowledge Institutions and how the organizations relate to one another. Though the supporter doesn't single out CSA practices as most of them concentrate on good livestock management to increase milk production. Githunguri cooperative organizes Climate Smart Agriculture service providers at a subsided price to offer training packages in CSA to its farmers. These supporters offer training all over Kenya on climate CSA practices as seen with NARIGP and KCSAP that are within 45 counties. The model also shows the linkages between the supporters and this important especially for them to achieve mitigation of GHGs emissions.

Figure 9: Business model for developmental partners



Source: (Author, 2018)

Table 6 explains an overview of the business model describing the clusters, business model stating the funders, service providers, clients, and describing services offered (free, subsidized and fully paid for).

Table 6: Overview of Seven business models identified

Cluster	Business model	Description	Funder	Service provider	Clients
A Free service	A1	Largely free services	Donor, government Public or private	Public or private	Farmers, small enterprises, other service providers
	A2	Paid by companies,	Companies	Private	Farmer, Small enterprise
	A3	Voucher	Government, donor	Private	Farmers, cooperatives
B Subsidized services	B1	Part-payment by farmers	Government, donor Fees, in-kind contributions	Private	Farmers (group
	B2	Subsidized	Government, donor, Membership fees	Cooperative	Cooperative members
	B3	Paid by indirectly client	Paid by client Private	Private	Entrepreneurs, cooperatives
C Fully paid services		Buyer/seller provides free services or products as part of the transaction	Client: embedded in price paid for other transactions	Input or output company	Farmers

Source: (Author 2018)

Note the client can be a farmer, entrepreneurs or any individual interest in farming as a business

4.1.5. Enabling requirements to scale up climate smart agriculture

Enabling environment for climate-smart agriculture will comprise policies, institutions, and finances. Up-scaling CSA to prompt the desired transformation in agricultural production systems and food systems requires supportive policies, institutions, and financing. Human capital factors like gender. level of education of producers and economic conditions and output market development and policy environment are important. The socio-economic position of the household is critical and is varied in Kenya where some are so poor and others so wealth.

Poor farmers may ensure their survival by taking up the CSA practice while wealthier farmers make decisions to maximize profits

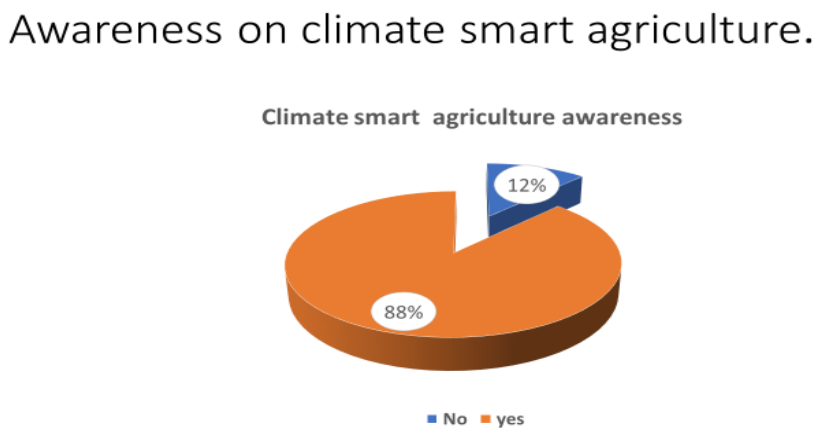
Policies for climate-smart agriculture-Kenya like 2030 Agenda for Sustainable Development that guide national development plans with three components: the SDGs, for global policy framework; the Paris Agreement on climate change (NAMA -Kenya); are key and the need for awareness and their enforcement.

Political good will so as Public policies, expenditure, and planning frameworks, should work towards an integration of new climate-smart agriculture policies and support measures at the national, subnational and local levels. Representatives from stakeholder groups involved in all sectors and at all levels need to participate fully in this coordination and integration process and all the strategies have to be supported by a financial investment of the Kenya government and developmental partners either private and civil society. The enabling environment is important and awareness is needed to reach all Kenyans as CSA is critical for increased productivity and mitigation of GHGs.

4.1.6. Knowledge of climate smart agriculture

The data was collected from knowledge Institutions and the TVET colleges comprised 17 respondents. The findings indicated 15 respondents is which 88% were aware of CSA practices while 2 represented 12% (see figure 10) unaware of CSA practices. Majority of the interviewed respondents were familiar with climate smart agriculture and this opens high opportunities for up-scaling CSA to trainees.
The data was further analysed to determine the significant different male and female respondent and the P value was 0.002 (see table 7) and we conclude there was a significant difference on the male and female respondents' understanding CSA.

Figure 10: Climate Smart Agriculture Awareness



Source: (Author 2018).

Table 7: : Climate Smart Agriculture Awareness

	Levene's test		
		P Value	**Conclusion**
Figure 10	Climate smart awareness	0.002	There is a significant difference on respondents' understanding of CSA

NB. Levene's results are in annex 11

4.1.7. Knowledge institutions

The knowledge Institutions as shown in table 3 included Nairobi University- the Animal production department, Wangari Mathai Institute, Institute of Climate change and adaptation, Egerton University and Nairobi University-Animal production. All the four Institution administers their mandate of knowledge transfer and data was collected on presence or absence of a practical farm for CSA, up-scaling CSA activities and the approach used and the presence or absence of courses in their curriculum on climate smart agriculture.

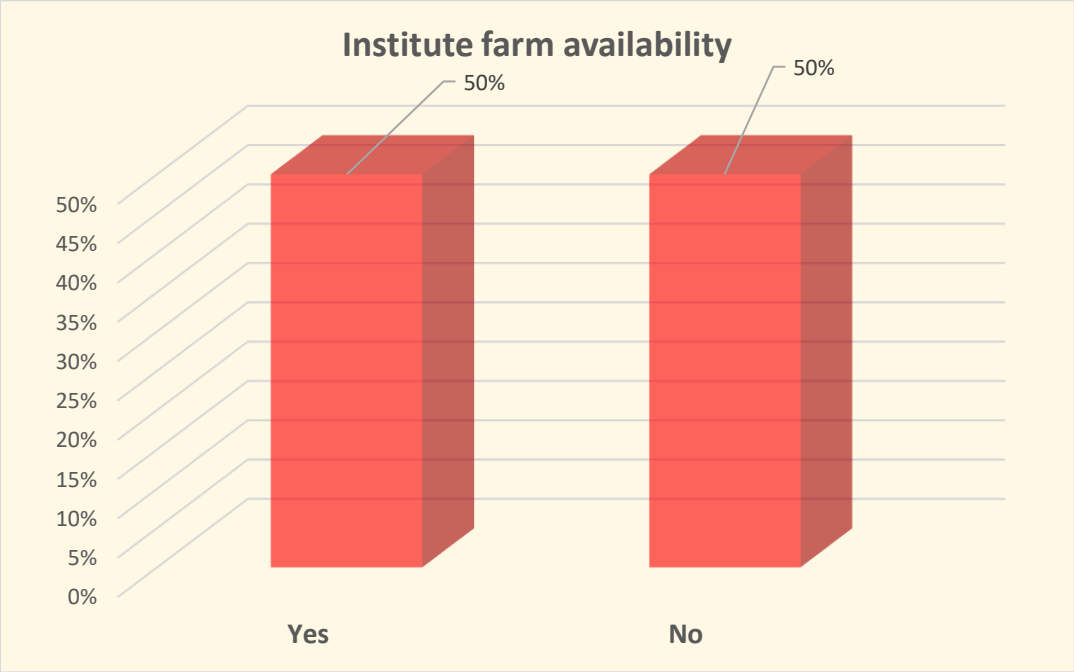
Table 8 and figure 10 show response on the presence of the farm for integration of CSA and is useful for agronomical practices though frequent tillage may reduce CSA mitigation. The land is utilized for fodder- Napier mixed with legumes. Outreach venues are opportunities for the knowledge Institute to up-scaling CSA at inhouse training and away from the institution.

Table 8: Presence of the Practical Farm and up-scaling activities and approach used

Knowledge Institution	**Practical farm present**	**Up-scaling activities**	**Approach**
Egerton University	Yes	Yes	Out-reach & In-house
Wangari maathai Institute of Peace and Environmental studies	No	Yes	Outreach and Pairing local student with Foreign student staying in need villages
Institute of climate change and adaptation	No	Yes	Outreach & Inhouse
Nairobi University (Ap)	Yes	No	N/A

Source: (Author, 2018)

Analysis of knowledge Institute Farm availability



Source: (Author, 2018)

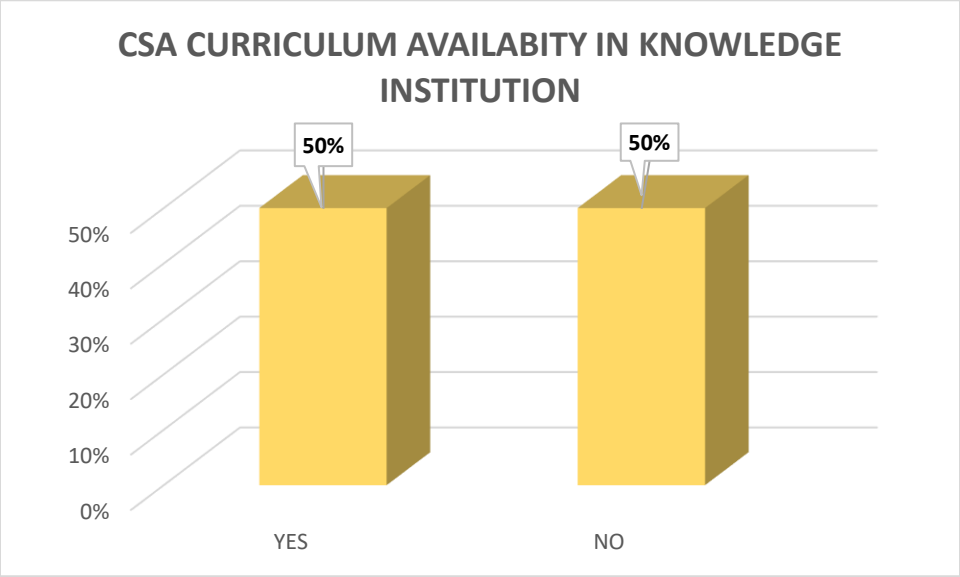
The data collected on presence or absence of courses on climate smart agriculture are shown in table 9 and figure 11 data shows 50% of the knowledge institutions sampled offers courses in CSA practices at different programme levels and type.

Table 9: Curriculum covering climate smart Agriculture.

Knowledge Institution	Response	Programme Level	Type of Programme
Egerton University	Yes	BSC, MSC& PhD	All production courses (e.g. Dairy Cattle, Shoats, Camel Production)
The Wangari Maathai Institute	No	N/A	N/A
Institute of Climate Change and Adaptation	Yes	MSc & PhD	Climate Change & Adaptation
UoN Animal Production Section	No	N/A	N/A

Source:(Author 2018)

Figure 11: Curriculum covering climate smart Agriculture.



Source: (Author, 2018)

Climate-smart practices implemented at the Knowledge Institutions that were useful to agricultural production was as revelation from the interviews conducted on the various activities at their practical farms.

4.1.8 TVET colleges

These refer to DTI, Baraka college and Ahiti Ndomba and are mandated to transfer knowledge and skills and similarly to the knowledge Institutions interviews were conducted on same factors. Findings were positive on presence of practical farm and up-scaling activities for all the colleges and all used the same approach of outreach as well in-house training as depicted in table 10 and figure 12. Fortunate for the colleges as the farms can be utilized to disseminate CSA agronomic practices like fodder and pasture planting and rotations, woodlots establishment, and for demonstration plots within and outside institutes and a big opportunity of up-scaling CSA.

Table 10: Presence of the Farm and up-scaling activities and approach used

TVET College	Practical farm present	Up-scaling activities	Approach
DTI	Yes	Yes	Outreach & In-house
Ahiti Ndomba	Yes	Yes	Outreach & In-house
Baraka College	Yes	Yes	Outreach & Inhouse

Table 10: Curriculum covering climate smart Agriculture.

Figure 12: Presence of the Farm and up-scaling activities and approach used (TVET)

Source: (Author 2018)

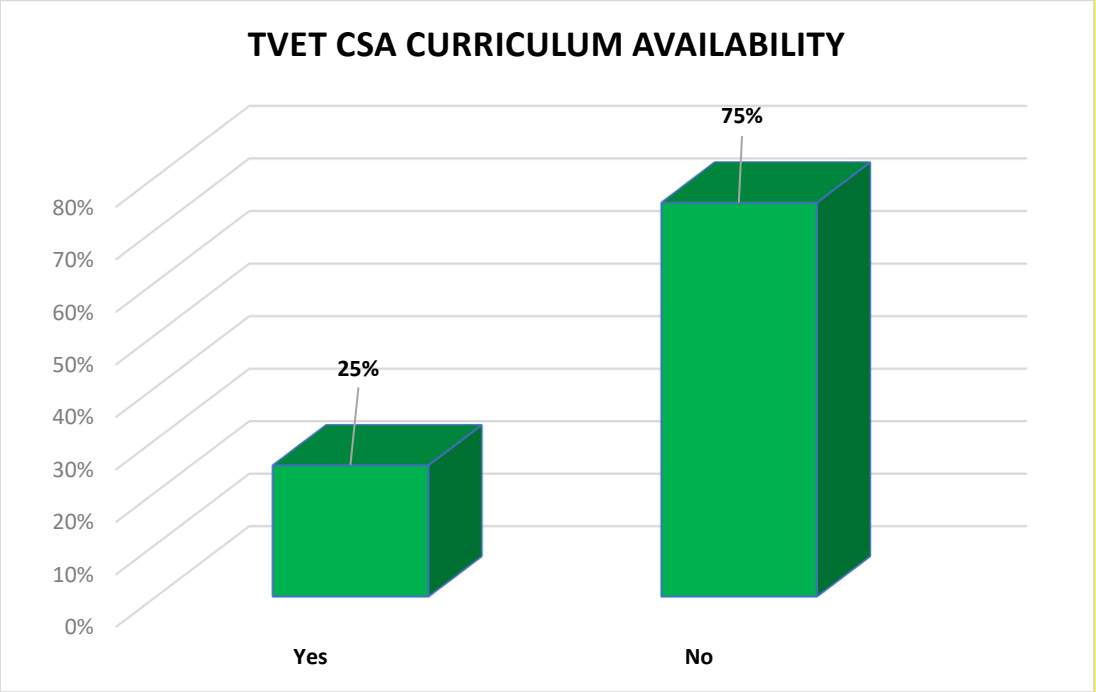
Concerning the CSA curriculum, it was found that only Baraka college offers courses in climate smart agriculture

Table 11: Curriculum covering climate smart Agriculture.

TVET Colleges	Response	Programme Level	Particular Program
DTI	No	None	N/A
Baraka College	Yes	Certificate& Diploma	Sustainable Agriculture and Rural development program-no programme specified
Ahiti Ndomba	No	None	N/A

Source:(Author 2018)

Figure 13: Presence of the Farm and up-scaling activities and approach used (CSA)



Source: (Author, 2018)

4.1.9 Government Ministries.

These included Ministries of Agriculture, Livestock and Fisheries department and Energy, and Natural Resources. The two ministries have the mandate to promote CSA practices at policy level, ensuring Kenyans understand their responsibility using the correct practices to increase productivity, food security, and protect the environment and Natural resources.

4.1.9.1 Ministry of Agriculture livestock and Fisheries Department (MoALFD)

The major role is service delivery to farmers in areas of agricultural practices and livestock management like agronomical practices, conserved agriculture, fodder production, breeding services, animal health, feeds and feed management. Reach farmers through training either in house or extension.

4.1.9.2 Ministry of Environment and Natural Resources

The ministry addresses four areas; water and Sanitation, environment, forestry, and natural resources and energy and climate change. Climate change is new unit with a mandate to promote renewable energy and climate change initiatives through education awareness by engaging the community through advocacy and training. Training include significance of tree cover, water conservation and protection natural resources. The ministry promotes alternative energy sources such as biogas, biomass and convert wastes to briquettes. Energy and Climate unit gives priority to women, youth & people with disabilities. Already, a curriculum has been developed targeted at

all public schools in Kiambu. The goal is to reach out to 60 schools. Ultimately, the department of Energy and Climate Change seeks to scale-up to five schools in every sub-county.

4.1.10. Non-governmental Organizations and consultants

This represents 36% of the Dairy value chain supporter as seen in table 3. They have an interest to promote CSA practices through poverty alleviation and increase productivity and profitability of rural household and small-scale farmers already engaged in a specific value chain. From the interviews data collected is summarized in table 12.

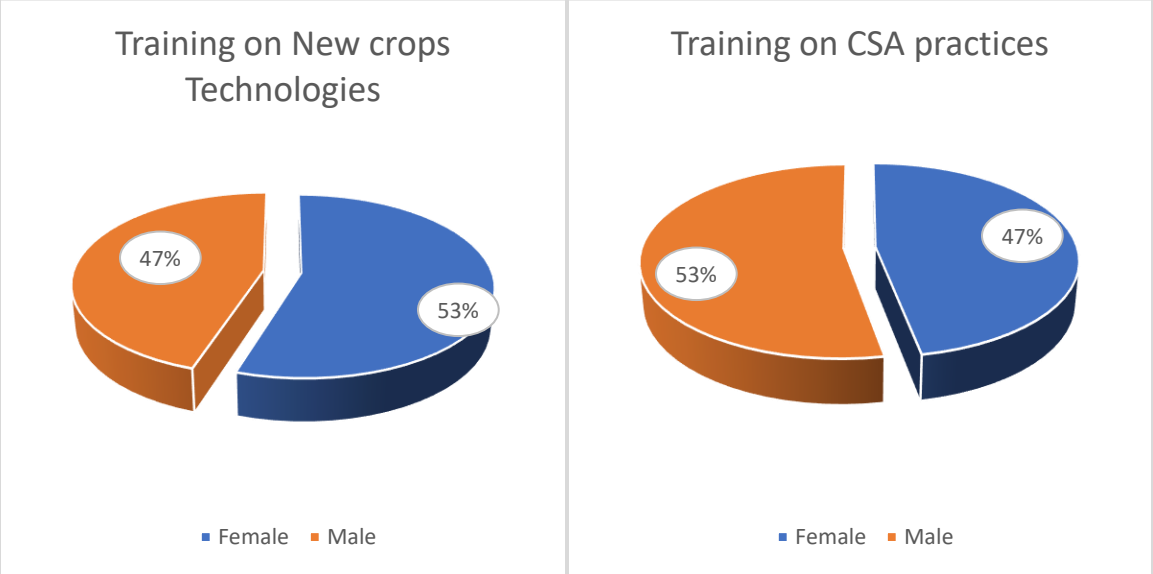
Table 12: Agricultural activities performed by NGOs and Consultant Firm

ASDSP	Value chain- food security, poverty alleviation, Environmental resilient	Training/up-scaling	Organized farmers Created linkages Increased milk production
SNV	Capacity building Renewable energy Livestock production	Reaching farmers, training	-17,000 Biogas installed -Increased milk production -2409 farmers trained -Increased CBEs coordination -Job creation
3R	Institutional governance Resilience of innovation Supply integration	CSA practices -adoption and mitigation	-Increased maize silage -QMP not successful
ILRI	Research & up-scale CSA across the county Breeding-milk production Fodder production	CSA projects mitigation &adoption Low emission	-Fodder adoption -Increased milk production -CSA knowledge and skills gained.
KCSAP	Increase agricultural productivity Shape resilience to climate change risks	Inception phase Formulation of TIMPs on value chains in 24 counties	-Increased productivity, -Reduced GHG emissions. -Enhanced resilience -521,500 beneficiaries
NARIGP	Increase agricultural productivity & profitability Respond to emergence in 21 counties	Implement TIMPs Strengthen Producer Organizations, Value Chain Development	-Inception stage
Agriprofocus	Networking Collaboration food security	Climate smart Inclusive business Nutrition	25,000 agribusiness professionals registered worldwide
Performeter	Livestock consultancy Dairy knowledge dissemination	Training- Dairy managers course Dairy investors course	Published two dairy magazines

4.1.11. Kenyan agricultural Research Institute

A governmental organization mandated to conduct research in Kenya. Data collected indicated successful trainings of 733 (47% male and 53% female) trainers on new crop technology and 272 (53% male and 47% female) trainers on climate smart practices in Eastern and Western Kenya as shown in figure 14. KALRO Naivasha has done research on Sahiwal breeding, have bred cows with increased milk production in addition to successful fodder adoption techniques by farmers in different counties and encourage the use bio-slurry and manure as fertilizer. These activities promote CSA practice

Figure 14: Training of trainers at KALRO



Source: (Adopted from KALRO 2018)

Table 13: Swot analysis for supporters

PESTEC	SWOT			
	Strength	Weakness	opportunities	Threats
Political Robustness	-Well-established learning institutes -Equipped Research Institutes -Large dairy herd - Presence county and national offices	-Weak enforcement of CSA policies -Insufficient accommodation -poor programme stream-lining -Weak monitoring and Evaluation system	Political good-will in support of CSA -Kenya NAMA and other programmes support CSA Most farmers have land titles which enriches CSA practices	-Low admissions of university students due university competition and GOK subsidies -Political violence -Poor Infrastructure -Regular strikes -Corruption

Economic Robustness	-High consumption of milk -Established processing plants	Weak Market development strategies -Lilted niche market access for CSA products -Inefficient procurement systems -Obsolete training equipment -low staff capacity Low staff morale	-Supporters willing to subsidize Training -Supporters ready to invest in dairy sector -High demand for dairy products -Youth ready to invest in profitable dairy business - Availability of new innovations. - Better networking with stakeholders -Existence of collaborating institutions -Good rapport with stakeholders	-Few collaborators -High Livestock diseases
Social Robustness	Strong relationship with other stakeholders Labour-force available	-Institutes unknown Ageing technical staff -poor succession management	Producer organizations offer venues for the improved services Clearly defined responsibilities in departments	-poor milk ethics -Land subdivision -HIV/AIDS infection
Technological Robustness	-Large land available in Institutes -Well trained experts	-Low CSA knowledge	-Dairy farmers educated and collaborative. -Intensification of crop-livestock integration -Well defined departmental responsibilities	
Environmental Robustness			-Suitable environment for dairy -Promotion of green energy	-Climate effects -GHGs emissions -Environmental degradation

Source: (Author 2018)

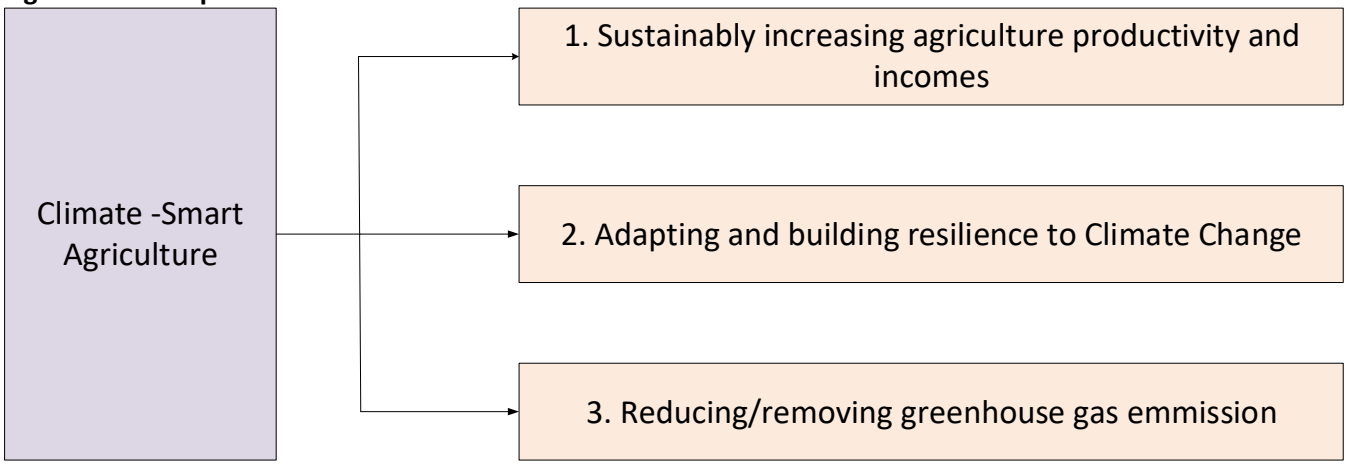
From the data which acts as pointer, there is need for CSA integration in the livestock sector and it is a responsibility of all supporters

4.2 CSA integration strategies by supporters

Figure 15 is an illustration of three pillars of CSA on increasing productivity and income, adoption and building resilience and reducing GHGs emissions. The three pillars can be expressed in terms of data collected on supporters' activities on milk production, CSA practices and up-scaling activities. Knowledge and skills

disseminated by supporters to trainees within the universities, colleges and in counties will eventually result into adoption of CSA practices hence increased productivity and income, building resilience and reduction of GHGs emissions.

Figure15. Three pillars of CSA

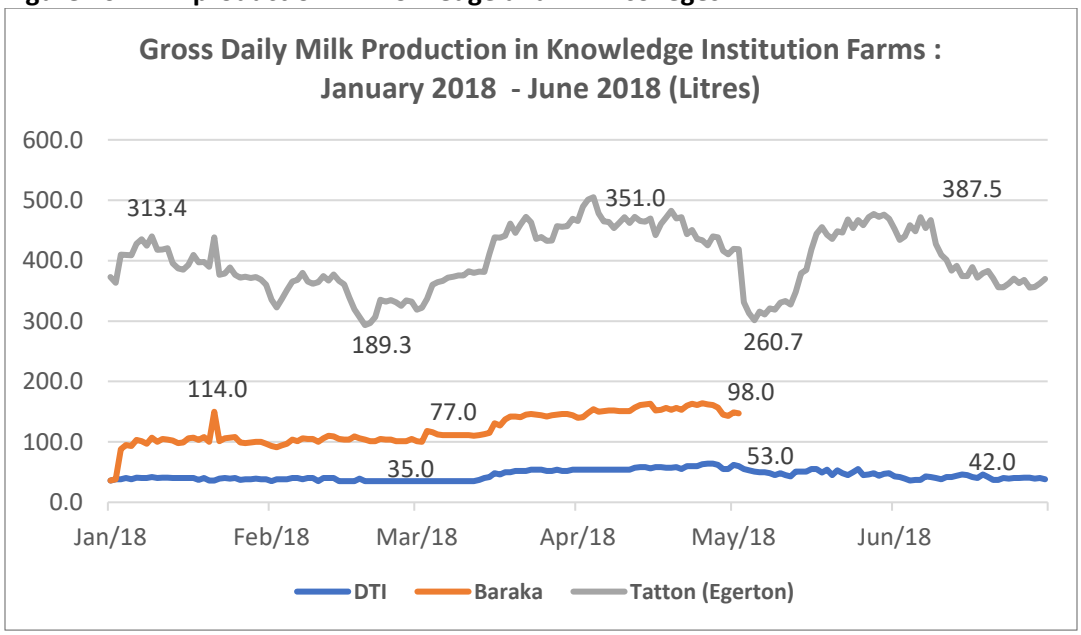


Source: Author 2018

4.2.1. Milk production in Knowledge Institute and TVET Colleges

Data on milk was collected from DTI, Baraka and Egerton university. Egerton and DTI provided six months milk production data for 2018 while Baraka provided twenty-two months' worth of milk production data from June 2016 to May 2018. Comparing the production as shown in figure 16 Egerton university had the highest daily production, followed by Baraka and DTI.

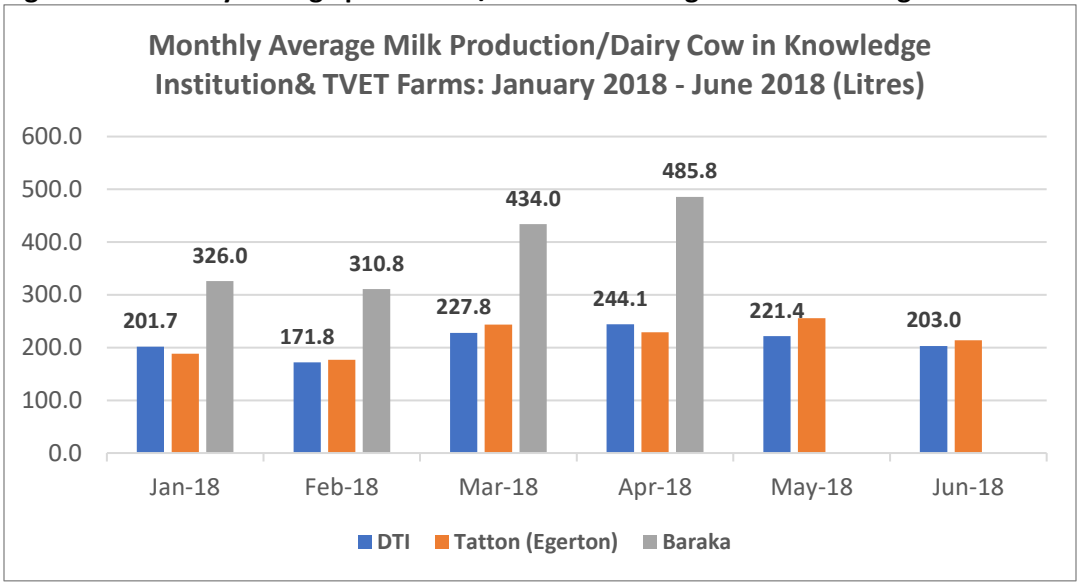
Figure 16: Milk production in knowledge and TVET colleges



Source: (DTI/Baraka/Egerton.2018)

Further analysis was done on milk about monthly averages and resulted that Baraka had the highest as compared to Egerton that had highest number of animals as seen in figure 17.

Figure 17: Monthly average production/cow in Knowledge and TVET college Farms



Source: (DTI/Baraka/Egerton.2018)

Effect of season on Milk Production

	Months											
	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Rainfall			**Long rains**					**Shower and sun**			**Short rains**	
Milk production	Low milk		Below normal milk production		Excess milk		Below normal milk production			Low milk	Below normal	Normal prod.

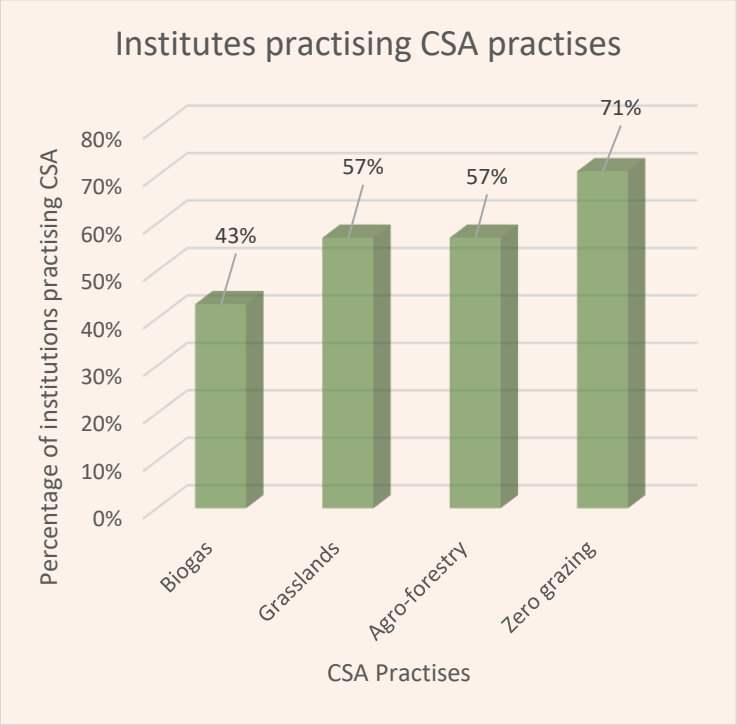
Source: adoption from Focus Group

NB: Towards the end of October short rains start and it may rain few days in January. July up to mid-August are the coldest months in Kenya, however, this year the weather pattern has completely changed and Kenya has experienced too much rains and colder.

4.2.2 CSA practices by knowledge Institutes and TVET colleges

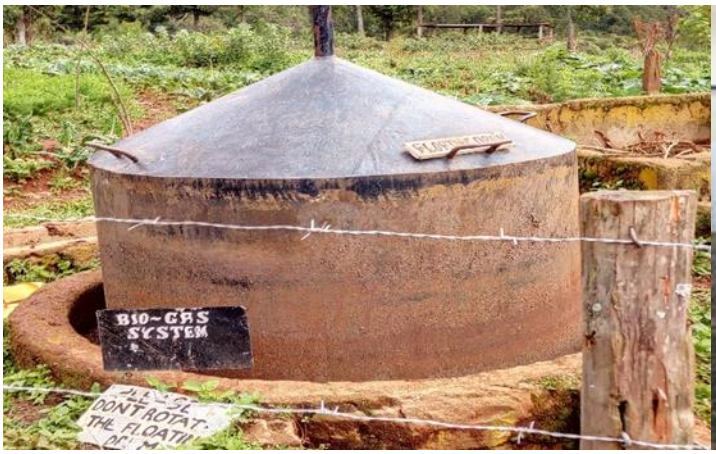
The practices included Agro-forestry, biogas (energy utilization), grassland, Livestock management/ zero grazing were available at knowledge Institutions and TVET colleges (7 in total) as indicated in figure 18.

Figure 18: CSA Practices at Institutions and TVET Colleges



Source: (Author 2018)

Picture: 1:Researcher observing CSA at Baraka.



Picture: 2::Bio-digester at Baraka

Picture 3:Researcher at Egerton Farm

Picture: 4: Transect walk at Egerton ***Picture: 5: Research team at farmer' home***

4.3 Dissemination and up-scaling activities

The data collected entails the strategies and up-scaling activities of CSA practices administered by Knowledge Institutes and TVET training colleges and their impact. As mentioned earlier these teaching institutions have a mandate to transfer knowledge and skills to Kenyans. Strategies include taught courses in the curriculum, modelled demand-driven courses in CSA practices and up-scaling activities at in-house and or outreach programmes.

4.3.1 Strategies at knowledge institutes and upscaling activities

ICCA and Egerton university teach courses in CSA in their curriculum at different levels but WMI and Nairobi - Animal production do have courses in CSA. None of the universities have short courses in CSA. Egerton does upscaling in 5 counties namely Kilifi, Bungoma, Nakuru, Kajiado and Tharaka Nithi and targeted at livestock management, agronomic practices and aquaculture, however, the university doesn't single out CSA practices.
WMI identifies their up-scaling activities through a need's assessment of the selected area. Findings indicated villages in Nyeri were assessed and students were attached there to collect more information on the problems (see table 14) then solutions to the problems were searched, and later published and was communicated back to the villages. ICCA offers courses in CSA at Masters and Ph.D. level hence there is need for it to offer short course in CSA especially for clients not ready to go for long courses. Findings indicated it did up-scaling activities in Oloitokitok and kajiado shown in table 14.

Table 14: up-scaling activities of knowledge Institutes

Institute	Location	Thematic Area	Approach	Goals
Egerton	Counties	-livestock management -Feed production -Fish-pond management -Dryland cropping - water harvesting -kitchen gardening	Outreach Inhouse	Farmers adopted the techniques
WMI	Nyeri	-livestock -crops -Environmental issues.	Outreach & pairing local and foreign student	Published & return solution to area
ICCA	Oloitokitok Kajiado	-Needs of the area	Outreach	Improved lives of vulnerable

Source: (Author 2018)

4.3.2. Strategies at TVET colleges and upscaling activities

The Dairy Training Institute (DTI) teaches certificate, diploma and short courses in Dairy technology and animal production and runs demand driven upscaling programs, in collaboration with Smallholder Dairy Commercialization Program (SDCP) and trains farmers on animal production and dairy technology. Baraka teaches certificate and diploma in sustainable development and does up-scaling activities in 5 villages namely Soweto, Shalom, Kisii Dogo, Bahati and Twin Stream and thematic areas include compost production, dairy production, fodder production, manure management and pest management and poultry farming. Ahiti Ndomba offers animal health and production at certificate, diploma and short courses and their up-scaling activities are concentrated at villages at the college. All shown in table15.

Table 15: up-scaling activities of TVET colleges

Institute	Location	Thematic Area	Approach	Results/Evaluation
DTI	9 Counties	Animal Production & Milk and Milk Products	Outreach & Inhouse	Residential -378 farmers trained Non-residential -720 farmers trained
Baraka	5 villages	Livestock Prod.-Manure, compost mgt	Outreach	Good progress, political crashes Destroyed major work
Ndomba	Communities around	Animal health Feed management	Outreach In-house training	Low animal disease incidents Adoption of feeding practices.

Source: (Author 2018)

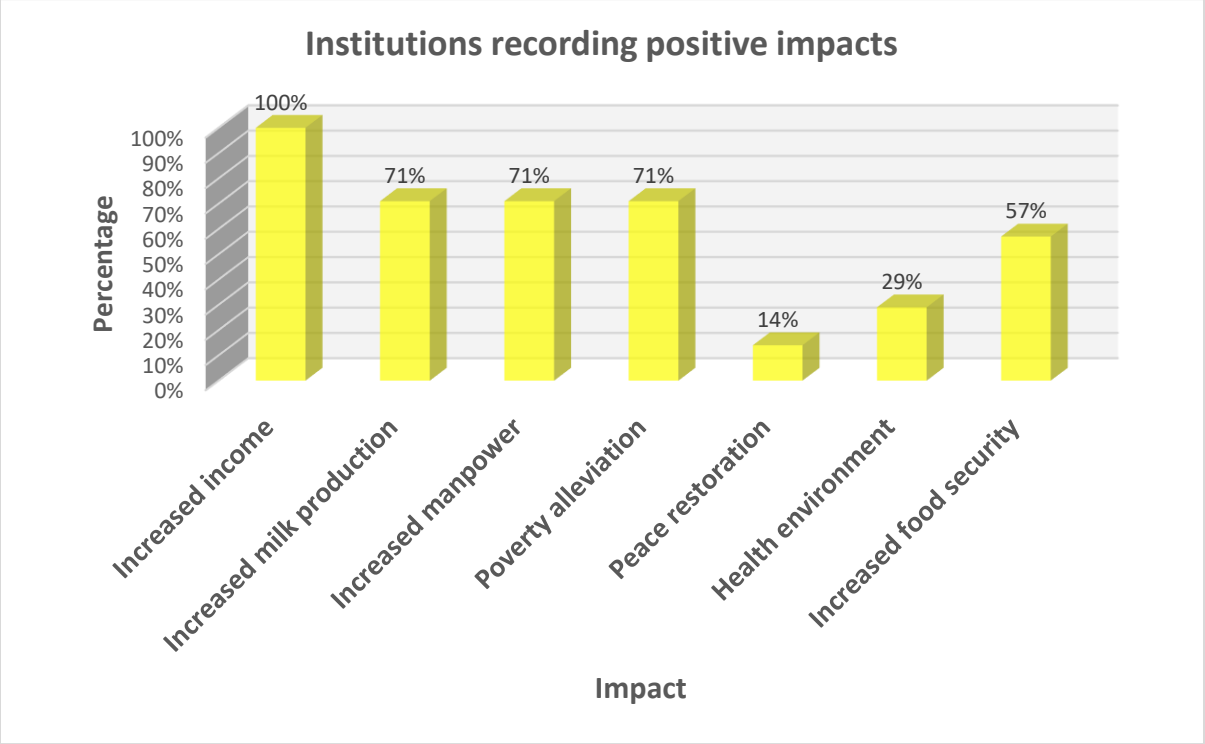
The approach strategy in knowledge institutions and TVET colleges variety such as areas of needs assessment or selection of the field, paring foreign students with local student (WMI), neighboring villages-Ndomba and Baraka,

working with counties DTI and Egerton. In addition, ICCA conducted field visits, demonstrations, consultations, research and publications.

4.3.3. Impact of Institutes and TVET due to dissemination and up-scaling.

The dissemination and up-scaling activities resulted into impact such as increased income, increased milk yield, increased food security (low emissions), poverty alleviation, increased manpower and peace restoration. This was as a result of the interviews conducted. The impact was rated in the 7 learning institutes and data is shown in figure 19 was obtained. 100% implies a positive impact at all institutions **(7/7 multiplied by 100%= 100%)** though none of the respondents provided quantitative data on the impact.

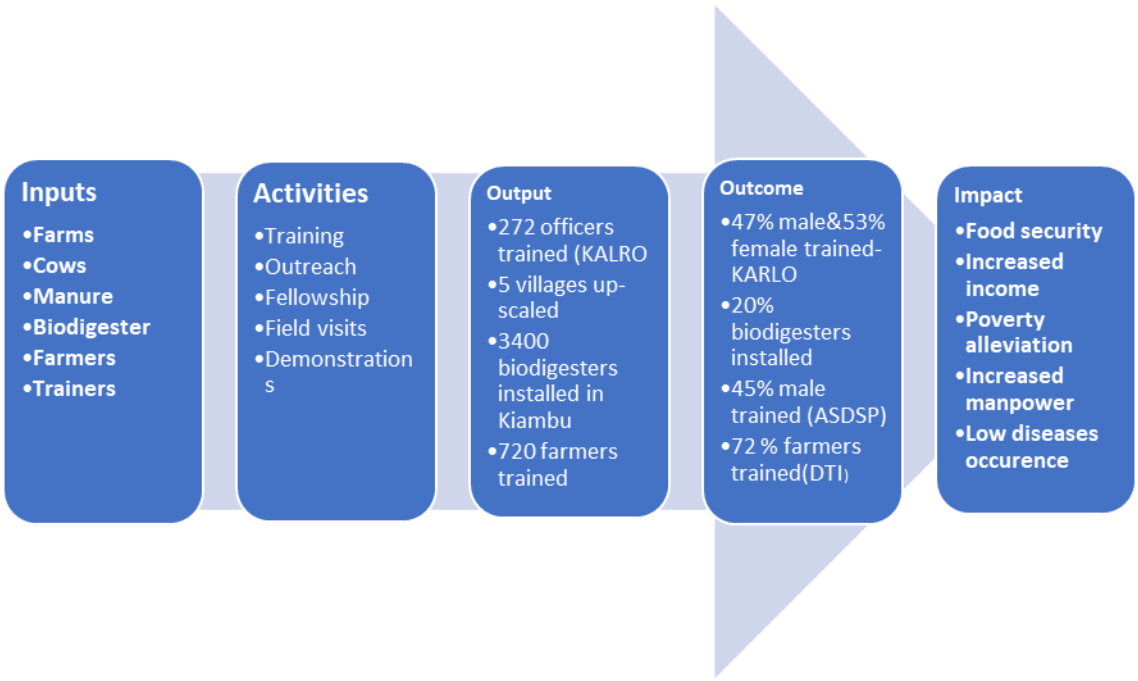
Figure 19: Positive Impact of Knowledge and TVET Colleges



Source: (Author 2018)

4.3.4. The theory of change

The theory of change is an illustration of the up-scaling event that was organized as shown in the figure below. It states the inputs, activities undertaken, output, outcome and the impact. The information used has been taken from results of SNV, DTI, KALRO and ASDSP.



Source: (Author 2018)

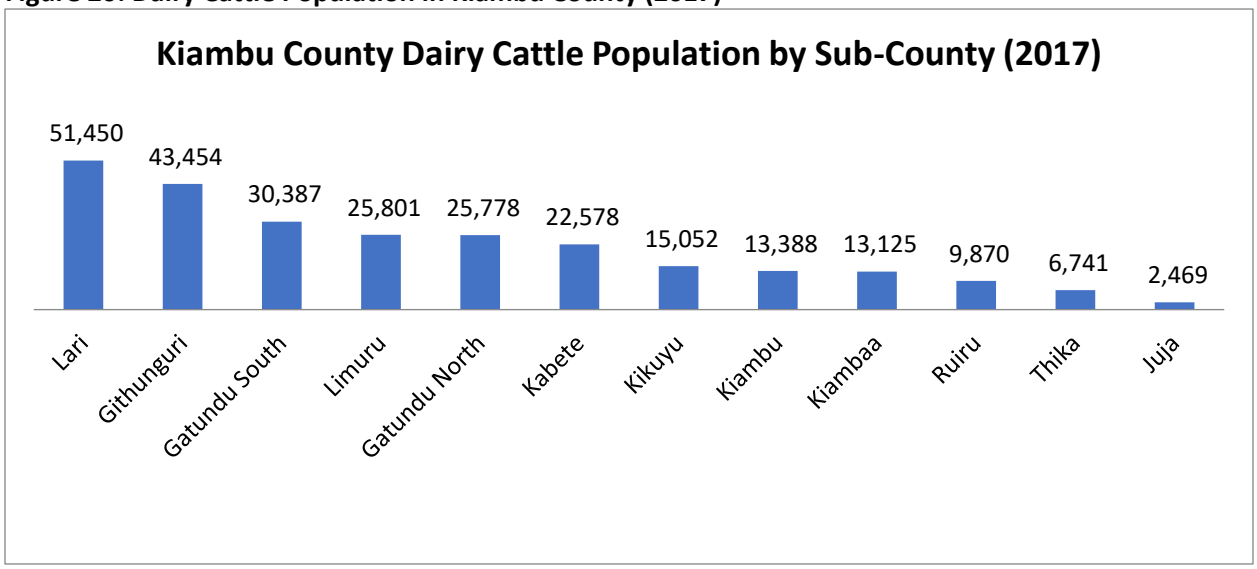
4.4 Dairy Sector in Kiambu

The data collected focused on milk production and number of dairy cattle in Kiambu with a biasness on Githunguri and Ruiru where the research was undertaken. A comparison of the milk volume and dairy herd and gender headed house-hold analysis was done. A general overview of trainings on CSA and its implication on CSA adoption.

4.4.1 Milk Production in Kiambu

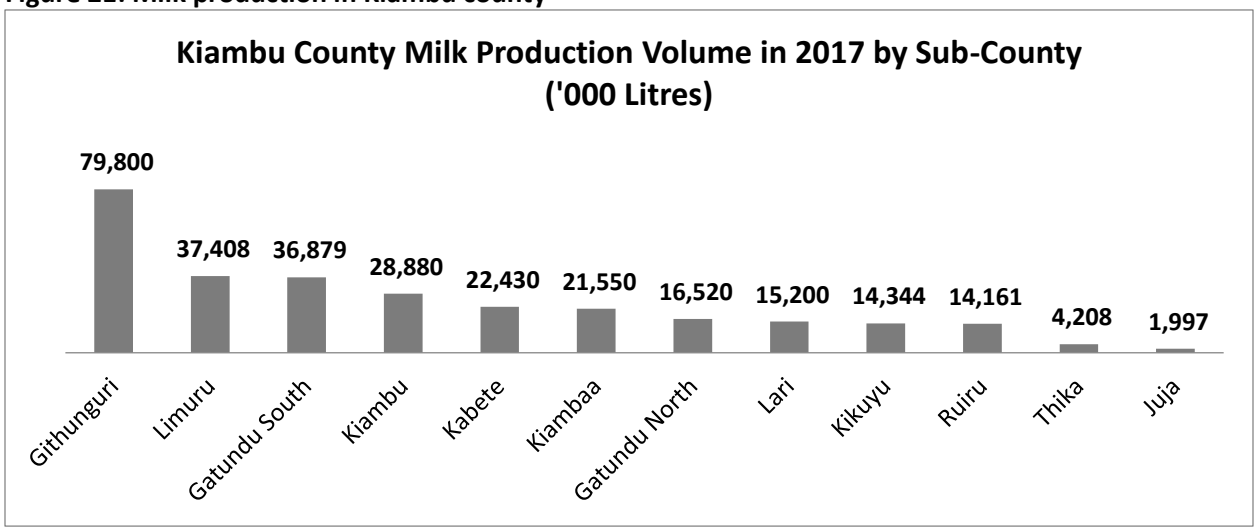
The data was collected on number dairy cows (as shown in figure 18) in Kiambu which stood at 260,091 producing 293,377,973 litres of milk (see figure 20 and figure 21). Githunguri subcounty had 43454 dairy cows and produced 79,800 kg of milk compared to Ruiru with 9,870 dairy cows producing 9,870 kgs of milk.

Figure 20: Dairy Cattle Population in Kiambu County (2017)



Source: (Adopted from KMoALF.2018)

Figure 21: Milk production in Kiambu county



Source: (adopted from KMoALF.2018)

4.2.2.1. Milk production in Kiambu varied by gender.

Across all dairy cow breeds, male-headed households produce higher milk yields per cow per day than female-headed households in all breeds and per season however youth headed household did better in only the exotic breeds. As show in table 16 and 17, the trend is invariable with the seasonality effects as indicated in table 13 as in wet season there is more milk due rain available for agronomical activities as compared with the dry season.

Table16: Milk production by Dairy Breed and Gender during the wet season in Kiambu County

Average Milk Production of Different Dairy Animals by Gender /cow/day during the wet Season(kgs)				
Type of livestock	**Male headed household**	**Female headed household**	**Youth headed household**	**Overall**
Local cattle	5.3	4.4	3.9	5
Cross breed cattle	10	8.7	7.5	9.4
Exotic cattle	12.6	9.9	13.2	12.1

Source:(Kiambu MoALF 2018)

Table 17: Milk production by Dairy Breed and Gender during the dry season

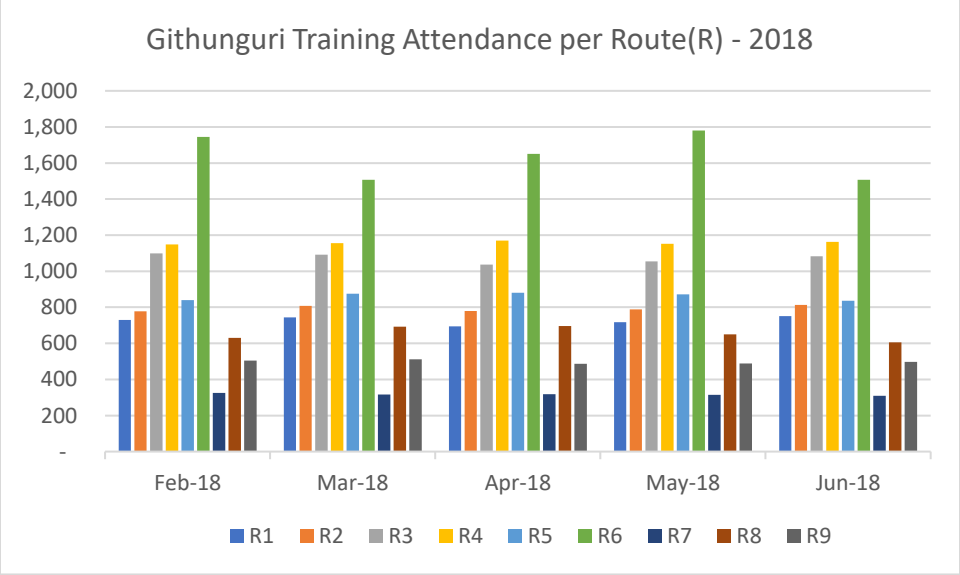
Average Milk Production of Different Dairy Animals by Gender /cow/day during the Dry Season(kgs)				
Type of livestock	**Male headed household**	**Female adult headed household**	**Youth headed**	**Overall**
Local cattle	4.9	4	3.3	4.6
Cross breed cattle	8.8	7.6	7.1	8.3
Exotic cattle	10	9	11	9.9

Source:(Kiambu MoALF, 2018)

4.2.1.2. Focus group at Githunguri cooperative

Findings indicated Githunguri had total of 24,936 dairy farmers of whom 14,000 were active members monthly. Trainings are organized monthly on Animal production and Health issues, financial management, and stress Management and usually, 50% of the farmers are trained from nine collection routes(R). Figure 22 shows trainings held in monthly in the nine collection routes.

Figure 22: Githunguri farmers training in 2018



Source: (Githunguri report. 2018)

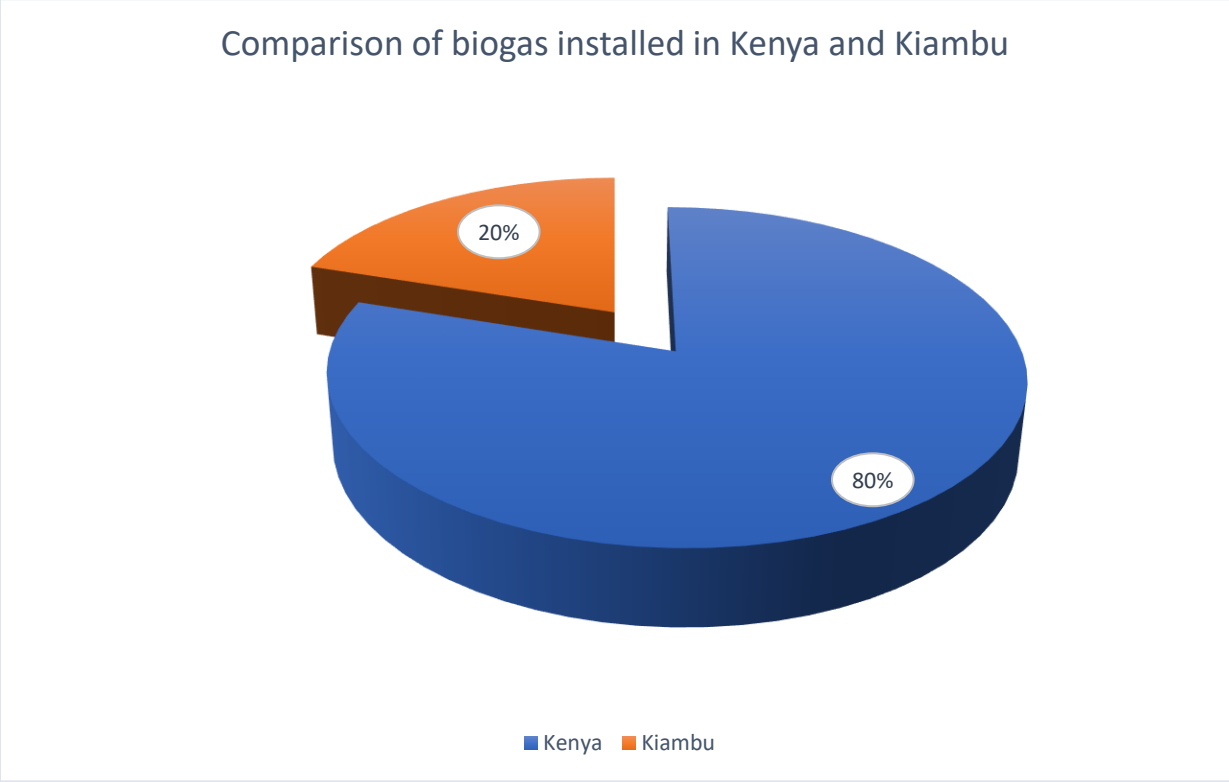
Though trainings are held, CSA practices are not singled out, but mainly organized as good livestock management practices and this has yielded fruits as milk production is high in Githunguri as compared to Ruiru as seen in figure 21.

4.2.1.3. Biogas installation

Data shows 3400 biodigesters have been installed in Kiambu compared to the initial projection of 40,000 by 2017 and 60,000 by 2025 by SNV Kenya. The adoption rate has been low and reason cited were limited awareness and high cost though compared to whole country Kiambu is doing well at 20% in comparison to 80% accounting for 46 counties, where 17, 000 biodigesters have been installed in the whole country as shown in figure 23. Biogas project is led by SNV Kenya in collaboration with other partners like Kenya biogas programme and Hivos.

Biogas is one way of promoting CSA practices hence there is need to encourage its promotion by supporters through awareness (trainings specifically on manure management and benefits of biodigesters) and more subsidizes in terms of loans.

Figure 23: bio-gas installed in Kenya in comparison to Kiambu



Source: (SNV.2018)

4.2.1.4. Gender Analysis

GENDER	Activities
Women	-Young were in in-put supply, milk sales, quality control -older were in milk production Most women were educated and empowered, run business and shared in the benefits Were represented by 30% in GOK employment
Youth	In milk production and transport, In road-shows, hubs and procurement
Men	In milk production and large- scale transport In real-estate business and share-holder of the co-operatives

Source: (Author 2018)

4.5. Partners of Dairy value chain supporters

Findings indicates almost all the knowledge institution partners are either NGOs, research, academic organizations and government Institutions. The partners largely act as financiers or research partners on projects.

4.5.1. Value chain governance and agricultural policies

Kiambu milk chain operates under market and modular governance. Market governance is all about trade and price between the buyer and the seller as there is minimal interaction as the case dairy farmers in the informal market. Githunguri cooperative operates its milk under modular governance as there a lot of linkages between farmer and cooperative on milk delivery, trainings offered, transport arrangements and food and feeds exchange. In Kenya, there are a number of agricultural policies set which have to be implemented by the Ministry of Agriculture Livestock and Fisheries and Ministry of Environment and Natural resources. Findings point at National climate change Response strategy of 2010, National climate change plan of 2013, NAMA but practically on farms only crops law, Forestry laws, land sustainability, environment protection, water use, and conservation are applicable. The supporters have to adhere to these laws and are subject to GOK scrutiny but it doesn't interference with the business and choice of operation though it has been with the agenda of the country.

4.6. Support organizations

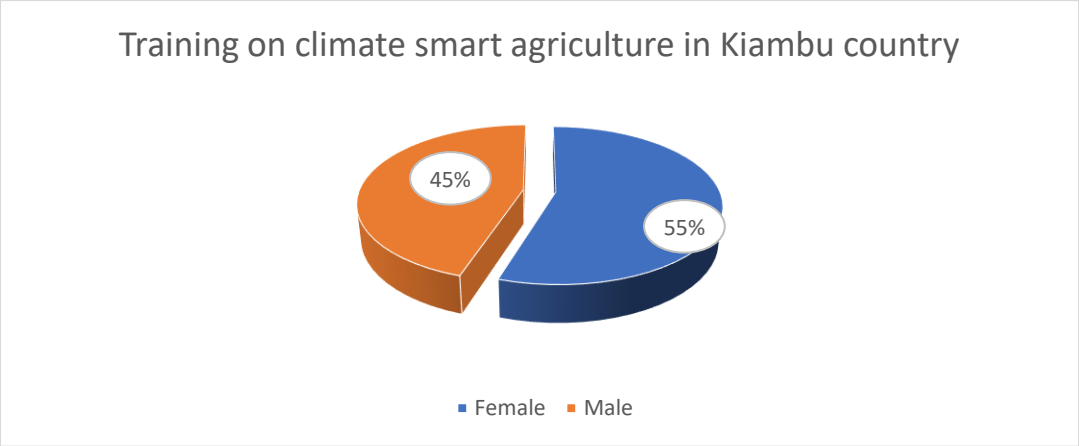
These are partners that supporter the dairy sector financially or in equipment and or capacity building. The can be NGOs, private organizations or consultants firms.

4.6.1. Agriculture Sector Development Support Programme (ASDSP)

This is a value chain project in Kiambu whose goal is to change Kenya's agricultural sector into an innovative, commercially oriented, competitive and modern sector which will contribute to improved food security, poverty reduction and equity in rural and urban Kenya, through environmental Resilience, social inclusion and value chain Development Targeted at increased milk and capacity building to service providers in public, private sector, and farmers.
Achievements include farmers organization and dairy platforms, created linkages, Increased productivity

and given coolers to farmers. Barriers included aging farmers, no succession plans, Poor facilitation, individualist approach hence informal market dominates. Training organized by the ASDSP where 11,442 males and 11998 females were and trained on CSA technologies

Gender training on Climate Smart Agriculture



Source: (KMoALFD, 2018)

4.6.2. SNV

SNV provides capacity development services to nearly 2,500 organizations in thirty-six countries worldwide (SNV Kenya,2016). SNV Kenya's operations span agriculture, renewable energy, water, and sanitation. It targets dairy and coffee smallholder farmers in Kenya and runs two biogas projects.

SNV Kenya evaluates its work on the KMDP on five thematic areas: Capacity building of CBEs in governance and financial management, training and extension activities for farmers, fodder development and preservation at CBE- and farmer level, business development with input suppliers and service providers and milk procurement and milk quality along the value chain. Achievements of SNV/KMDP are increased milk processors investment in training & extension services, adoption of fodder preservation and increased ensiled volumes, more involvement with CBEs, food security for 20,498 famer households, increased annual milk production, created 4,939 jobs at farm level and with processors and trained 2,409 farmers and 200 lead farmers

4.6.3. 3R (Resilient, Robust, Reliable)

3R Kenya Project focuses on dairy and research areas are cost of production, commercialization of fodder access and milk quality testing. It is examining emerging market-led Commercial Fodder Production (CFP) innovations in a bid to address the feed challenge in dairy sector, low quality, and inadequate fodder. 3R Kenya is also conducting a study on SNV's Service Provider Enterprises (SPEs) to assess their performance and effectiveness in providing sustainable incomes to youths in). Last but not least, 3R is implementing an applied study on emerging innovations in milk marketing with the goal of growing volume of milk through formal sector channels.

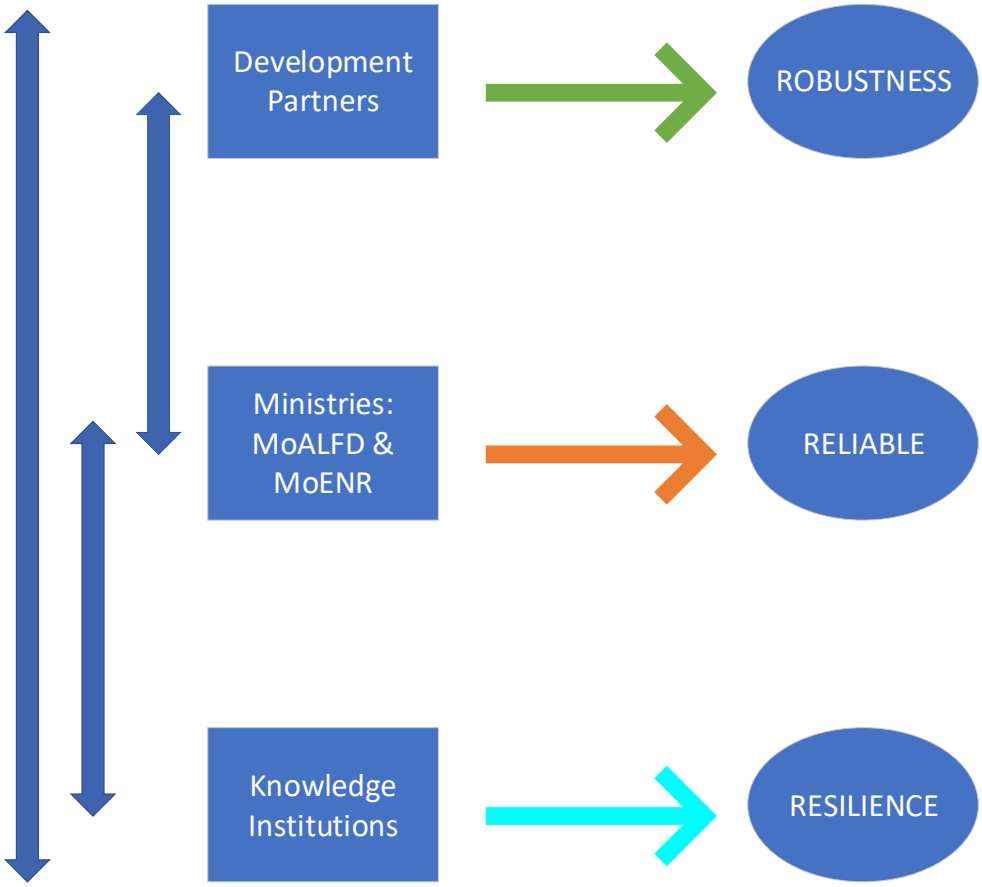
The Model Figure 15 describe the principle of 3 R- robustness, reliable and resilience that can be at applied by 10 organization interviewed. There are some relationships between them and each has a core function.
Sustainability growth and competitive dairy sector in Kenya is critical and there is need for resilient, robust and reliable economic business for dairy farmers.

Robustness focus on the dairy value chain integration in order to reduce transactional costs, enhance profit, promote efficient transactions with supply chain partners. It also enhances product safety and reinforce sustainability.

Reliability refer to institutional governance focusing on stakeholder's integration (government and private cooperation in the dairy sector on policy support and private investment.

Resilient is about knowledge exchange on innovation systems that are supportive in development. The model is important where producers are encouraged to engage in dairy farming as a business and apply CSA practices available at subsidized fees or pay fully.

3 Robust Reliable Resilient Model



Source: (Author 2018)

4.6.4. International Livestock Research Institute (ILRI)

The ILRI conducts upscaling activities in counties across Kenya targeted at improving animal and plant breeding milk production, fodder production and value addition. There are two projects on climate smart agriculture practices one on low emissions and mitigation and adaptation in the livestock sector. The low emission project will be conducted in three counties Nandi, Bomet and Murang'a research as from 2018.

4.6.5. Kenya Climate Smart Agriculture Project (World bank project)

Kenya Climate Smart Agriculture Project was initiated in 2017 and runs until January 2022. Its goal is to increase agricultural productivity and shape resilience to climate change risks in the targeted crop and livestock pastoral communities in Kenya and respond to emergence cases. The project is at the inception stage. KCSAP has five components which include 1) Upscaling climate smart agricultural practices to achieve the CSA triple-wins of increased productivity, reduced GHG emissions (mitigation) and enhanced resilience targeting 521,500 beneficiaries and increase milk production, 2)To strengthen climate-smart agricultural practices through support development, validation, and adoption of specific CSA TIMPS(technology Innovation Management Practices), 3)To support agro-weather, climate market, and advisory services to finance its development and their dissemination, 4) The project coordination and management to finance national and county-level project activities in coordination and management and 5) Contingency Emergency Response as a mitigation tool

4.6.6 Agri-profocus

It is networking organization with over 25000 registered agribusiness professionals all over the world. Its focus to meet food security challenge in collaboration. The organization encourages innovative 'agripreneurs' in inventing new, justifiable ways of doing business, exchange views and accomplish more in a philosophy of collaboration for people, planet and profit. Its key areas are CSA, Inclusive agriculture, Nutrition, agriculture, and circular economy.

4.6.7. Perfometer

The Main agenda of Performer is dairy and livestock consultancy in terms of advocacy and training. The organization, targeted at young well-versed experts in agri-business and agriculture related experts to form a consultancy team who work together to disseminate knowledge to dairy farmers at fee. Work done include construction, bill of quantities, training in dairy managers and dairy investors where two short courses are operated running for 6 days and 5 days respectively. Partners with SNV and Strathmore university to support training forums and capacity building of their staff.

4.6.8. National Agricultural and Rural Inclusive Growth Project (NARIGP)

The development objectives of NARIGP are to;
1. Increase agricultural productivity and profitability targeting rural communities in selected Counties and provide response in case of emergency,
It has four components;
1) Supporting Community-Driven development, aiming to strengthen community-level institutions' ability to identify and implement investments that improve their agricultural productivity, food security, and nutritional status and linkages to selected Value chains (VCs) and Producer Organizations.
2) Strengthening Producer Organizations and Value Chain Development aims to build POs' capacity to support member Common Interest Groups (CIGs), Vulnerable and marginalized groups to develop selected priority VCs in targeted rural communities.
3). Supporting County Community-Led Development aims to strengthen the capacity of county governments to support community-led development initiatives identified under Components 1 and 2.
4). Project Coordination and Management, finances activities related to national and county-level project coordination. Respondent cited poor relationship between research and extension on technology adoption by farmers

4.6.9 Supporter Matrix

Supporters	Roles	Suggestions to improve
Egerton University	Training	Incorporate CSA in other departments
Nairobi (A/P)	Training	Introduce CSA and do up-scaling
Wangari Maathai Institute of peace and Environmental studies	Peace and environmental training	Introduce CSA programmes
Institute Climate Change Adaption	CSA training	Introduce short courses in CSA
Dairy Training Institute	Livestock training	Introduce CSA programmes
Baraka college	Sustainable Agriculture	Partner with other TVET to share
Ahiti Ndomba	Livestock Training	Introduce CSA programmes
Ministry Agriculture Liv & Fishery Department	Service delivery	Focus more on CSA integration
Ministry of Energy & Natural resources	Energy & Natural resource service	Focus more on CSA integration
Netherlands Development Organization (SNV)	Capacity building, fodder production, milk quality	Concentrate more on CSA practices
3 Robust, Reliable Resilient	Value chain, policy, innovation	More focus and incorporate CSA
Agri-profocus	Networking	More focus on CSA- food security
International Livestock Research Institute	Research	Focus more on CSA, Low emission and mitigation
Agricultural dairy Development support programme	Value chain and CSA but not in Kiambu	Introduce CSA in other counties
National Agricultural Inclusive Growth Project	CSA Practices in 21 counties	Accomplish work, publish and share
Kenya Climate Smart Agricultural project	CSA practices	Accomplish work, publish and share

4.6.10. Business Canvas Model

From the findings, the key supporters were the ministry livestock in which all the practices (KCSAP and NARIGP) will be implemented and the Kenya Agricultural Livestock Research Organization. Selection based to CSA practices with wider scope in the country and where farmers traditional access information. In Kenya, the major entry for dairy farmers is MoALFD and KALRO hence the selection of the two business models.

Business canvas model for Ministry of Agriculture and livestock

<table>
<tr>
<td rowspan="2">Key Partners

NGOs
KALRO
Nairobi university
Jomo- Kenya University
Cooperative office
Ministry Energy & N. resources
International livestock centre
Micro-finance
Githunguri cooperative
Dairy training Institute
Takamoto biogas company
Kenya seed company
Brookside
</td>
<td>Key Activities

Training and extension
Composting manure demos
Improved fodder development and distribution
exhibitions
Animal health services
Value addition services
Services in A.I
Plan field days
Prepare brochure and manual
Organize short courses
Link farmers to biogas
</td>
<td rowspan="2">Value Proposition

High quality milk
High quality finished products
High yielding cows’ low emissions
Climate smart fodder
Climate smart energy
Health herd
</td>
<td>Customer Relationship

Supervision
Trust
Subsidized provision of inputs
Extensionists
</td>
<td rowspan="2">Customer Segments

Small-scale farmers
Milk grader
Medium and large-scale farmers
Milk collectors
Retailers
Milk transporters
Dairy processor
ATM handers
Feed suppliers
</td>
</tr>
<tr>
<td>Key resources

Development agents
Dairy cattle
Farmer training centre
Farmer center biodigesters
</td>
<td>Channels

Field days
County farmer training center (CFTC)
Nairobi International trade Fair
Shamba- shape-up
Mass media like FM Radio, TV
Breeders Agricultural shows
Kenya agricultural shows
</td>
</tr>
<tr>
<td colspan="2">Cost Structure</td>
<td colspan="3">Revenue streams</td>
</tr>
</table>

Salary, transport costs, maintenance costs and cost inputs	**Service fees** **Manual and brochure sales** **Short courses Fee**
Social and Environment gain **Clean environment**	

Source: (Author 2018)

Business canvas Model of Kenya Agricultural Research organization

Key Partners • Knowledge Institutions • Ministry Livestock • Ministry Energy • Dairy processors • Ministry of finance • TVET Colleges • Kenya dairy board • Other Research stations • Ministry Livestock • Farmer association • International livestock research Institute	**Key Activities** **Research** • AI services provision • Exhibition and demonstration • Breed development • Conducting research • Release research output • Technology and innovation transfer • Manual and brochure in English and Kiswahili **Key resources** Research centres On farm Research On station Research County livestock office Skilled experts Dairy herd labour	**Value Proposition** • Knowledge support • High quality feeds • High yielding dairy cows • Zero-grazing • Sahiwal cattle • High quality products • Feed analysis • Technology transfer • Market linkage	**Customer Relationship** • Commitment • Supervision • Trust • Subsidized provision of inputs • Extensionists • Word of Mouth **Channels** • Field days • County farmer training centre(CFTC) • Nairobi International trade Fair • Shamba- shape-up • Mass media like FM Radio, TV • Breeders Agricultural shows Kenya agricultural shows	**Customer Segments** • Small-scale farmers • Milk grader • Medium and large-scale farmers • Milk collectors • Retailers • Milk transporters • Dairy processor • ATM handers • Feed suppliers

Cost Structure Salary, labor and maintenance cost, Transport, Cost of inputs.	**Revenue streams** Consultant fees Tours and exhibition fees Sale breeding stock Sale of hay Feed analysis fees
Social and Environmental cost Emission in feed production and transport	**Social and Environment gain** Environmental health, awareness creation

Enabling Environment

Enabling environment for climate-smart agriculture will encamps policies, institutions, and finances. Up-scaling climate-smart agriculture to prompt the desired transformation in agricultural production systems and food systems requires supportive policies, institutions, and financing

Dissemination and up-scaling climate smart practices at teaching Institutions

Government Ministry

Ministry of Agriculture promote agricultural practices and livestock management such as agronomical practices, conserved agriculture, fodder production, breeding services, animal health, feeds and feed management.

Ministry of energy and Natural resources promote renewable energy and climate change initiatives through education awareness by engaging the community through advocacy and training. Training include significance of tree cover, water conservation and protection natural resources

CHAPTER 5: CONCLUSION AND DISCUSSION

5.1. Conclusion A

5.1.1. Gender of respondents and awareness of climate smart Agriculture

Majority of the respondents interviewed were men. From the findings, it can be concluded that most of the respondent interviewed from the teaching Institutions (Knowledge and TVET colleges) were aware of climate smart agriculture. The Levene' test at 5% level indicated there was significant difference between male and female respondent interviewed at p=o.13.

5.1.2 Role and Functions of supporters

Findings from power and interest grid indicates the NGOs, knowledge Institutions and TVET colleges are concerned with CSA awareness, poverty alleviation, productivity, and profitability increase at household level (trainees) while the policy makers, Ministries and KALRO are interested in administering policies on CSA, increase food security and reduce GHGs from the livestock sector. It can be concluded that despite their interest and power not much has been achieved in up-scaling CSA practices these Ministries, NGOS, consultant firms, KALRO, and the teaching institutions.

5.1.3. Challenges and opportunities

The study also concludes that the supporters have opportunities to invest in the dairy sector in terms of CSA practices to achieve increased food security and lower GHGs emission despite the challenges and barrier experienced.

5.1.4. Curriculum of Teaching Institutions

On curriculum, only Egerton, ICCA and Baraka had courses on CSA practices though DTI and Ahiti Ndomba teach courses in Climate change in their diploma programmes.

5.1.5. Value chain governance and agricultural policies

Githunguri milk value is governed by modular and market and Agricultural laws are set and implemented by the government ministries and Kenya Agricultural Research organization and it is a requirement for the NGOs and the consultant firms to adhere to laws in their services or operations in Kenya.

5.1.6. CSA practices

50% of the knowledge Institutions and 100% of the TVET colleges had a practical farm, where CSA practices are conducted. The climate smart agriculture practices carried out at knowledge Institution and TVET colleges included biogas, Agro-forestry, grassland management, and zero-grazing. It can be concluded that the knowledge and TVET colleges disseminate knowledge through up-scaling activities using outreach, inhouse and pairing local students with foreign students at either in villages/communities nearby or in counties within the country.

5.1.7. Strategies at knowledge institutes, upscaling activities and impact

ICCA and Egerton university teach courses in CSA in their curriculum at different levels but WMI and Nairobi - Animal production do have courses in CSA. None of the universities have short courses in CSA. All the knowledge institutions do up-scaling activities except Nairobi University-Animal production, and their approach included outreach, in-house and pairing foreign students and local students. Positive impact was recorded by all teaching institutions.

5.1.8. Strategies at TVET colleges and upscaling activities

Among the TVET colleges it's only Bakaka that offers CSA course in their curriculum and fortunately, all colleges do upscaling activities using outreach and in-house approach.

5.1.9. Milk production at Teaching Institutions and Kiambu

Comparing of the milk production from the teaching institutions, Egerton university had the highest daily production, followed by Baraka and DTI. Further analysis was done on milk about monthly averages and resulted that Baraka had the highest as compared to Egerton that had highest number of animals.

5.1.10. Milk production in Kiambu county and gender role in CSA

It can be concluded that Githunguri sub-county produces the highest amount of milk in Kiambu county hence its production is higher than Ruiru sub-county. Considering gender, male-headed house-hold produced higher milk per cow per day than the female household in all breeds per the seasons however the youth household produce better in only exotic breeds than male and female and the wet season recorded higher production compared to the dry season. The study also concludes that majority of the women were in in production, milk testing, and milk trade, Majority of the youth were in ICT, road shows in promotion of CSA, and in dairy production, while men were in bulky transport, decision making and really estate business.

5.2. Discussion A

5.2.1. Gender of respondents and awareness of climate smart Agriculture

The majority of respondents were men was attributed to the constitution of Kenya 2010, where employed is based on gender rule of 30% women and 70% hence likely to get more men in governmental work place than women. Findings on climate smart agriculture awareness indicated 88% knew the concept while 12% were not aware of the concept and this correlated with the Institutes not conducting research related on climate smart agriculture on their farms. Similarly, the focus group at Githunguri cooperatives also evidenced their low knowledge in climate smart agriculture practices, in their research on value chain development established that farmers have detailed knowledge of their land but lack straightforward information on good practice and management, yet same information can be availed via a mobile handset), though some practiced it unknowing in terms of good agricultural practices. UNESCO (2010) that states capacities of service providers are rather weak and a mismatch between the type of training offered and the labor requirements of the market in agricultural sector.

Although there was a significant difference between male and female respondent interviewed, this finding did not affect the outcome of the results. The Kenyan society may urge that men have more energy and vigor, but in my understanding, women excel equally as men when it comes to academic fields.

5.2.2 Role and Functions of supporters

According to the commission of higher education in Kenya, the knowledge Institution are permitted to transfer quality education to students and any other individuals. The TVET colleges likewise are governed by Ministry of higher education in administering training. There other supporters in their interest to increase profitability and increase food security are doing it under the agreement of the Kenya Government. ministry of Agriculture promotes agricultural practices and livestock management such as agronomical practices, conserved agriculture, fodder production, breeding services, animal health, feeds and feed management.

Ministry of energy and Natural resources promote renewable energy and climate change initiatives through education awareness by engaging the community through advocacy and training. Training include significance of tree cover, water conservation and protection natural resources and agro-forestry enhances water retention according to (Lawson, 2005)

5.2.3. Challenges and opportunities

Agreed by Rosenstock *et* al.,2016 Partnership for Africa's Development (NEPAD) convenes a diverse group of development and technical partners as part of the Alliance for Climate-Smart Agriculture in Africa. Reported, Chesterman.S.2016, a range of highly-cited potential CSA practices to evaluate the evidence base supporting this potential, as well as to identify knowledge gaps in continental and regional institutions. Harvey. 2014 cites opportunities and challenges for integrating adaptation and mitigation in tropical agriculture as seen with the knowledge Institution in CSA practices.

Challenges experienced by knowledge Institutions and TVET colleges included few experts, inadequate equipment and modern farms for practical work on CSA and Sala at *al.* (2016) cites that to achieve technologies preparedness to make important changes, and weighty financial investments by governing institutions and donors is critical

5.2.4. Curriculum of Teaching Institutions

Among the knowledge institutions only Egerton, ICCA and Baraka offer CSA courses in their curriculum as climate change and effects have greater impact on the livestock sector as well on the lives of human beings on earth. Baraka college classified as TVET college offering climate smart agriculture as research confirmed that sustainable agriculture is part of climate smart agriculture (Neufeldt et al, 2013).

Though the courses didn't emphasize CSA but on good agricultural practices, they were only carried in 50% of the Institutions and also not in in other programmes within the same institution. There is need to disseminate CSA courses to all Institutions and to more programmes using same criteria

5.2.5. Value chain governance and agricultural policies

Dairy value chain operates with different governance (Gereffi et.al., 2003) to link the suppliers and producers but there is need to different the types of value chain. The agricultural policies relevant in Agriculture and climate change NACCP. 2012 are critical in the implantation of CSA practices

5.2.6. CSA practices and training

Findings indicated that climate and environment unit was newly established and has laid its mandate of training and advocacy on climate smart agricultural activities and environmental issues, Schaller at al. 2016 urges that ''Mitigation must become an integral part of projects from the outset. This is crucial if CSA is to be taken seriously as a new and beneficial concept, and not merely as new wording for long-standing practices without innovation''

Agricultural small Dairy support programme indicated it had trained 45% male and 55% female while Githunguri trained 50% of their farmers monthly from the 9 collection routes which are low though critical, in adoption of new innovations and practices which occur in social economic setting and require capital investment such as finances and skilled labour according to Ellis (1993). Good organization and capital allocation would encourage competent adoption and diffusion of interventions to acquire the anticipated positive impact in the livestock production (Mutoko et al., 2014). Although trainings are held at Githunguri cooperative the farmer had an impression that services were not sufficient in terms staff/extension ratio to farmers which stood at 1:1000 in Kenya and it was same in Ghana, as cited by Opare and Wringley-Asante. (2008). In Tanzania, a similar observation was done and it showed an unbalanced ratio of extension officer to farmers as reported by Ahmad, (2008).

As a CSA practice, a total of 3,400 biodigesters were installed in Kiambu in comparison to 17,000 biodigesters installed in the whole country. Biogas is one way of promoting CSA practices hence there is need to encourage its promotion by supporters through awareness (trainings specifically on manure management and benefits of biodigesters) and more subsidizes in terms of loans.

5.2.7. Strategies at knowledge institutes and upscaling activities

There need to introduce CSA courses in the curriculum of WMI, Nairobi university and short courses on CSA in all the knowledge Institutes. From the result findings, it shows most Knowledge Institution engaged in up-scaling activities with the farmers in different part of the country and variation is due to the fact that farmer practice mixed farming activities favorable in the area. According to Franzel et al. 2004. it was necessary to assess whether and how successful strategies can be adapted to different sites.

5.2.8. Strategies at TVET colleges and upscaling activities

There is need to introduce CSA courses in the curriculum of other TVET colleges as Baraka's high milk production was attributed to the CSA practiced at the college compared to DTI and Ahiti Ndomba. Need also to consider offering short courses demand driven in CSA practices.

5.2.9 Milk production at knowledge institution and TVET colleges

Comparing of the milk production from the teaching institutions, Egerton university had the highest daily production, followed by Baraka and DTI and the volumes were to too low compared with 30kg in exotic and 7kg in local cows as the average production which is indicated in livestock reports (MoALFD. 2013). There need to introduce genes of high yielding dairy cows according USDA 2013 to improve the milk production. The variation was attributed to management practices, basically CSA practices and seasons (see table 12). CSA practices in terms of efficient feeding, breeding management, and good health management leads to high milk production. Seasonality indirectly affects milk production where long rains there was excess and normal milk production and low or below normal production in the dry season but with good CSA practices, seasonality can be managed through proper planning and conservation.

Egerton had an average of 35-50 cows in milk and with highest milk production at 5kg/per/day while DTI and Baraka both had 6 cows with milk average to 3kg- a quantity below the average production of small-scale farmer in Kenya, this indicates a big difference between best producing animals (35 kg /cow/ day) and least production (4 kg/cow/ day) reported with MoAL&FD reports. The average milk production was low at 7kg /cow/day was (MOLD, 2013). Further analysis was done on milk about monthly averages and resulted that Baraka had the highest as compared to Egerton that had highest number of animals, fortunately, the highest monthly production correlated with the CSA practices at the farm and courses in the curriculum. Unfortunate for Egerton which would be on equal status with Baraka as they apply CSA on the farm in the curriculum but the farm manager mentioned issues of milk ethics (stealing milk and corruption at the farm led a wide variation as observed in Figure 17. There is an optimistic correlation between milk production and rainfall hence, there is need for efficient CSA practices to ensure maximum milk production in the long rains that can reserved to be used for the rest of the year.

The positive impact of dissemination and up-scaling activities resulted into increased income, increased milk, increased manpower, poverty alleviation, peace restoration, and increased food security hence the need to continue promoting knowledge dissemination and up-scaling

5.2.10. Milk production in Kiambu county

In Kiambu, Githunguri sub-county produced the highest amount of milk hence this production is higher than Ruiru and this attributed to the. The large variation is attributed to training in CSA practices and good livestock management carried at Githunguri by extension officers from Githunguri cooperative and livestock office which is not the case with Ruiru subcounty which is not affiliated to any cooperative. The findings also showed that male headed household produced better volumes of milk as compared with the female headed household and this is related the responsibility of women in livestock production in sub-Sahara countries which is based on gender and cultural norms according to Kristjanson et al. (2010) where women were involved in milk production and quality control while men were in bulky transport, really estate and decision making, therefore, they can access CSA training and invest in good management due to their access to finances. About youth headed household produced better in exotic breeds than male and female household concurs with literature where KJWA. 2018 urges no youth should be left behind in livestock sector**.** The total milk production per gender in household is still below the average production of the exotic cattle which stands at 30kg and local cows at 7kgs as indicated in the ministry report MoALF. (2013) and it has been due to inability of most smallholder farmers to practice good animal husbandry as agreed by IFAD (.2010)

5.3. Conclusion B

5.3.1 Linkages of the knowledge institutions

The linkages of knowledge institution in disseminating CSA ranked from government Institutions, research and or academic Institution and Non-governmental organization who acted as donors or financiers or research partners

5.3.2. The guiding policy on Climate Smart Agriculture.

The guiding policy on CSA in the knowledge institutions included the environmental protection, Forestry laws, waste disposal, building assessment by MoENR, proper land use and tree cover of 10% per the Kenyan policy.

5.3.3. The enabling environment for Climate Smart Agriculture

The enabling environment included good agricultural policy, good governance, information and knowledge on inputs, financial investment, that link climate finance to agricultural investment. Also, it included linkages with Government Ministries, private and public partners.

5.4 Discussion B

5.4.1 Discussion on linkages and challenges

The result show there was a strong collaboration between the knowledge Institution and their Partners mainly for funding and research and this was positive as it would enhance efficient and further up-scaling activities though funding seemed a major challenge as agreed with Kotabe at *a*l. (2000) saying despite modest development, financing Institutions is a difficult endavour.

5.4.2. The guiding policy on Climate Smart Agriculture.

The guiding policy on CSA in the teaching Institutes are concerns on environmental protection, forestry laws land use and 10% forestry cover and all these laws are listed in table 1 on the relevant policies to agriculture and climate change, NACCP. 2012)

5.4.3 Discussion on enabling requirement/Environment

The enabling environment included good agricultural policy, good governance, information, and knowledge. Lack of information may lead to price changes according to Lipper, (2014) and financial investment is a channel linking climate finance to agriculture investment as cited by Beddington etal. (2013). Enhanced linkages with Government Ministries, private and public partners are key elements in this area. There is need for good institutions for research urges Altbach and Salmi (2011).

5.5 Discussion on Organizations

Findings indicate the researcher managed to interview 10 organizations which then classified in 3 categories- services fully paid by clients/ commercial firms, partly or subsidized services, largely free services paid for the members

1. Commercial firms/fully paid services- Perfometer and knowledge institutions short course programmes. The organization basically transfer CSA and other livestock courses at fee paid fully by clients
2. Partly/ subsidized Company-Included 3 Robust, Reliable, Resilience, SNV Organizations applying the principle of Robust at farm level CSA technologies, Reliable at the Institutions in terms guiding policy and Resilience-knowledge exchange and innovation systems. (Mierlo. 2018). Agriprofocus- A network focusing on collaboration and connecting partners together. Building successful partnerships requires careful consideration due their differences in the priorities as reported (Coburn et al., 2008). Githunguri is also grouped in this category
3. Largely free services included are ILRI, KALRO, Institutions performing research on breeding strategies, fodder production, low emission of greenhouse gas as agreed (Henderson at el., 2015) and adaptation and mitigation of CSA (Kenya Government, 2010a). Projects funded by donor included- climate smart agricultural NARIGP. Their goal is to increase profitability and reduce poverty based.

Non-governmental Organizations and Consultant firms

They act as an innovation platform with an interest to promote CSA practices through poverty alleviation, increase productivity and profitability of rural household and small-scale farmers already engaged in a specific value chain

5.6. Discussion on the effective organization in my option

The effective organization in delivery of services to the farmers was the government ministries and research organization (KALRO). These organizations are known by farmers and farmers can access knowledge and skills from on-farm in County farmers training centers , on farms in the research stations and field days or demonstrations at contact farmers in the field. The two organizations are reachable to the farmers and their services are effective. These services are affordable to many farmers as most of the time such services are sponsored/donor funded or subsidized

5.7. Limitation of the study

The data collected was qualitative and it was not easy to analyze such data though it was valid as original data from the ground. The location of respondent in the study were far from each other and it required a lot of travelling and making appointments and sometimes after travelling you can find the respondent had just left for another urgent meeting. The respondent in the study were far from each other and it required a lot of travelling and making appointments and sometimes after travelling you can find the respondent had just left for another urgent meeting and that is the case with the government ministries.
It was not easy to get the contact of the respondent for communication, which meant, that you travel physical to the respondent place to make the appointment and in some office, entry was restricted, especially if you didn't have full details of the client. Researchers are busy officers and it was difficult for some to get time for interview so at one time I had to reschedule a meeting at night

CHAPTER: 6. RECOMMENDATIONS

The study provides recommendations for the improvement in three sets, for improvement of policy formulation and enforcement at knowledge institution and Government, for further studies and extension.

6.1. Recommendations for knowledge institution, stakeholders and policy makers

A policy framework is needed to guide all the counties to have a climate and environment unit in their department for effective up-scaling of CSA technologies as seen in Kiambu county. Stakeholder meetings to look at policy and make relevant changes.

1. Need to increase incentives to promote alternative sources of income for smallholder farmers to enable them enhance their income diversification and will require strong public-private partnership between the stakeholders
2. Capacity building improvement of extension officers and lecturers on CSA for them to update their knowledge and impact same to small-scale farmers and trainees.
3. Regular curriculum review to include emerging issues- requires knowledge institute to have a strong relationship with government and development partners to facilitate the exercise.
4. Knowledge institution to diversify CSA to all trainees in their programmes (vocational and long courses) through curriculum review and awareness to trainees as this shall allow frontline officers who work with farmers to access CSA knowledge and skills
5. The low level of awareness from findings hampers the transfer of CSA and acquisition of modern agricultural technologies at WMI, ICCA. This calls for efficient communication channels and advertisement of the institutes in local languages and through local leaders.
6. Supporters to encourage farmers form producer organizations to help improve their access to information and innovation
7. Concerted efforts of knowledge institutions, development partners, extension workers, and county government to facilitate smallholder farmers and create more awareness approach on CSA practices and interventions.
8. Encourage farmers to collaborate with global partners to enhance educational achievements, rural community enforcement and incentives to dairy farmer already practicing

6.2. Recommendations for studies

1. A similar study using the quantitative approach should be conducted in similar sites with similar objectives to determine to gather both qualitative and quantitative data to test whether the findings in this study were unique to the investigated site and should be able to document findings as the projects that are in formation stage during this study
2. An environmental assessment impact should be carried out to check on effects for increased use of fertilizers and pesticides to establish the sustainability and variability in high potential counties in Kenya. Advise on use of bio-slurry and manure and shown good results
3. The flow of information from farm level to research and government is a strategy to upscale CSA. Need to streamline flow of information for the research to work on the pressing issues affecting farmers. This ensure that knowledge on suitable adaptation methods available is not lost but upscaled. These benefits can be obtained through participatory methods that allow the voice of farmers and extension officers to be heard.

6.3. Recommendations for extension.

Curricula preparation for extension as findings from KALRO are never included into the curriculum. The MoALF should have nationally position to supervise and set relevant findings and include them into the present syllabus. There is need to have an on-line position where Manual and brochure can be off-loaded from the net.

6.4 Recommendation for the Knowledge Institution

Refresh course of 6 weeks for the trainers in Knowledge Institution- This suggestion can work where the institution can provide a learning venue or environment for training then the trainers can be hired to train the officers. There is need to sensitize the officers earlier and courses can be conducted for the long holiday.

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ANNEX

1.1 DEFINATIONS OF CONCEPTS

Adaptation-Adjustment in natural or human systems in response to climatic effects, which moderates harm or exploits beneficial opportunities.
Adaptation-Change or adjustment to improve principles or make it suitable to different situation
Capacity building- In the context of climate change, the process of developing the technical skills and institutional capability in developing countries/people/ economies in transition to enable them to address effectively the causes and results of climate change.
Carbon sequestration-the process of removing/reducing carbon from the atmosphere and depositing it in a reservoir, such as soil or trees.
Climate smart Agriculture- is the dairy farming practice that sustainably increases productivity, enhances resilience and mitigates Green House Gases (GHGs) where possible to avoid climate change
Greenhouse gases-The atmospheric gases responsible for causing global warming and climate change. The major GHGs are carbon dioxide (CO2), methane (CH4) and nitrous oxide (N20).
Mitigation- the action of reducing the severity, seriousness, or painfulness of something: disaster/calamity
Silage-Animal feed harvested and conserved under anaerobic conditions
Supporter- Stakeholder that an organization partners or does business together.

ANNEX 2: Certificate curriculum in Dairy Technology and Management

Department/ Unit Code		Unit Title	TLH	TPH	TH
DAIRY	1	Fluid Milk Processing	32	32	64
DAIRY	2	Fermented Milk Processing	32	32	64
DAIRY	3	Cheese Making	40	40	80
DAIRY	4	Fat Based Products Processing	32	32	64
DAIRY	5	Quality Control of milk and milk products	48	48	96
DAIRY	6	Operation and Maintenance of milk processing equipment and systems	24	24	48
ANPD	7	Dairy Cow Production	32	32	64
ANPD	8	Dairy Goat Production	32	32	64
ANPD	9	Dairy Camel Production	32	32	64
EXTN	10	Entrepreneurship	32	0	32
EXTN	11	Agricultural Marketing	32	0	32
DAIRY	1	Introduction to Dairy Technology	48	0	48
ANHE	2	Introduction to Anatomy and Physiology	24	24	48
ANHE	3	Introduction to Animal Health	24	24	48
EXTN	4	Agribusiness management	32	0	32
BASIC	1	Mathematics	16	0	16
BASIC	2	Computer	0	32	32

Department/ Unit Code		Unit Title	TLH	TPH	TH
EXTN	3	Communication Skills	24	0	24
EXTN	4	Extension Education	24	0	24
BASIC	5	HIV and AIDS	16	0	16
		ATTACHMENT	0	320	320
			576	704	1280

Annex 3: Curriculum in dairy production and management

Department/unit Code		Unit Title	TLH	TP H	TH
ANPD	1	Pasture and Fodder Production and conservation	48	48	96
ANPD	2	Dairy Cow Production	32	32	63
ANPD	3	Dairy Goat Production	32	32	64
ANPD	4	Dairy Camel Production	24	24	48
ANPD	5	Feed Formulation and Milling Technology	48	48	96
ANPD	6	Maintenance of farm structures and Equipment	48	48	96
Dairy	7	Milk Bulking and Processing	24	24	48
EXTN	8	Entrepreneurship	32	0	32
EXTN	9	Agricultural Marketing	32	0	32
Dairy	1	Introduction to Dairy Technology	48	0	48
ANHE	2	Introduction to Anatomy and Physiology	24	24	48
ANHE	3	Dairy Herd Health Management	24	24	48
ANHE	4	Reproductive Health and Neonatal Care	24	24	48
ANHE	5	Introduction to Dairy Herd Diseases and Parasites	24	24	48
EXTN	6	Agribusiness Management	32	0	32
Basic	1	Mathematics	16	0	16

Annex 4: Certificate curriculum at baraka college

CODE	TITLE	CONTACT HOURS	CREDIT RATING
GM 110	Introduction to SARD	30	3.0
GM 112	Our environment	30	3.0
GM 113	Integrated Morality	45	4.5
GM 114	Family Sustainability	45	4.5
GM 115	Community Development	40	4.0
GM 116	ICT for Rural Development	40	4.0
GM 117	Work Experience	-	
GM 118	Projects	-	
GM 119	Field Attachment	-	

CP 210	Principles of Crop Production	50	5.0
CP 211	Agroforestry	35	3.5
CP 212	Vegetable Production	30	3.0
CP 213	Annual and Perennial Crops	50	5.0
CP 214	Floriculture	30	3.0
CP 215	Fruit Crop	30	3.0
CP 216	Indigenous Plants	20	2.0
AP 310	Principles of Animal Production	35	3.5
AP 311	Animal Health	30	3.0
AP 312	Livestock Feeding	20	2. 0
AP 313	Ruminants:		
	• Dairy cattle	30	3.0
	• Sheep	25	2.5
	• Dairy Goat	25	2.5
AP 314	• Non- Ruminants		
	• Pigs/Rabbit / Fish Poultry	20	2.0
AP 315	Bee-keeping	30	3.0
		25	2.5
AE 410	Soil and Water Management		
AE 411	Farm Mechanization		
AE 412	Farm Structure		
BM 610 BM	Farm Management	60	6.0
611 BM	Start Your Own Business	40	4.0
612 BM	Processing of Farm Produce		
613	Agricultural Marketing	35	
		25	
FS 710	Organic Farming	40	4.0
FS 711	Dryland Farming	25	2.5
EAC	Social/spiritual/cultural	-	-

Annex 5: Diploma curriculum at baraka college

DC101 Introduction to Biological & Physical sciences.
DC102 Mathematics and Statistics for SARD.
DC103 Rural Sociology.
DC104 Development Economics.
DC105 Development Education.
DC106 Community Development.
DC107 Communication for Rural Development.
DC108 Social Ethics.
DC109 Community Health.
DC110 Foundations of Sustainable Agriculture.
DC111 Integrated Natural Resource Management.
DC112 Agriculture Engineering.
DC113 Crop Enterprise Management.
DC114 Livestock Enterprise Management.

DC115 Farm Management.
DC116 Rural Business Development.
DC117 Community Research Project.
DC118 Social/Cultural/Spiritual Activities.

Annex 6: Master of Climate change and adaptation

Degree Code:
Degree Name: MASTER OF CLIMATE CHANGE ADAPTATION (MCCA)
Degree Type: MASTERS
Degree Duration: 2
Level: Non-Specified
Semester: Non-Specified
Course Name (All courses have 45 hours)
Impacts of Climate Variability and Change
Vulnerability and Adaptation
Climate Change and Adaptation Policies, Legislations and Treaties
Climate Change Mitigation
Research Methods in Climate Change and Adaptation
Foundations of Climate Change Science
Resource Use Efficiency
Critical Debates in Global Climate Change and Adaptation
Resilient Agro-ecosystems
Land Management and Governance
Climate Sensitive Agro-ecological Zones
Climate Change and Food Production Systems
Climate Change Implications for Fisheries and Aqua-culture
Overview of Climate Risk Management
Drivers of Risk, Policies and Approaches, Tools and Practices
Decision Support Tools for Reducing Climate Risks
Regional Focus
Urban Areas, Climate Change and Adaptation
Economics of Climate Change and Adaptation
Livelihoods, Poverty, Human Security and Climate Change
Infrastructure and Industry Adaptation for Climate Change
Climate Change and Health
Health Vulnerability to Impacts of Climate Change
Climate Change And Climatotherapy

Health Statistics and Climate Change
Health Interventions in A Changing Climate
Integrating Climate Change Policies at Multiple Levels
Policy on Technologies
The Politics of Water
Principles of Communication
Strategic Communication for Influencing Environmental Behaviour
Process and Structure of Mass Communication
Climate Change Information Packaging
Information Dissemination and Advocacy
Greening the Built Environment
Technologies for Climate Change Adaptation in The Urban Environment
Technologies for Climate Change Adaptation in The Rural Environment
Renewable Energy Technologies
Technologies for Carbon Foot-print Reduction
Early Warning Systems and Communication
Climate Change and Water Policy
Water Resources and Climate Change
Water Pollution and Rehabilitation
Water Resources Management
Prediction and Management of Droughts and Floods
Early Warning Systems and Communication
Ecosystems, Climate Change and Adaptation
Bio-geophysical Impacts of Climate Change
Air, Soil and Water Pollution Abatement
Climate Dynamics
Application of Remote Sensing and Gis In Climate Change and Adaptation Assessments
Scenarios Development
Knowledge Management and Capacity Building
Institutional Mechanisms and Issues
Gender and Climate Change
Policy Development
The Politics of Climate Change

Annex 7: Check list of knowledge farms

How many animals are being milk?
What equipment at the farm-zero-grazing
What is the grazing system used at the farm?
How is manure used at the farm?
Is the farm divided in paddocks?
What are the milk trends for six months?
What type of animals are kept at the farm
Does the Institute use Biogas for cooking?
How is the feeding system?

Annex 8: Questionnaire for the focus group for Githunguri dairy

1.Name interviewee TASK/ROLE:
2.What is climate smart agriculture……
3.How is climate smart agriculture practiced/carried out
4.What are the activities/ improved practices/trainings promoted by the supporters/ project/Factory?
5. How did you handle these activities in the various routes or to farmer groups within the Factory area?
6. Which fertilizers are farmers encouraged to use
7. Any trainings on Biogas in various route
8. Do you consider gender and youth inclusiveness in your trainings?
9. Do you give a priority to a particular group or to special issues like climate smart agriculture?
10.ADOPTION: What upgraded agricultural practices are popular among farmers? what proportion of Githunguri farmers have adopted at least one of the improved agricultural practices?
11. What do you think are the main reasons for the uptake of these improved practices?
12. BENEFITS: In your own observation are there benefits among the farmers? What are the benefits of these practices
14. BARRIERS: Any agricultural practices that were not adopted or rejected or abandoned?
15.Share a list of practices not adopted completely
16.What hindered their adoption within this farming system?.....
17.What reasons outside this farming system might have contributed to their unsuccessful adoption?
18.SUPPORT: What institutional support would enable more promotion of better agricultural practices in this cooperative area
19. Which NGOs/institutions/organizations are appropriate to the promotions and implementation of improved agricultural practices in this cooperative?
How are the above-mentioned institutions/NGOS/ supporting the promotion of agricultural practices in the in this cooperative?
20.POLICY:
What policy support could encourage successful application of improved agricultural practices in this area?
Any effort by the government (County and National levels)/cooperative that would create a favorable environment for uptake these practices
21. SUSTAINABILITY:
How prepared is the farmers within the community or other stakeholders to continue with the promotion and scaling-up of the improved practices (livestock and feed production) in this area?
What are you already doing that may empower the community to go on with the activities?
OPPORTUNITIES What opportunities are available for farmers to improve-bonus, quality payments, capacity
22. FUTURE PLANS: What are your plans in terms of improved agricultural practices (food security and efficient production

23. EVALUATION: What the greatest strengths (in your own assessment) in the implementation approach of Factory/ project/NGOSs activities within this cooperative
What are its key weaknesses?
What lessons have you learned from working in this cooperative with projects, NGOs, Governments agents
Share a success story of your experience at Githunguri**…… ……**

Annex 9: Questionnaire for DTI -Farm manager, Ndomba farm manager,

1.Name of interviewee……
2. Gender. ……
3. Name of institution……
4. Position of the interviewee……
5. Task/Role of interviewee……
6. What is climate smart Agriculture?.....
7. What does climate smart agriculture farming entail?.....
8. Available one day/one-week course/Certificate/diploma programs related to climate change ……..
9. Gender considered in selection of candidates YES/NO…….
10, Gender in selection of staff considered……
11. Does the curriculum include courses in climate change/environment conservation? YES/NO……..
12. If no, is there a possibility to include in future as climate is global Agenda and key to achieving food security
13. If you yes, are they elaborate enough to impact knowledge and skills on climate change, climate adaptation and mitigation and whether all programmes {certificate and diploma) are covered?
14. The contribution of the program to the livestock sector……
15. Internships offered for trainees/other students……
16. Type of research conducted in the liestock sector……
17. What agricultural policies do apply in the farm ……
18. Reason for supporting……
19. Technology released to the smallholder farmer……
20. Monitoring and evaluation of your support system……
21. Climate-smart practices done by Institute……
22. Challenges……
22.Opportunity……
23. Partners working together----……
24. Relationships with dairy stakeholders……
25. Existing gaps in the service you provide……
26. Impacts of the department……
27. Future plans……

Annex 10: Gender analysis of respondents

Test Statistics	
	What is your sex?
Chi-Square	6.125[a]
df	1
Asymp. Sig.	.013
a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 16.0.	

P=0.13. Therefore reject H_o and conclude that there is significance difference between males and females.

Test Statistics	
	Are you aware of CSA?
Chi-Square	9.941[a]
df	1
Asymp. Sig.	.002
a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 8.5.	