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The Relationship Between Climate Change and Food Insecurity In Sub-Saharan Africa

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Dedication

This thesis is dedicated to my mother Faniswa Faith Royi. Your fighting spirit is the reason why I was able to pick myself up and complete this thesis. I love you so much and I hope you continue resting in peace mama.

Acknowledgements

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Abstract

According to the research conducted for this thesis, climate change has a potential to be a hazard to food security in not only South Africa, but also to most of Sub-Saharan Africa. The threat is presented in terms of food distribution and consumption, including agricultural productivity. Food security is impacted by global warming, global warming in turn is a direct result of climate change since it affects the supply of food, its accessibility, how it is utilized, and whether or not people can afford it. The only way to mitigate the dangers is through an integrated policy approach that protects fertile land from global warming. The key point presented here is that Sub-Saharan Africa has all of the resources necessary to adapt to climate change and secure food supplies; nevertheless, it is critical that they first recognize the hazards that various agricultural products face because of global warming. However, a lot of emerging countries face significant challenges as a result of a lack of robust institutions, making policy changes difficult. The influence on food security will be significant, and it may be broken down into three categories: availability, access, and use. Systematic peer-reviewed literature reviews of climate change and food security research were undertaken utilizing the realist review approach as the methodology for this study. In order to alleviate the region's acute food insecurity, adaptation approaches were thoroughly investigated. This is related to development challenges, where adaptation is necessary to mitigate negative effects and improve the population's ability to participate in development processes. Finances are also a concern for poor countries, such as South Africa, because there is a disparity between the cost of adaptation and government subsidies. The remedy could come in the form of technology interventions that help to make food systems less vulnerable to dangers.

Key words:

Climate change, food security, health, vulnerability, access, development, utilization, adaptation, malnutrition, sub- Saharan Africa, global warming.

Abbreviations

1. CDD- Community Driven Development
2. DFID- The Department for International Development
3. FAO- Food and Agriculture Organisation (of the United Nations)
4. GCM- General Circulation Models
5. GECAFS- Global Environmental Change and Food Systems
6. HSRC- Human Sciences Research Council
7. IGBP- The International Geosphere-Biosphere Programme
8. IHDP- International Human Dimensions Programme on Global Environmental Change
9. IPCC- Intergovernmental Panel on Climate Change
10. ISS- Institute of Security Studies
11. NEPAD- New Partnership for Africa's Development
12. SSA- Sub-Saharan Africa
13. UN- United Nations
14. UNDP- United Nations Development Programme
15. UNFCCC- United Nations Framework Convention on Climate Change
16. WCRP- World Climate Research Programme
17. WFP- World Food Programme
18. WFS-World Food Summit

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Chapter 1

1. Background, contextualization and the significance of the study

1.1) Introduction

This chapter will mostly include information that was submitted as part of the proposal for this thesis. This chapter looks at the background of climate change in Africa as a whole and then it goes on to further explore climate change in sub-Saharan Africa by contextualizing the themes that will arise. This chapter then goes on to further explore what the significance of the study is.

1.1.1) Background

Many countries around the globe, particularly Africa, are becoming increasingly aware of the influence that climate change has on food security as well as the other climate change trials that are emerging. According to Bwalya (2013), the African continent has often been labeled as the continent that actually is most vulnerable to climate change. A study by Liliana (2005) argues the same thing as Bwalya (2013), but Liliana (2005) adds that the severest consequences of climate change is felt by productive land, which is also where agriculture occurs, making these consequences extremely critical because they threaten food security. A reduction in agricultural productivity is expected in Sub-Saharan Africa, with estimates ranging from 21% to 9% by 2080. (IPCC, 2007). According to Liliana (2005), by 2025, two-thirds of African arable land will have been lost due to drought and a general lack of rainfall. It's worth noting that global pollution and food production are growing at different rates. When analyzing the figures of global population and agricultural productivity, the World Food Programme (2016) concludes that food production is insufficient to meet demand. This means that more and more countries will become food insecure as time goes on. The purpose of this thesis is to investigate in depth exactly how climate change affects, or rather impacts, food security in Sub-Saharan Africa.

1.1.2) Contextualisation of Food Security

According to LE Page (2004), the idea of "food security" was coined around the early 1960s and was mostly used in international development literature. When all people have continual

access to nutritious foods that meet their dietary needs and can lead healthy lives, they will have achieved food security, according to the World Food Summit (held in 1996). Factors like market access have an impact on food security, financial means to purchase food, and the ability to generate one's own food. Another definition of food security offered by Anderson (1990) is that it is defined as people being able to get enough food when they need it.

The fundamental reason why food availability and food security are often used interchangeably is that both concepts are used to assess food security. Thompson et al. (2010) distinguished the two notions, stating that food availability insinuates to having food of excellent quality, in adequate amounts, available at all times. According to Aliber (2010), the HSRC considers three factors when determining what food security is. Food availability, food access, and food use are the three dimensions. The first phase entails ensuring that a country has adequate nutritious food, both on a national and household level. When it comes to defining food availability, it's more about a country's households being able to really obtain adequate food, and that food must be sustainable. Food access, according to Ludi (2009), is defined as the ability of households and people in a country to purchase what are judged to be sufficient quantities of high-quality foods. The third and final dimension is food usage, and according to Negin et al. (2009), food security is mostly determined by how people use food, with the awareness that the first two dimensions are required for this dimension to exist. The FAO (2011) and Wlokas (2008) both concur that the most immediate method in which the issue of climate affects food in/security is by suffocating and suffering the availability of food due to variations in the production rate of various types of foods.

Smith et al. (1993) and Reddy & Moetsane (2009) have opposing views on what food security is. While Smith focuses on a particular country's and/or region's ability to produce enough sustenance for its people, Reddy & Moetsane argue that national food self-reliance does not reflect the realities on the household level because a country may have the ability to produce sufficient food but the people may not. Another intriguing take on food security is provided by the UNDP (2006), who examines the relationship between poverty and food insecurity, noting that the two ideas are intertwined and have a significant impact on one another, as well as how they relate to unemployment. They link these three by examining how a person's standard of living is low while they are unemployed, driving them into poverty and preventing them from obtaining the nutrients they require on a daily basis.

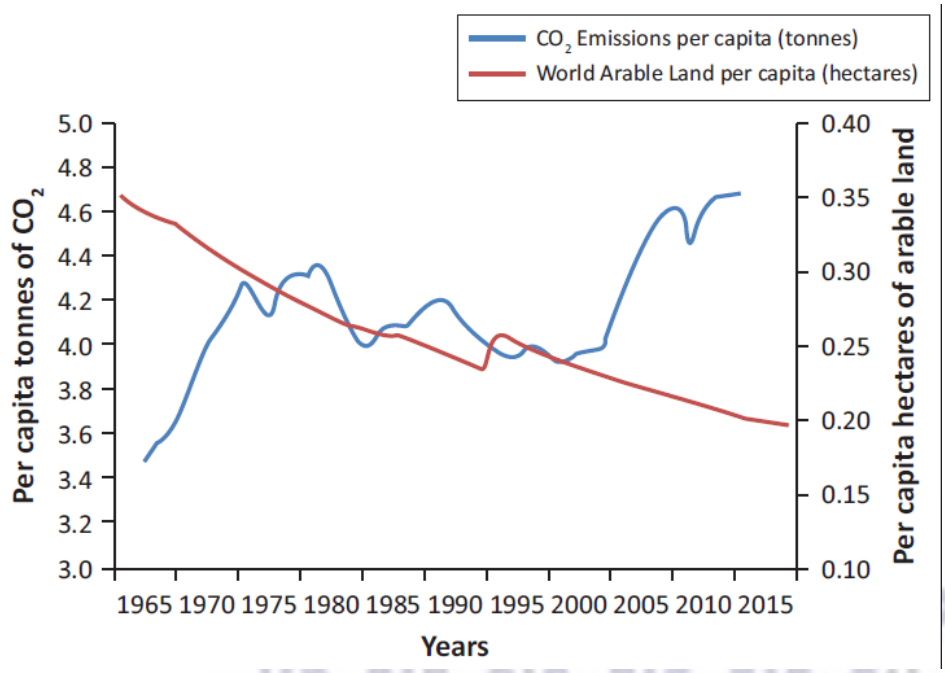
When attempting to capture the essence of the various definitions offered above, one can agree that there is no single way to define what food security is, but the dimensions that any definition should cover are: food availability, sustainability, accessibility, the way food is used, and whether or not food is available. Another individual who nailed it was Ziervogel (2009), who argued that food availability isn't the only factor that determines food security; access, as well as how it's used, is crucial. The World Bank issued a paper in 2016 that discussed how climate change has a large impact on food usage capacity since there is a significant decline in food production rates, and when people are unable to obtain food, their nutritional requirements are not satisfied.

1.1.3) Contextualization of Climate change and Food security in the sub-Saharan Africa region

According to a UN report published in 2012, one out of every four households in the Sub-Saharan African region lacks access to the food they require to thrive. According to a presentation by the IPCC (2007), South Africa is becoming increasingly vulnerable to climate change, with the consequences having the potential to be disastrous because they will affect and suffocate the livelihoods of millions of people. The report went on to say that by 2080, agricultural productivity is expected to fall by 12%. The issue of constantly rising precipitation temperatures will almost certainly impact the rate of steady food production in a. negative manner. Climate change is wreaking havoc across the African continent, not just in Sub-Saharan Africa. According to Gutu (2012), Ethiopia, for example, is experiencing some of the most severe effects of climate change, particularly in terms of decreased food production, and the gap is widening every year. Similar developments were also observed in the European Commission's (2009) report. It asserted that climate change will cause a dip in crop yields in Africa, which in turn will lead to an increase in the price of food and that people will have no choice but to shift their production and consumption patterns as a result.

We all know that South Africa, and the southern hemisphere in general, is one of the most sensitive to the consequences of climate change. Stressors include floods, droughts, and viral outbreaks. Overall, according to Hendriks (2005), South Africa is a food secure country, although food insecurity affects 58-73 percent of households. Without a doubt, climate change poses the greatest danger to food security in South Africa. One of the observations that can be made from the graph below is that, starting in 1965, CO2 emissions were fairly low and there

was a higher percentage of arable land.



Source; World Bank (2016)

Figure 1: A comparison between CO2 emission and arable land

There was a significant reduction in arable land and a significant increase in CO2 emissions. The loss of arable land is also due to global warming, which happens to be a direct effect of climate change. The following is what starts a vicious reaction:

- global warming produces droughts, which reduce arable land.
- Rural households rely heavily on subsistence farming;
- when arable land disappears, so does subsistence farming, and people begin to face food insecurity.

Barret (2002) offers a policy implementation that will speak directly to lowering greenhouse emissions as well as a policy that will speak to the obligation of reviving degraded areas as one of the solutions to this challenge.

1.2) Significance of the study

According to Ericksen (2008), sub-Saharan Africa and other areas that rely on subsistence farming are becoming increasingly vulnerable to climate change hazards on a yearly basis. GECAFS's further investigation into the subject suggests that the threat will only rise, and these places will become increasingly vulnerable. According to Ericksen (2008), the only way for these places to have a fighting chance is for extreme intervention, which means that adaptation

techniques must be undertaken in order for these areas to be able to combat these dangers. Failure to adapt is likely to add to the likelihood of food insecurity in the Sub-Saharan African region.

The goal of this study is to bring attention to the major concerns that exist at the intersection of climate change and food security. It also aims to investigate adaptation measures that will help the Sub-Saharan African region combat food security vulnerabilities. Because the area of climate change study is still relatively new, there are some information gaps and some phenomena that require more in-depth investigation and broader answers. This research is likewise being carried out with the hopes of contributing to the advancement of knowledge.

2. Literature Review

The fact that there isn't a single, agreed-upon definition for climate change is perhaps the biggest reason why there are so many differing viewpoints on the subject. Climate change is a word that can be used to describe change conditions in climate/ weather conditions over a period of time. It refers to the various variations that occur in a climate system, as well as the reasons for the changes, the types of changes, and the impacts that the changes have (ISS, 2010). Food security, according to the WFS (1996), is defined as people having constant access to sufficient foods that are both nutritious and meet their dietary requirements.

We already know that Africa, out of all the continents, is supposed to be the most susceptible to the negative effects of climate change, and this is owing to the fact that expert forecasts show that temperature will grow by 3-4 degrees Celsius over the next era (Boko et al., 2007). Poor crop production as a result of climate change will result in food shortages, which means people will start paying more for food, and as a result, people will begin to reduce their consumption patterns (European Commission, 2009).

Advocacy is urgently needed to bring together diverse international and domestic organizations from various sectors so that they can adapt to the problems posed by climate change, particularly in the area of public health (Costello et al., 2009). These institutions, according to Campbell-Lendrum (2007), will be able to conduct research on the subject, which will aid in the prediction of future repercussions and will directly influence the way forward in terms of actions. After reading a lot of literature on the subject, one can conclude that climate change has a bearing on food security, and the region where it is most prevalent is Sub-Saharan Africa. What stands out is disadvantage is that these are the same areas that are heavily reliant on agricultural economic activities, which are climate sensitive. It's difficult to locate information

that speaks directly to the major components because there isn't much research on the subject. As a result, this part will evaluate various literature on what exactly are the implications of climate change and how they narrate to food security in the Sub-Saharan region, in order to assess what is presently known about the problem and identify areas that should be prioritized for future research.

2.2) The impact of climate change on the availability of food

As previously said, food availability refers to when adequate high-quality portions are available for individuals to consume. According to Thompson et al. (2010), food availability has become the most commonly used indicator of whether or not people are food insecure. It is also maintained that the real and most significant impact of climate change on food security will be the availability of food as a result of the catastrophic drop in agri-productivity. In the Sub-Saharan region, there are a variety of factors that have a direct impact on the region, including rising temperatures, lack of rainfall, extreme weather conditions, and rising sea levels.

According to Felix and Romuald (2012), the literature collected from the Sub-Saharan region reveals that there is a dispute on the influence of climate change on food security. The issue centers on how climate change has the prospective to alteration agricultural production to higher latitudes, which has the potential to work but, in the process, will reduce cropland productivity in lower latitudes.

Agricultural output will be reduced by up to 50% in 2025, according to Liliana (2005), due to a lack of rainfall in the evaluations of the 2020 perspective. According to Nelson et al. (2009), there will be a large calorie drop in 2050, with an extra 24 million children aged zero to five years old joining the already massive number of undernourished youngsters. Climate change will have the greatest bearing on food security in Sub-Saharan Africa over anyplace else in the world, owing to the region's high reliance on subsistence farmers, who are ill-equipped to deal with environmental challenges (Gregory, Ingram and Brklacich. 2005).

2.3) The impact of climate change on the accessibility of food

Food accessibility and food availability may appear to be the same thing, yet they are two distinct aspects of food security. This dimension suggests to people's capacity to afford or acquire sufficient food. According to Chijioke & Waschkeit (2011), numerous factors contribute to an area's ability to get sufficient food, and food costs, poverty, limited access to markets, excessive unemployment rates, and education status are some of the causes that

contribute to access in the Sub-Saharan region. When of how heavily this region relies on subsistence farming, these conditions will strike this region the hardest. However, this will change during Jun-Aug, which is a time when markets become the secondary source of food because demand is not satisfied due to the change in season (Brown, Hintermann & Higgins. 2009). Access to food in poor nations has greatly increased over the last thirty years; nevertheless, recent years and those to come will see an increase in food prices, which will have an impact on income growth, and this will be due to climate change.

2.4) The impact of climate change on food utilisation

The third component of food security is food utilization, which comprises how food is consumed, whether the food is wholesome, and whether or not a person can maintain a healthy lifestyle with the food available to them. This dimension is concerned with a person's ability to not just eat food but also to benefit from it (Negin et al., 2009). The reason for the importance of this dimension is that, while access and availability are significant, they do not guarantee a reduction in malnutrition, which is also a big problem in the Sub-Saharan region. As a result, (Negin et al., 2009) claim that not acquiring the necessary nutrients for a human body is likewise defined as food insecurity because you are getting nothing from the food you are eating.

Food consumption is the least studied aspect of food security, which is particularly concerning given the role that utilisation plays in malnutrition, which is one of our most pressing issues. This dimension also contributes to citizens who are healthy and productive. The dominating culture of subsistence farming is the easiest explanation for why there aren't more people suffering from starvation. People are able to extract micronutrients from the fruits and vegetables that they grow, and the threat that climate change poses to subsistence farming is the same reason that people will be unable to obtain the micronutrients that they are accustomed to from food grown by themselves.

2.5) Theoretical and conceptual framework

Introduction

When dealing with a topic involving climate change, finding the appropriate theory becomes slightly more difficult. This is due to the fact that the topic is relatively new in the field of research, so there aren't thousands of existing knowledge articles that can pinpoint which theory

is appropriate to use and when. Food security is a little different, because this is a topic that social scientists have been debating for decades, and there is more theory-based literature on the subject. In order to establish a proper theoretical framework for this investigation, a number of techniques and theories were critically evaluated.

2.5.1) Entitlement Approach

This technique is used by all agencies that are responsible for analyzing food security. Famine mortality is a reality, according to this approach, since people are unable to get sufficient food, whether by swapping, transferring, or purchasing (Sen, 1981). This is significant because food security depends on it. Regardless of what this strategy maintains, climate change is cited as an issue that will inevitably limit people's ability to participate in this study.

It's vital to remember that alleviating hunger isn't only a matter of boosting average food availability; it's also with this in mind that the importance of this strategy is emphasized. Food entitlement, according to Sen (1981), is an important aspect of significantly lowering hunger; however, this may or may not be related to food availability markets in general. There are a lot of elements, according to Sen (1981), that could encourage food entitlement. Changes in policy, new technologies, changes in the environment, or simply the attributes that influence how a person secures their access to food are all factors that influence how a person secures their access to food.

Regardless of the various reasons, climate change has a significant impact on how people control their food supply. When adequate adaptation tactics and policies are not adopted, people do not have enough control over their food (Delgado et al, 2010).

According to Young et al. (2001), the entitlement approach acknowledges the complexity of food security because it is influenced by a variety of factors, including the community's location, the proximity of food access points, international regulations that may affect food availability, and international policies. These factors are among the factors that must be considered while analyzing food security. Sen's study was significant because it provided a fresh viewpoint on the issue of hunger relief.

The entitlement approach not only emphasizes the importance of actual facts and research on the bearing of climate change on local and domestic nutrition systems, but it also emphasizes

the importance of alternate food sources. Some of the main factors of food entitlement reproduction are social vulnerability as a result of the political economy and livelihood system (Bohle et al, 1994).

When agricultural production is low, those who are largely dependent on these crops, such as subsistence farmers, may often look for any other form of labor in order to keep their income and supplement the food that they can no longer produce. Because there is still that entitlement to food, which tends to be more labor-based now, the determinant of food security shifts to a more non-farm economy (Vincent and Cull, 2009).

There are a few drawbacks to this method. According to de Waal (1990), the approach asserts a linear order of entitlement letdown that leads to hunger, then malnutrition, finally starvation and death. Individual responses to famine, on the other hand, have been studied and shown to be highly different. During times of hunger, humans, according to Corbett (1988), use several coping methods, prioritizing their livelihoods by protecting productive assets.

2.6) Problem statement, research questions, aims and objectives

Figure 1 shows that as time passes, our odds of conserving the Earth for future generations diminish. Climate change has been a key contributor to extreme weather actions such as famines and rain excesses. Because soil isn't obtaining the nutrients it needs to grow properly and efficiently, crop production is unable to survive in these harsh conditions. Temperatures are also at an all-time high, and this hot air has a severe influence on crop output, resulting in food insecurity for those who rely on these products to exist.

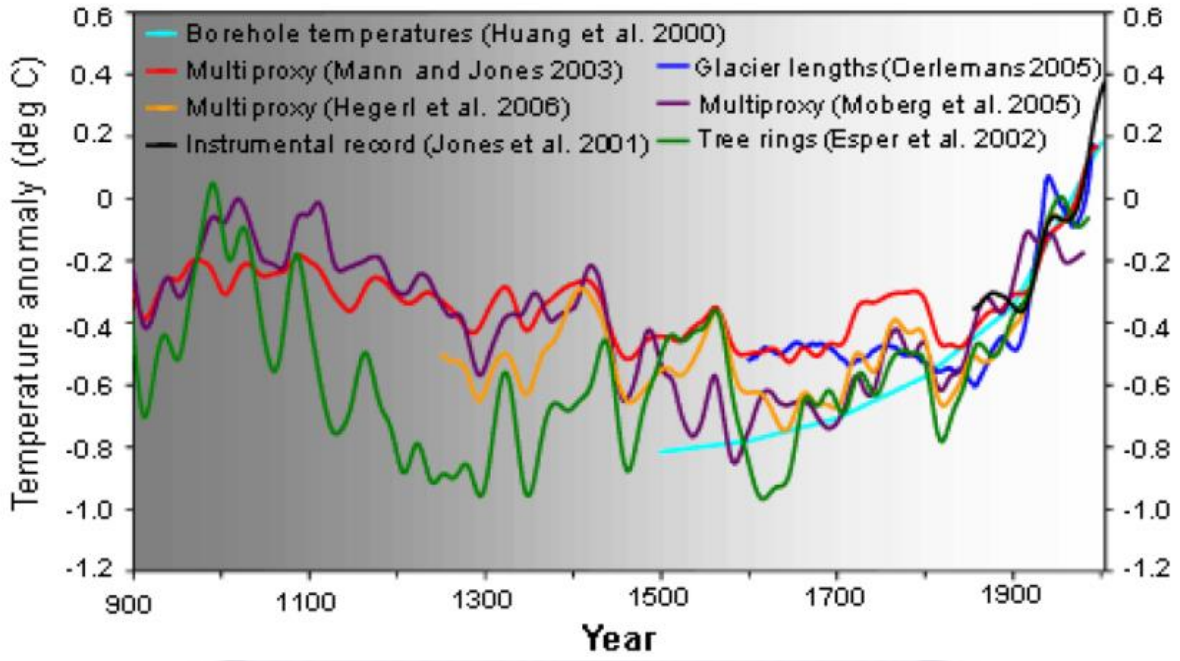


Figure 2: Surface temperatures over the past 1000 years

According to Stern (2006), existing mitigation measures are not working quickly enough and are also highly costly. This dissertation examines the impact of climate change on food security, as well as possible solutions to the problem. Agriculture provides sustenance for billions of people worldwide, but it is also the most disaster-prone industry.

Research questions

- What is the impact of climate change on food security?
- How does climate change influence each one or more dimensions of food security?
- What adaptation strategies can sub-Saharan Africa implement?

2.7) Aims and objectives

The purpose of this thesis is to look deeply at the major effects of climate change on food security in Sub-Saharan Africa. This thesis will also take a quick look at potential adaptations and policy recommendations. The main goal of this thesis is also to look into the coping mechanisms that various areas in the region have implemented in order to be better prepared for the challenge.

2.8) Research Methodology

In research, there are two sorts of methodologies: quantitative and qualitative. Qualitative research is concerned with in-depth details as well as obtaining information from the perspective of the study's participants (Williams, 2006). The qualitative methodology is mainly

focused with achieving what is known as a dense description. The quantitative approach to methodology differs from the qualitative in that it emphasizes numerical representations of interpretations with the goal of understanding them (Creswell, 2003). The quantitative technique approaches will be used in this investigation. When trying to fill in the gaps left by other methods, this strategy comes in handy. This strategy will be the most effective for this study because it will look at statics and correlation while also attempting to comprehend people's lived experiences.

2.8.1) Data Collection

The research will primarily rely on secondary data. Primary data is still crucial in research, especially when there is a need to contribute to what is previously known about a subject. Secondary data, on the other hand, will provide much-needed clarification on the problem and, given the ‘new normal' of COVID times, may be the safest method of research.

The study will look into specific themes such as the primary impacts, how individuals are coping, what the government brings to the table, people's livelihoods, and the economic impacts of the nexus. The use of basic random sampling will be beneficial depending on the study's goals.

2.8.2) Data Collection Techniques

Literature review: This study will rely on peer-reviewed articles, conference papers, and reports from international organizations that conduct considerable research on climate change and food security. Other objectives of this thesis was to incorporate the most recent work possible, and the publication date had to be after 1995. Google searches will be utilized to acquire access to Google Scholar in order to obtain information from various sources; however, this study also used manual searches, which proved to be effective in data collecting. The majority of the literature used in this study was published in English.

2.8.3) Data analysis

After the data gathering has been completed, the data will be analyzed. According to Bird (2009), the type of data analysis that is done when using this approach is referred to as "triangulation." Bird (2009) goes on to say that triangulation aids in the integration of data obtained from two independent methods as well as the reduction of bias.

2.9) Limitation of the Study

The outcomes of this thesis are not intended to be generalized to all of Africa, but rather to add to the conversation round climate change adaptation and household food security in Sub-Saharan Africa. Climate change adaptation and household food insecurity were the two main variables studied.

2.10) Ethical considerations

In order to carry out quality research for this thesis, ethical authorization was requested from the UWC's Higher Degrees Committee in order to conduct this research in an ethical manner. Ethics, according to Strydom (1996: 63), is a conventional of moral philosophies proposed by a person or organization and thereafter universally accepted.

2.11) Tentative Chapter Outline

Chapter 1- Introduction

- Contextualisation and background
- Contextualisation of Food Security
- Contextualisation of Climate change and Food security in the Southern Africa region

This chapter will present the background of the study and will look at what climate change is and what food security is through the conceptualisation of each of the concepts. Finally, it will have the delimitation of the study.

Chapter 2- Literature review

- Introduction
- The impact of climate change on the availability of food
- The impact of climate change on the accessibility of food
- The impact of climate change on food utilisation

This chapter is where different literature that exists in the study is presented, it is also where different definitions are provided by different authors.

Chapter 3- Theoretical framework

Introduction

- Food systems theory
- Entitlement Approach
- Community driven development

This chapter is comprised of the theoretical framework of the study. This is where suitable theories are matched to contemporary challenges.

Chapter 4- Problem Statement

- Aims and objectives
- Research questions

This chapter is where the problem statement is located along with the goals and purposes of the study.

Chapter 5- Research Design

- Research Methodology
- Data Collection
- Data Collection Techniques
- Data analysis
- Limitation of the Study

This chapter is the research design which consists of the research methodology, data collection and data collection techniques as well as the data analysis.

Chapter 6- This chapter will consist of the recommendations and conclusion which will present the concluding arguments and what ought to happen moving forward

2.12 Conclusion

Climate change and food security in Sub-Saharan Africa were discussed in detail in this chapter. Climate change has been mostly fueled by human activity. One of the ways humans are still contributing to climate change is through releasing greenhouse gases into the atmosphere, deforestation, and veld fires have all contributed to the development of excessive temperatures, which are detrimental to agriculture and, in some cases, make living conditions miserable. The research dilemma that people in Sub-Saharan Africa face was also explored in the chapter above.

Chapter 2

Literature review

2. Introduction

Chapter 2's primary goal is to examine the link between climate change and food insecurity in Sub-Saharan Africa in greater depth. This paper makes use of different concepts which for the purposes of being conceptually clear, these concepts need to be defined because these often have various interpretations and definitions. This section will be looking at the concepts, namely, climate change, food security, susceptibility and climate adaptation and then making the link as to their significance and what makes them relevant to the paper. This chapter will also be exploring the different theoretical frameworks which are most relevant to this study.

If we look at a subject of research, the study of climate change is deemed to be 'new' and important to the discipline and niche in a sense. It is perhaps because of this that there is no universal definition of climate change and what encompasses it. The most ‘simple’ definition of climate change according to ISS (2010) is that it refers to the change in weather patterns over an extended period of time and the simplest definition of food security is provided by the World Food Summit (1996) where being food secure was classified as having unlimited access to healthy, nutritious and affordable whenever needed.

According to Boko et al. (2007), Africa was found to be most at hazard from climate change-related risks in an assessment of climate change risks. This was ascribed to rapidly rising temperature levels that are still increasing at an alarming rate.

This section will be looking into broad literature that focuses on climate change and its relationship with food security in sub-Saharan Africa. It will also be looking at other components that feed into this relationship such as adaptation and vulnerability.

2.1 Impacts, susceptibility, and adaptation to climate change

Climate change experts and researchers have made use of multiple approaches in order to food security and how it related to climate change impacts, vulnerability, and adaptation. One such effort is to pre-empt the outcomes that climate change might have on the manufacture of food by using various climate change scenarios using broad data from global climate to various other circulation models. According to Funk et al (2008) the process that is followed by the researchers includes first looking greenhouse gas emissions, these are then inputted into circulation models such as general circulation models (GCM) which in turn project or rather predict climate norms (temperature) in the future. Climate norms that are often paid the most attention to is rain, how long crops with take to grow (Sarr, 2012), if water will be available and finally the soil health. The GCM then makes use of this information to come up with future scenarios that will calculate what will happen with future crop yields. According to Slingo et al (2005) the findings from GCM then inform what type of crops need to be considered for future planting and inform food production as a whole.

What stands out about the approaches used above is that these are top down approaches and are often carried out at the global scale in order to assess vulnerability. According to Kunstmann and Jung (2005) carrying out these types of assessments on such a huge scale often means that, when looking for isolated data, the assumption is that it will remain the same results that were found on the global level because they are scenario based.

The primary outcome that the scenarios seek to find is how will crop yield be affected in the long term, they also look at how food production will be affected (Lobell et all, 2008). According to Kotir (2011) what these scenarios have found for sib-Saharan Africa is that, East Africa will be experiencing more rainfall and that South East Africa will experience much drier weather. These changes are attributed to crop yield becoming more and more scarce. Kotir (2011) also states that the estimated decrease in crop yield in sub-Saharan Africa be between 10-20% as soon as 2050 is it also predicted that the arid land in the region is going to expend as well as the semi-arid land. According to Sarr (2012) there will be far less rain in the West African region and that the rainfall pattern will not be as predictable decreasing their crop yields drastically.

According to Parry et al (2005) there are adaptation plans that are proposed by the scenarios as well. These include making changes to the variety of crops which has the potential to slow

down or completely change the effect of climate change impacts. Both theoretical and hypothetical scenarios are considered when extracting GCM data.

Climate based scenario studies are interested in finding specific things, the first is what the impact on food production be if current weather norms change? What the problem is with this approach is that it neglects every other aspect that forms part of food production, the assumption here is that all other aspects will stay the same which is never really the case. Unlike in more case specific approaches, global approaches are not clear on adaptation capacity is to be achieved and the adaptation process as a whole. As much as getting a clear understanding of the long-term impacts of what the changes in climate norms will do to food supply, it is also just as important to provide insight into what the suitable adaptation strategies are. According to Smit and Pilifosova (2003) farmers in sub-saharan Africa often deal with interannual extremes that makes farmers more vulnerable. According to Adger and Kelly (1999) these GCM measures fail to take into account the role of adaptive measures to such research, it fails to focus on the importance of having adaptation strategies that are suitable for specific areas and finally this research fail to take into considering the role plated by other human related factors instead of looking at the relationship that climate change has with other stressors in order to contribute food security.

The GCM research is arguably very important work in the field of climate knowledge as this kind of information is useful for bigger bodies such as the IPCC and world governments but unfortunately does nothing for the farmer in sub-Saharan Africa. These measures are also only useful when looking at food production and only that but makes no mention of the effects of food production on food security of people and households. It also does not take into account the accessibility of food and well as the utilization of food which are major aspects of food security. The GCM seem to lack the human element as it does not cover it in any on the research and therefore the impact on people is not very well analyzed.

Many scholars, including Adger (2006) have placed an emphasis on not looking at climate change in isolation, they argue that the different stressors that inform food security need to be considered. Scoones (1998) argues that the measures could stand to benefit by adding the human element to the research explicitly. This type of research will then be able to determine how vulnerable the human system will be and will be able to document it so as to make recommendations that will work for people. This the opposite of the top down type of approach

that is employed by GCM and is instead more of a bottom up approach. O'Brien et al (2004) argues that these 'vulnerability approaches are the most effective.

According to Smit et al (2009) vulnerability research as opposed to these climate scenario research approaches, seeks to take a deeper look into climate adaptation by covering all if the bases in terms of what type of adaptation is needed, how the people of that particular society have adapted in the past if there were any changes and look at any relevant information that points towards what type of adaptation that they will need in the future. According to Bryan et al (2009) farmers in the Wenchi in Ghana have expressed that for them, the most frustrating among the climate changes are frequent droughts and unpredictable and mediocre rainfall. The solution or rather the adaptation approach employed to combat these changes is that the farmers are now planting crops are quick to mature as well as crops that are not very sensitive to drought. This is a good example of adaptation.

According to Bryan et al (2009) farmers in both Southern Africa and in Ethiopia reported they were experiencing higher temperatures in their respective countries and they also noticed that there was much less a drastic decrease in rainfall. However, unlike the farmers in Ghana, many of the farmers from both South Africa and Ethiopia chose not adopt any adaptative strategy. The main challenges that they reported as having barred them from adopting the necessary measure was that there was a lack of land (these were the farmers in Ethiopia) and those in South Africa reported having no access to credit.

Sub-Saharan African regions are face heavy constraints such as barely any technical, social and political resources, these are also contributing factors to other issues that they face such as poverty and scarcity. According to Downing et al (1997) these are the very same issues that make is very difficult for people in this region to cope with changes in climate and environment. There are a few community based studies that have provided invaluable insight into what are some on the issues that various communities in this region have been facing and how this has affected their livelihoods. Reid and Vogel (2006) found that in KZN, South Africa there were different stresses at play in individual's daily lives that made it difficult for people to adapt to climate related changes but they are now more vulnerable. This basically means climate change together daily stressors that people have are factors that contribute to individual's inability to adapt.

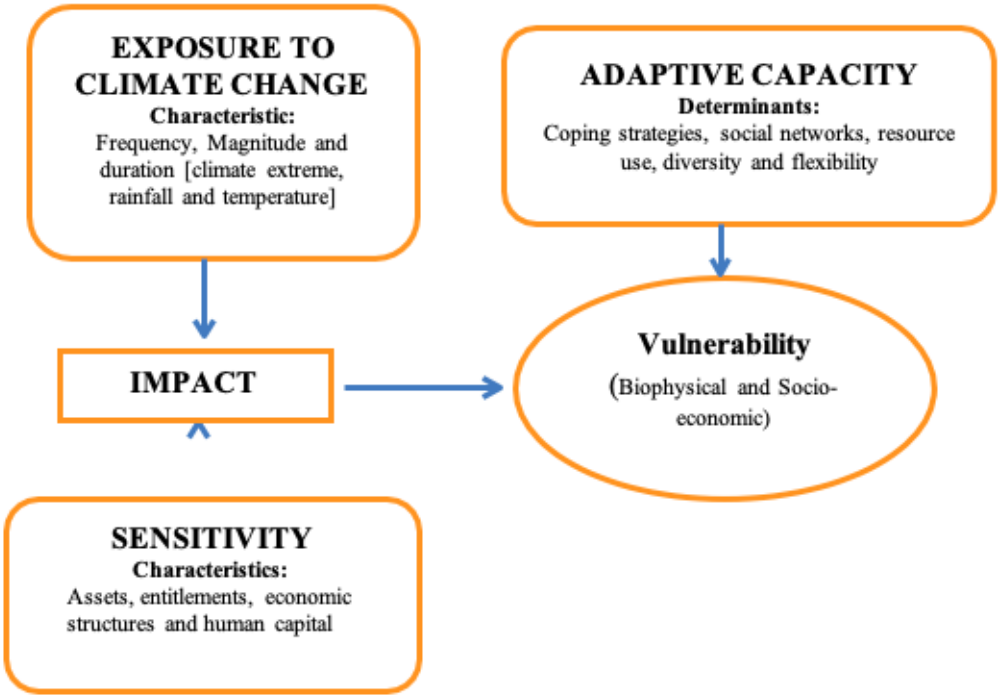
It is this approach of vulnerability research that allows for researchers to find the link between climate change and food security an example of this can be found in a study by Codjoe and Owusu (2011) where a community in Ghana was experiencing heavy floods which destroyed crops that households depended on greatly. The community then had to reach out for assistance in terms of foodstuffs but the floods had caused so much damage to infrastructure that the roads were in a state that made it almost impossible for foodstuffs to be delivered to the community in need.

Vulnerability research makes it possible to investigate and document issues that are faced by people existing in sub-Saharan within the problem of climate change and not look at the different issues in isolation. This approach has also shown that there is more to food security than just food production.

2.1.1. Vulnerability

According to Gerald et al (2010) not many realize or even comprehend the amount of control that climate in general has on daily development on the African continent especially the economic aspect which is driven by the agricultural sector. According to Abou-Hadid (2006) rural farmers in the sub-Saharan region will experience the this the worst as they are predicted to be hit the hardest by climate change bearings. These impacts will not only be environmental but will also be social and economic. When the environmental factor is affected this means that the farmers who depend almost entirely on natural resources will be left in an unfavourable position.

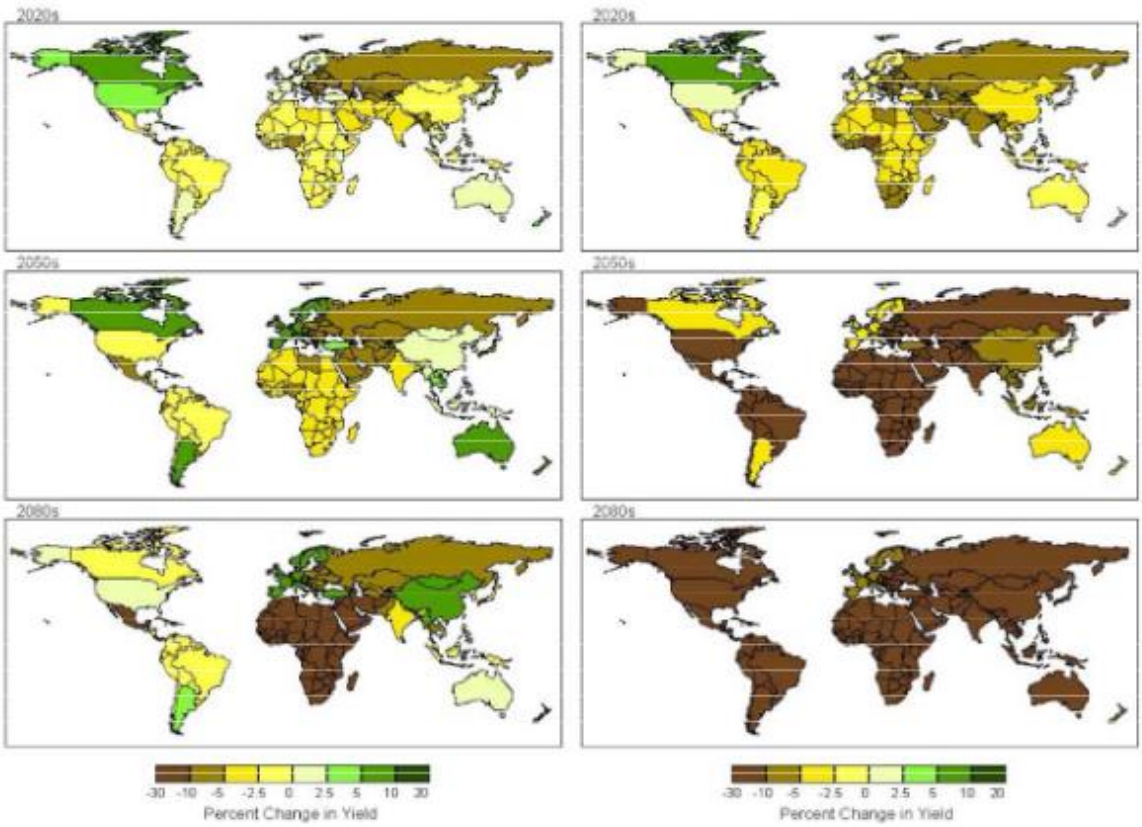
Figure 3: An assessment showcasing vulnerability



This figure was modified from the work of Gbetibouo and Ringler (2009)

Developing countries tend to be more susceptible to the conditions that amplify helplessness to climate change impact. Below there is an illustration that depicts drastic shifts in climate change impacts and future predictions:

Figure 4: Predicted changes by 2050 as compared to 1990



Source: Parry et al (2004)

These conditions are what make it difficult for developing countries to keep up and to cope with climate related risks. According to Leary and Kulkarni (2007) there seems to be a general lack of understanding in developing countries in the importance of being informed of and preparing for climate hazards. There is also a need to governments to research best practice and not only write up policy to mitigate the risks but to also take action by implementing these plans.

Water supply for local rural communities depend heavily on climate (rain), fertile land, agriculture, livestock, firewood, fuel wood, etc are some of the natural resources that will be most impacted by climate related disasters and according to Hunter (2011) it is the rural households that will be largely impacted and making the natural resources that they depended on for a long time, not an option anymore. Another aspect of how climate change can make communities is through water. Major climate risks such as floods, droughts, tropical cyclones, etc all play a part in terms of affecting and/or influencing water-supply in the sense that the

scarcer water becomes, the higher the changes of water sources becoming contaminated and therefore end up causing diseases such as cholera. According to the IPCC (2007) this could also end up affecting food supply because the same water is also used for irrigation.

As previously stated, climate change has not always been taken seriously or even considered a risk that had the potential to destroy people's lives in both a literal and figurative sense. When looking at the problems facing sub-Saharan Africa, climate change has not always been part of the list more especially in social studies. According to Mitchell and Tanner (2006) one of the most important things that scholars and researchers in the field can do is to make sure that information gets to the people who need it the most by raising awareness about the issues and problems that are brought about by Climate change and how these affect them so that people become part of their own solutions as they will have a good understanding of the nature of their problem and will understand what kind of adaptation solutions will work for them.

2.1.2. Adaptation

Adaptation strategies and the use of coping mechanisms are said to be a vital part of climate adaptation literature. Previously, coping mechanisms and adaptation techniques were applied to two distinct concepts, this thesis makes use of these concepts in a synonymous manner, alternating between each one. This paper also uses climate change adaptation and general adaptation the in the same way that these concepts above have been used, in a synonymous manner. Some scholars have used these concepts in isolation to one another but for the purpose of this study, these concepts are synonymous and will be used alternatively.

According to McCarthy et al (2001) can be defined as changes in courses, exercises and/or structures that need to be considered when looking at the changes in climate, this tracks any potential risks or opportunities that could be brought about by climate change related events. Climate change knowledge is rapidly changing and is always being redefined by scholars in the field. Adaptation has many different definitions as well, because of these advancements in the field. According to the IPCC (2001) as cited by Francisco (2008) adaptation can be described as those specific actions that people choose to take in anticipation or in response to changes or to future projected changes in climate so as to mitigate risks or seize opportunities that arise because of changes in climate.

In almost all of the literature that exists in relation to adaptation, the similarity that exists between the different definitions that are provided by the scholars is that mitigating the effects and reducing climate risks is at the core of adaptation in each definition and/or interpretation. "Adaptation to climate is the process through which people reduce the adverse effects of climate on their health and well-being, and take advantage of the opportunities that their climatic environment provides" (Burton, 1992). Another scholar that had a similar definition of adaptation is Stakhiv (1993) where he defined it as "an adjustment that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change" (Stakhiv, 1993),

It can be gathered that adaptation is indeed a measure that can be employed by individuals, groups and/or communities in order to protect not only themselves but also their surroundings from adverse consequences of climate change. According to Watson et al. (1996) measures are not always planned out, sometimes these measures are impulsive which stems from panic when climate related catastrophes start looming.

The definition adaptation that this paper is mostly aligned with is the definition given by the UNFCCC (2007) which defines adaptation as a process that is utilised by different societies in order to put themselves in positions where they are able to cope better with a future that is uncertain. Taking a deeper look at what this statement means, it's clear that in order to cope with climate change, people must ensure that proper actions are taken to reduce the negative consequences or seize the opportunity presented by climate change's beneficial benefits. The only way in which to do this is to ensure that the necessary changes and adjustments are made and honoured. Adaptation could arguably be the solution necessary in responding to the challenges that are presented by climate change and the failure of societies to adapt is what brings about the detrimental effects the unavailability of food which then leads to food insecurity.

Societies/people being able to adapt is what drives any adaptation strategy. According to Watson, Zinyowera and Moss (1996) adaptation can be defined as the extent to which changes made are apparent in practice as well as in the way in which systems are structured in order to show preparedness in case of climate related disasters. This basically means that the environment where the adaptation plans are made around, should be an enabling environment

and allow for the plans to thrive. Adaptation in itself is a very intricate process and requires collaboration in order for plans to be executed effectively.

At the core of it, adaptation is a process that can defined as a dynamic process because it is influenced by a number of factors such as the socio-economical geographical and a number of other factors. Since this is the case, there is no 'one size fits all' approach to adaptation because the capacity for different societies to adapt is also influenced by different factors. This is in line with Francisco (2008) who put forward that each country, community, right down to the household all have adaptive capabilities that differ immensely due to the factors mentioned above. According to Francisco (2008) countries that are more developed tend to have much adaptive capacities which are much higher than countries that are not as developed. Low- and middle-income nations have the most to lose from climate change than high-income countries.

The next important aspect to cover is working with climate change impacts and which adaptation measures are able to assist with this. As previously mentioned above, adaptive measures can be both reactive and proactive. Those that are put in place following panic caused by apparent climate change effects vs those that are put in place as an anticipatory measure.

The conceptualisation of adaptation is an important step when looking for actual strategies that can be put into place so as to adjust to climate change. According to Francisco (2008) the strategy that is used also depends heavily on locality. People in various parts of the world experience climate change effects differently. In other parts of the world some communities experience drought, others floods, others famine, etc so the policies for adaptation in these parts of the globe will not be the same because they will each have different needs. According to Francisco (2008) for some communities, adaptation methods could be as simple as changing the time of year when they plant seeds or changing the type of seeds planted and in other communities the adaptation strategy might be something as complex as having to invest in flood control infrastructure. Below is an example of a multilevel approach to flood preparedness:

Table 1: Floods and droughts preparedness

Local level/community in case of floods flood	**Local level/community in case of drought**	**National level in case of floods and droughts**
buildings are storm/flood proof	Enhancing agricultural production	Conducting regional vulnerability assessments
Constructing, or turning an existing building into, an emergency shelter	Establishing community grain banks	Establishing early warning systems
Establishing evacuation routes	Food preservation	Providing communities with 'safe' land for building
Protecting water supplies	Improved water resource and watershed management	Strengthening infrastructure (such as roads and bridges)
Preparing emergency supplies of food	Deep wells	Large-scale reforestation
First aid training	Drought-resistant crops	Protecting watersheds
Reforestation	Adapting planting schedules	Good urban planning
	Soil preservation	

Adapted from Trobe (2002)

There are different types of adaptation strategies, plans, measures, options and these are often used in a synonymous manner. These can be put into place before any climate related event occurs (anticipatory), it can be spontaneous or as a response to panic (autonomous) and these could also be due to policy that has be deliberately put into place. According to the IPCC (2007) different types of adaptation can be realised on different scales: the household, private, government, local and the higher levels. It is argued by Balaghi et al (2010) there is a lot of knowledge building that goes into ensuring that institutions build adaptive strategies. The knowledge can be traditional, scientific or technological.

The fourth assessment report by the IPCC goes further in explaining the different type of adaptation measures. According to the IPCC (2007) an example of a technological response could be constructing infrastructure that will protect communities from rising sea levels while a behavioral measure would be making changes to their food choices.

In the vast literature that exists on climate change adaptation, it is apparent that there is a looming contestation to distinguish between 'cope' and 'adapt'. This paper does not use these terms in isolation to one another given the context of this research. Scholars such as Davies (1993) make a simple distinction between the two terms 'cope' as a more short-term response to whatever situation e.g food shortage and defines 'adapt' as a more long-term solution.

2.2. Food security

There is more to food security than just how much food people have available. There is an inevitable link between climate change and food security in sub-Saharan Africa. Food security is understood differently in different contexts. Even in 2021, the most popular and widely agreed upon definition of food security is the definition provided by the World Bank which goes, "food security is attained when all people have physical and economic access to sufficient food at all times to meettheir dietary needs for a productive and healthy life" (World Bank, 1986). This is the second most popular definition of food security is the definition of FAO (2002) which states that food security is "a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2002).

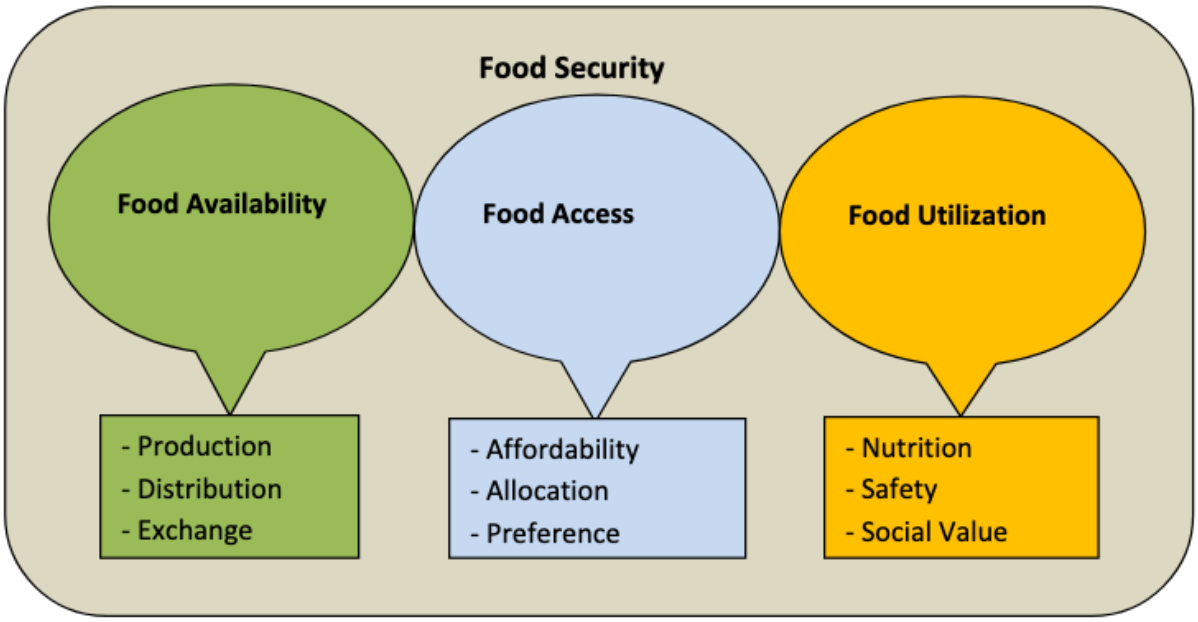
Both of the definitions above have some components in common when it comes to definitions of food-enabling environments. Both definitions focus on how food security is affected by social, political and economic factors and do not dwell as much on the importance on the environmental factors which are arguably the most important. The environmental is important because it determines agricultural activity which is the cornerstone of food supply. This is how climate change and food security relate to adaptation.

The definitions above also show a shift in thinking and in the way in which food security has been conceptualised. The older the research o food security, the more it focuses on the lack of food production being the main reason for food in/security. According to Eriksen (2008) food security can be measured in four different ways, on the individual level, household, community and the national level. For the purpose of this study, the definition of food security that is most relevant is one FAO definition which does acknowledge that food security cannot be viewed as a linear concept but instead is multidimensional. Food availability relates to the production and distribution of food, which is a different aspect of food security. Food accessibility means having access to the types and quantities of food you require, regardless of where you live or

how much money you have. Food utilisation which refers to the actual value of food in terms of nutrients, how safe the food is etc.

According to Barret (2010) food being available is absolutely necessary but it is not enough if food cannot be accessed and being able to access food does not guarantee that the food will meet the dietary requirements that it needs to meet in order for it to meet utilization standards. This means that shops or traders will easily have food in stock but people will not necessarily have the resources needed to purchase or trade the food, they may also have some funds but it may not be the type of food that the body thrives on. Below is an illustration of the different components of food security:

Figure 5: basic tenants of food security



Adapted from Barret (2010)

According to Devereux et al (2004) food insecurity is the absence of food security and there are 2 types of food insecurity. It can either be temporary or continuous, when it is temporary it is referred to as being transitory and when it is continuous it is labelled as being chronic. The point where food insecurity exists when there exists an absence of the different components that make up food security, Devereux et t (2004) explains it as, when food is unavailable, when

there is no economic power to purchase food, when food distribution is not adequate or when households are able to utilize food.

According to the WFP (2009) the reason why continuous food insecurity is referred to as being 'chronic' is because it is long-term and it seems that there is no way around the persistence of it. The use of the word chronic means that household and individuals are at a point whereby this is their consistent reality and they are not in any position to meet the minimum requirements for food consumption consistently. According to WFP (2009) this is condition is reach when the situation remains the same for six months.

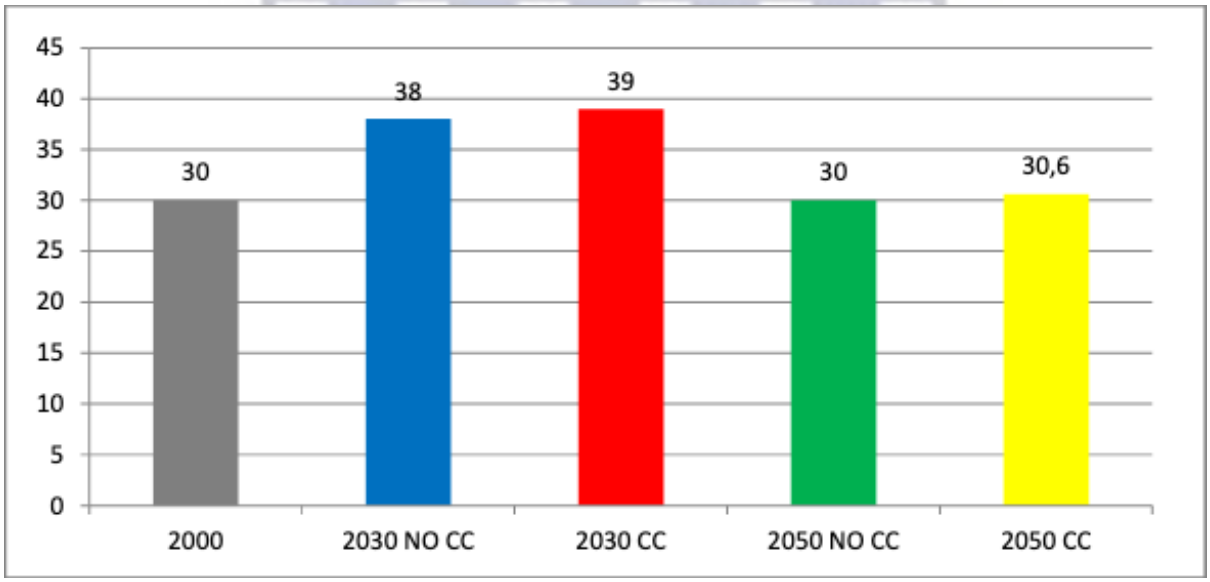
Contrary to the above is transitory food insecurity. According to Mjonono (2008) this occurs when a person is not able to meet their food needs for a short period of time and shows signs that will have the ability to recover and become stable once again. According to Devereux (2006) it is of great importance to understand and be able to distinguish between these two so that the type of responses may be tailored to the specific need in terms of any intervention that is introduced as a mitigating or adaptive response. The context of sub-Saharan Africa, chronic food insecurity according to Devereux (2006) often stems from a place of inequality and other underlying causes.

2.2.1. Climate change impacts on food availability

According to Renzaho and Mellor (2010) the most emphasized and predominant aspect of food security is food availability. There are a number of indicators that are used in order to gage food availability namely, food and crops being produced, livestock and the national food balance. According to Barret (2010) the main reason as to why the focus is predominantly on food availability is because this aspect is relevantly much simpler to calculate as national food balance sheets are considerably easy to obtain. These contain specific information about the particular country's food supply. According to Misslehorn (2005) only focusing on food security as a determinant of food security will skew the analysis and will not produce a broad enough context.

In accordance with Thompson et al. (2010), the greatest threat to food security from climate change will be the reduction in agricultural output, which will have an impact on the availability of food resources. According to Felix & Romuald (2012) climate prediction for sub-Saharan Africa for the next 30 years show an increase in temperatures, excessive rainfall in some regions and a drastic decrease in others and sea level rise. Croplands will be most affected as there will be less and less fertile land to grow food which is the top food source in sub-Saharan Africa. Liliana (2005) states there will be a major drop in food production by almost 50% due to the extreme weather conditions. Another devastating effect according to Nelson et al (2009) is the large calorie decline which is also estimated to hit its peak in the year 2050 the number of malnourished children will also increase quite drastically, the projected amount of cases is 30 million by 2050 and it will be most evident in children between 0-5 y/o.

Figure 6: Impacts on malnutrition



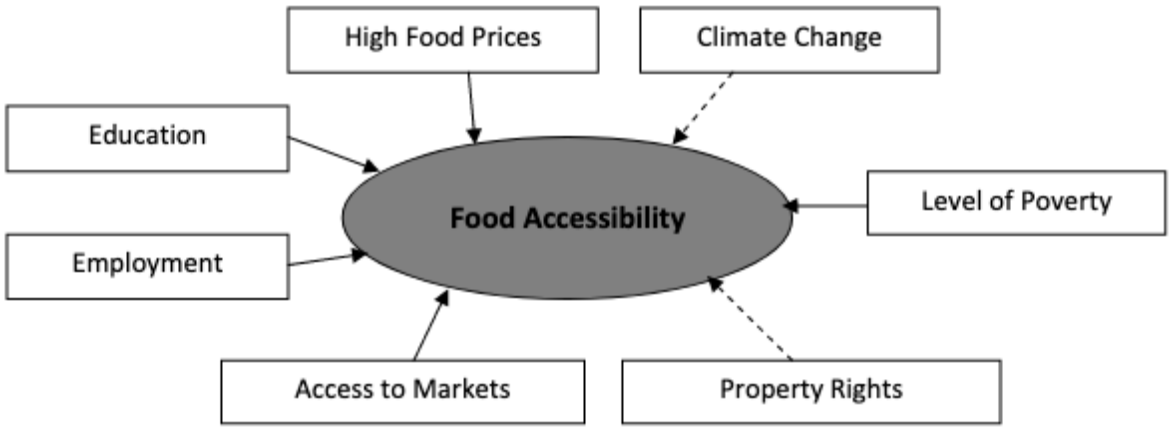
Source: Adapted from Nelson et al (2005)

According to Gregory et al (2005) it can be argued that, even though climate change will bring about devasting impacts in regions all over the world, sub-Saharan Africa might be hit the hardest. The reason for this is the heavy reliance on subsistence farmers who themselves have previously reported not having the necessary resources (land and credit) to put adequate adaptation plans into place.

2.2.2. Climate change effects on food access

There are many factors that effect and determine food accessibility. Some of these include financial resources at disposal, affordability, having an environment that is both socially and economically allowing for food access, right down to import and export Renzaho and Mellor (2010). According to Sen (1981) access is mostly not at all in the control of the individual, in most cases it has a strong institutional focus, things such as share, food prices, government policies, consumption etc. Below is an illustration of the determinants of accessibility:

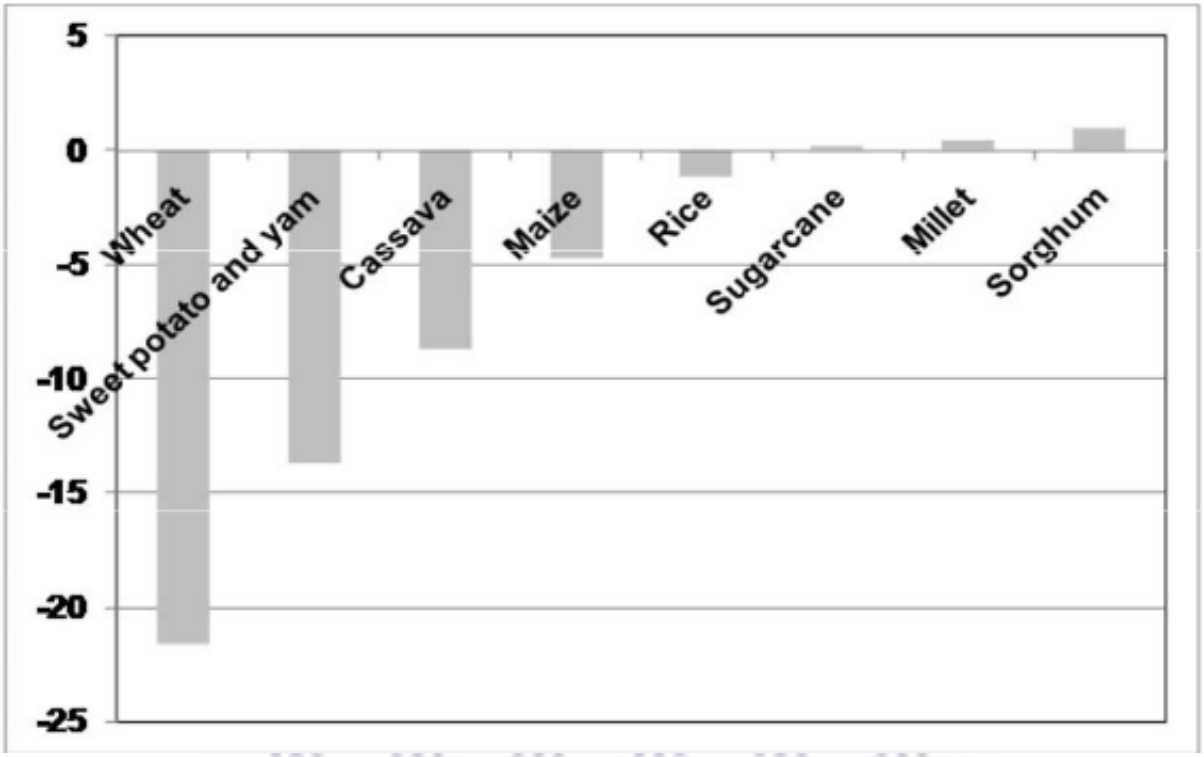
Figure 7: Accessibility determinants



Source: Gregory (2005)

According to Chijioke & Waschkeit (2011) in sub-Saharan Africa there are many underlying and history predeterminants that affect food access in the region such as the high inequality that has left a large number of the people living in poverty, high unemployment which also contributes to the lack of financial resources. Also, the level of education does not allow for many to get the kind of employment that would guarantee a stable income and therefor increase the accessibility of food. According to Chijioke & Waschkeit (2011), another way that sub-Saharan Africa in particular is that there is not much agricultural produce in the winter months so people need to rely on retail for food supply which tends to be very expensive for those with limited financial resources, which is a large population in the region.

Figure 8: projected change in food production in SSA (percentages)



Source: IFPRI (2007)

2.2.3. Climate change impacts on food utilization

Utilization focus primarily on the type of food that households have access to. According to Webb et al (2006) a household the ability of have food availability and accessibility however remain unsecure in terms of food, the food needs to also have good nutritional value and also safe to consume and not impede ones' health. Outside of the food itself, households should also have the necessary utensils to make and consume the food.

Food utilization remains a very important component of food security, equally as important as availability and access. This component is very important because it is closely linked with one of the issues that plague the sub-Saharan region which is malnutrition. It is an unfortunate reality that food prices are increasing, the price of an average household basket increases at

every quarter and the population is not making ends meet. Negin et al (2009) argues that food that is regarded as being unhealthy is one of the leading causes of malnutrition and therefore of people only have this type of food at their disposal then they should be regarded as being food insecure since the dietary requirements of the body are not met. Not many researchers make utilization a priority considering the direct influence it has on malnutrition in the region.

2.3. Food security and livelihoods

Missehorn (2005) states that food security is a multifaceted concept that is made up of multiply layers and is influenced by external stressors that can be either political, institutional, biological, social and economic. When conceptualizing food security and taking into account the multiple stressors about is an important part of livelihood approaches because it considers the individual and how they are affected. Below is an illustration of how food systems are affected by climate hazards:

Table 2: how climate impacts food supply in sub-Saharan Africa (SSA)

Climate change impact	Region/Country	Direct consequences for food systems
Average temperature increase **Hot days & nights** **Warm spells/heat waves over most land areas**	Countries of SSA	- Increased evapo-transpiration, resulting in reduced soil moisture - Greater destruction of crops and trees by pests - Greater threats to human that reduce the productivity and availability of agricultural labour - Reduced quantity and reliability of agricultural yields - Greater need for cooling/refrigeration to maintain food quality and safety - Greater threat of wildfires
Extreme events - **Droughts** - **Floods**	Semi-arid and sub-humid Africa (particularly the Sahel, Horn of Africa and Southern Africa),	- Crop failure or reduced yields - Damage to forests - Destruction of agricultural inputs - Increased land degradation and desertification - Damage to crops & food stores - Soil erosion, inability to cultivate land due to water logging
Change in rainfall amount and patterns	SSA	- Reduced quantity and quality of agricultural yields and forest products - Shortage of water and heavy reliance on irrigation
Sea-level rise	West Africa (Gambia, Gulf of Guinea, Senegal), Southern Mediterranean (Egypt) and East Africa (Mozambique) East Africa (Mozambique)	Loss of cropland and nursery areas for fisheries through salt water intrusion Salinisation of irrigation water, estuaries & freshwater systems which will threaten - irrigated crops - aquaculture in low-lying areas - coral fisheries dependent on spawning grounds in mangrove swamps

Source: Missehorn (2005)

2.4. Consequences for food security and climate change policy

Vulnerability of regions is also determined by where they are geographically located. The disadvantage of many developing regions, including sub-Saharan Africa is that these regions are situated in lower latitudes which is where climate change impacts will cause the most devastating effects then in regions that are located on higher latitudes. According to the Tear Fund (2006) there are many countries around the world that have gone through the process of researching what the implications of climate change will be for their respective countries, but there are very few that actually completed the process by also looking at the suitable adaptation

strategies as well as the necessary policy requirements and/or implications. According to Abou-Hadid (2006) the best thing that a country that exists in the developing world to ensure that they prepare as best as possible for climate change impacts because they are inevitable and from the side of governments and decision makers, the importance should be placed on assessing risks and formulating policies to guide how the country or region will navigate the lessening of the climate related risks predicted in the assessments and most importantly to take the necessary action in seeing these plans through.

When the process starts with creating awareness of climate risks and improving the knowledge of people in ensure that people will understand and when people understand, they will want to do something about the problem that they now realize that they have. According Mano (2006) policy interventions and/or changes are more likely to succeed when people are aware of what the intervention is trying to address and how this will make their lives better.

It is important for countries to understand that from a policy point of view, they do not exist in a vacuum and realize the importance of making sure that policies that are put in place also work for the poor and marginalized members or society. According to Gerald et al. (2010) it is imperative that national governments introduce policies that will be in line with the global community and not risk having policies that will impede on the supply, demand and world trade of food. This means that policies need to cater for everyone and in this case they need to ensure that farmers will be able to gain access to funds that will assist them with adapting to changes that are brought about by climate change some applies for water management entities as well.

According to Clark et al. (2010) the process of adaptation and policy is not at all simple and requires a lot of research and well-thought out approach that will ensure all the necessary actors play their part. They approach needs to be systematic and all those involved need to act their part as farmers alone cannot make the change that is required.

Policies addressing food security in particular also need to focus on investing in adaptation that will finance farmers by making the agricultural sector more resilient and therefore promoting food security. Adapting to climate change is probably one of the more important actions that sub-Saharan needs in order to guarantee a future for the next generation. It is imperative to have broad approaches when tackling policy because climate change is a reality not because of only global warming but also because of what people do to the environment, people are to

blame for a large amount of environmental degradation which in turn speeds up the predicted climate change impacts.

Nevertheless, it's hard to criticize national food security policies without taking regional or local issues into account. This level of research is important since most agricultural policy decisions are decided at the national level, said Bals et al (2008). These decisions are based on whether imports address food security concerns and how much assistance is made available for national agricultural policies (Bals et al, 2008). A national perspective is taken in this study due to the fact that most climate adaptation policies and programs are formulated and executed at this level.

If we want to help people most at risk of food insecurity, we need to know this information in order to develop effective adaptation policies. So the household level was found to be the most relevant explanation for how climate change affects food poverty in this context. It's the income of the family that determines whether or not they are food insecure as long as there is no worldwide food crisis (Bals et al, 2008).

2.5 Conclusion

According to this article, climate change and sectoral climate impacts will distress individuals in Sub-Saharan Africa in many ways. The modifications aren't uniform across the district. Flooding is more likely in East Africa, which can have major health repercussions and damage infrastructure. West Africa is likely to experience severe food production impacts, including decreased marine productivity, causing serious food security issues as well as negative implications for human health and employment. South Africa is experiencing the most precipitation loss, as well as the threat of drought. As rural livelihoods degrade, sea-level rise threatens an increasing number of densely populated coastal towns, whose populations are forecast to grow and who may witness even more in-migration. The possible interactions and amplified repercussions across sectors have yet to be represented in the studies. Due to the resulting uncertainty, integrating consequences across sectors and population dynamics remains a major concern for science, as well as adaptation planning and decision making.

Chapter 3

Theoretical framework

3. Introduction

As indicated in the preceding chapter, the goal of this chapter is to investigate relevant literature on the subject. This chapter will also cover the theoretical underpinnings of the study, as well as the arguments for and against alternate ideas. The subject's essential concepts are discussed and described. More examples of comparable inquiries can be found throughout the chapter. The two theoretical frameworks that support agricultural development and food security are discussed in this section. The approach to rights and the approach to long-term livelihoods are two different things (SLA). The Entitlement Approach to Food Insecurity emphasizes people's ability to receive food through the proper channels, entitlements against the government, and other methods (Sen, 1981). In the same breath, the Sustainable Livelihoods Approach is viewed as a way of thinking about development's aims, scope, and urgencies, as well as a design and development paradigm, and as a foundation for evaluating interventions for their efficacy in reducing property inequality (Krantz, 2001). Without focusing just on economics or food security, the sustainable livelihoods approach is a comprehensive method that attempts to identify and provide a framework for understanding the key hazards and characteristics of poverty.

3.1. Entitlement Approach

The entitlement method was created to assess poverty in a famine as a transient occurrence brought on by drought or other internal factors that necessitates government intervention to alleviate starvation within the country (Sen, 1990). The approach is said to have been invented by Amartya Sen, a well-known professor. Amartya Sen is a world-renowned expert on food security and, in particular, hunger. His well-known entitlement concept has become a significant paradigm for understanding global food security and hunger. Poverty and Famines: An Essay on Entitlements and Deprivation, published in the late 1970s, established the notion.

The entitlement method, according to Sen (1990), is a collection of different commodity packages that a person can receive through the use of multiple networks of relationships impacted by a range of social, political, and legal considerations available to someone in this position.

Sen came up with the concept of entitlement as a reaction to his discontent with prevailing popular beliefs, notably those centered on food supply. The method of food availability highlights people's ability to command food using legal means available in their culture. The method focuses on each human's entitlements to products, particularly food, and considers starvation to be the outcome of not being entitled to any bundle that contains adequate food. The entitlement strategy, on the other hand, differed on underpinnings and won the food insecurity war on grounds. The policy focuses on poverty and food access rather than food availability. Similarly, the entitlement model sees food insecurity as a state of "not having enough food," according to Bringham (Bringham, 2003). This position opposes the food availability theory, which claims that food scarcity leads to food insecurity. According to the entitlement mindset, people don't have enough food because they're poor, not just because they're hungry (Bringham 2003). To put it another way, food insecurity in rural regions is mostly driven by a lack of purchasing power among the poor; this illustrates why a country can be food secure on a state and local level yet food insecure on a community and household level. This is a regular occurrence in nations with large economic disparities between rich and poor, such as Southern Africa.

The rise in popularity of the entitlement notion has ushered in a new perspective on hunger, especially in developing countries. Poverty is the root source of food insecurity, so the strategy was created with that in mind. Previous approaches to food security did not adequately address the issue of poverty in connection to food security. The issue of poverty was not brought to the forefront until Amartya Sen's entitlement model was adopted. More crucially, the method threw doubt on hunger hypotheses based on Malthusian principles. Natural disasters, such as crop failures, are regarded to be the cause of famines, hence the strategy was crucial. Sen's method differed from Malthus' in that he focused on determining why some groups of people in the same place have enough food while others go hungry. As a result, the strategy focused on the elements that influence how food is distributed across different socioeconomic groups.

According to the entitlement perspective, starvation is mostly caused by access issues, such as the inability to prepare, acquire, or otherwise command the food they require. As a result of their inability to procure food owing to financial constraints, many people go hungry or are food insecure.

Endowments, entitlement modelling, and achievement-set are the three pillars of the entitlement technique (Sen, 1981). Each of these principles is discussed in more depth further below. Endowments are a legally authorized form of food distribution. Among these include money, property, technology, and animals, as well as labor power, "know-how," and citizenship (Sen, 1981). The entitlement mapping, also known as e-mapping, is the second component. This includes trades of goods and services, as well as endowment and food (Sen 1981:46). The entitlement mapping is reflected in the proportion between money receipts and food prices, as well as farm input-output rations. The entitlement-set is the third and last item, and it depicts the basket of food, products, and services that a person can obtain with their endowments. An endowment can be converted into a bundle of rights. In this category, there are two sorts of entitlements: direct benefits and indirect entitlements.

Direct entitlements cover food production for personal consumption. Indirect entitlements include people's food purchasing power and their freedom to eat as a result of social security systems, succession, or other legal arrangements. It's crucial to keep in mind that some people use both approaches. This is particularly true for the poor, who receive food in a variety of forms.

According to the entitlement method, food security deterioration can be traced back to either a decline in endowments or a worsening in currency fluctuations (e-mapping) between the endowment and the entitlement set. The technique disproves the theory that hunger is caused by a population-to-food-availability mismatch. Sen accomplished this by referring to the well-known Great Bengal Famine of 1942-3 (Sen, 1972), during which food supply was at an all-time high in Bengal's history. Despite abundant food, the Bengal famine claimed the lives of about 1.5 million people. Concerns about trade entitlements, according to Sen (1981), caused the food crisis. During the Bengal Famine, those who were weak and alone suffered the most.

Famine, chronic hunger, and other kinds of food insecurity can all be understood using the entitlement approach. In addition, the strategy targets challenges such as endemic starvation and deprivation. One of the benefits of the entitlement method is that it may be used on a global, national, community, family, and individual level. As a result, the strategy is in line with the previously stated notion of food security. Individual endowments, entitlement mapping, and entitlement-sets are also used to direct cause and remedy research. What's more, it broadens the scope of analysis available to individuals. In the social, economic, and political domains, the method also provides a conceptual framework for analyzing causes and remedies. A person's entitlement set, according to Sen, is a way of representing his or her "complete authority over things," which encompasses all relevant rights and responsibilities. A person's entitlements are described as "the fullness of things he can have by virtue of being a person of his legal rights," as opposed to rights, which are described as interactions between distinct agents (for instance, one person and another or one individual and the state).

There are certain flaws in the entitlement strategy. Woldemeskel (1990) criticizes the idea, claiming that it ignores the effect of market forces and institutions (as cited in Bringham, 2003). He continues by claiming that the technique fails to account for institutional considerations, market forces, and availability. As an institutional element, the government can and should play a critical role in tackling the food security problem.

Hunger and food insecurity were once considered to be connected to a decrease in food availability. Hunger, and especially famine, is caused by a severe lack of food, which may be relieved by increasing food production and distribution. As a result, thinking about food security was often framed in terms of leading sectors food supply, which fit well with early modern agricultural development concepts, notably in parts of Asia during the Green Revolution era (Wiggins, 2004). Increasing availability via technological productivity improvements looked to offer a way out of poverty, hunger, and food insecurity throughout the world (Wiggins, 2004). In the early 1980s, the idea that famines are only due to harvest failures was debunked, giving way to hypotheses based on "entitlements" failures, or people's inability to get the food they require due to poverty. Sen (1981) notably reinforced this line of thought by explaining the Bengal famine of 1943 in terms of the disparity between rising rice prices and stagnating agricultural wages, leaving farm workers unable to buy enough food. Food

access, or "entitlement" in Sen's terminology, is as important as, if not more important than, food supply (Wiggins, 2004). As a result, focus has shifted from increasing food supply to reducing poverty. An adequate and acceptable food supply is important for the eradication of hunger; yet, increasing food supply does not always mean increased food security for everyone (Pretty et al., 2003).

According to modern famine studies (particularly Amartya Sen's work), major famines with universal hunger and high mortality can occur even though aggregate food resources are no less adequate - and often considerably more abundant - than usual. In such cases, hunger is induced by a lack of food availability rather than a shortage of food. When there is a surge in food insecurity, increasing the overall food supply will not necessarily help; the most important aim is to establish and defend systems of entitlement to food for individuals who have been refused access to current food sources (DeRose, 1998).

When farmers' livelihoods are jeopardized by poor harvests, aggregate food availability is diminished, and prices rise, widespread entitlement failure is a possibility (Derose and Millman, 1998). It can also occur on its own, such as when unemployment or rising food prices limit the amount of nourishment that some groups can buy, or when nutrition resources are redirected away from people and directed toward military reasons (Derose and Millman, 1998). The problem is that famine can have a variety of reasons, so we can't conclude that there's a food shortage in general just because some households are food insecure (Barrera and Brown, 2011).

A variety of fresh viewpoints on food security have lately emerged, according to Wiggins (2004), challenging the entitlement paradigm. There exists some in this paradigm the difficulty is that entitlement theory ignores non-economic factors like conflict and health, while downplaying the role of assets and portraying famine victims as passive. Famine was more of a health calamity than a food one, according to De Waal's (1989) recounting of proceedings in Darfur in 1984. Increased knowledge of the variety of food insecurity and famine settings, as well as the many factors that could explain occurrences (Maxwell, 1996), are among the other new perspectives (Maxwell, 1996). Knowledge food crises, according to this perspective,

necessitates an understanding of impoverished people's livelihoods and the measures employed to protect them, particularly in Africa. The vulnerability of people, as well as their coping methods for dealing with the dangers they confront, have become hot topics.

3.2. Food systems theory

A food systems approach, according to Ingram (2010), systematically links the actions of food growers, producers, transporters, sellers, and customers to food security and environmental outcomes. A food systems methodology, according to Vincent and Cull (2009), is also useful because it allows for the identification of complex drivers that contribute to food insecurity in any particular location at any moment, as well as the examination of interactions and communications between these variables.

According to Evans (2008), despite the fact that climate change is a key stress on food systems, particularly in southern Africa, other numerous stresses such as violence, HIV/AIDS, governance, the rise in interest in biofuels, and economic cycles, as witnessed in 2008, all have a role in increasing vulnerability. Although food security is not attained in many circumstances, according to Ingram, Ericksen, and Liverman (2010), People are hungry and have repeated hunger pangs, or they suffer from a range of diet-related non-communicable diseases, or they spend the majority of their money on terrible or inadequate foodstuffs (Ingram et al, 2010).

Food security analysis, on the other hand, needs a systems perspective. Food security analysis has evolved based on a systems or livelihoods approach in this situation, and it contains four important food security criteria: availability, stability, use, and access to food. Climate change, not only availability, is predicted to have an influence on all four of these criteria (Vincent and Cull, 2009). The Global Environmental Change and Food Systems (GECAFS) Project, which advocated this strategy, was a collaboration between the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme on Global Environmental Change (IHDP), and the World Climate Research Programme (WCRP).

Ingram and Brklacich claim that (2002). The GECAFS project investigated the susceptibility of human food systems to climate change and their interactions with it. The research was

produced in response to a growing demand for integrated assessments of food system vulnerability and global environmental change implications, as well as adaptation options and the impact of various adaptation strategies on both environmental and socioeconomic circumstances.

According to Ingram and colleagues (2010), a food system includes the processes of food production, food preparation and packaging, food distribution and sale, and food consumption (i.e. connecting distribution networks to consumers) (Ingram et al, 2010). The causes of these actions, as well as their social, environmental, and food production implications, are covered in order to investigate the dynamic connections between GEC processes, food systems, and remarks from food system discoveries. The drivers are the connections that govern how food system activities are carried out between and between bio geophysical and human settings. These operations provide a variety of results, some of which aid food security and others which leads to environmental and societal issues. Some factors have a direct influence on the food system's outcomes (e.g. household income levels or disease status). There are also links between other food system outcomes, like environmental legislation and local industry accessibility, or economic groups and access to food (Ingram et al, 2010).

A food system approach, according to Ingram (2010), links the actions of food growers, processors, distributors, retailers, and consumers in the food supply chain to food security and environmental consequences (Ingram, 2010). According to Ingram, these processes may be viewed as fluid and dynamic processes grounded in social, geopolitical, economic, historic, and environmental settings using a food system perspective (Ingram, 2010). Understanding the links between global change (GEC) and food security might be easier using a food system perspective (Ingram, 2010). A food systems approach allows for a comprehensive examination of all food security issues. A food systems approach is also advantageous, according to Vincent and Cull (2009), because it allows for recognition of the various drivers that lead to food security or insecurity in any particular location at any given time, as well as assessment of the interplay and recommendations that function between these factors (Ericksen, 2008). Apart from climate change, which is putting a strain on food systems, particularly in southern Africa, a number of other factors, including violence, HIV/AIDS, effective governance, the surge in interest in biofuels, and market swings like those seen in 2008, all contribute to higher susceptibility (Eide, 2008; Evans, 2008).

Food security is a significant consequence of any given food system, and while it is not always attained, it is a major outcome of every given food system. According to Ingram et al., some people are malnourished and have repeated hunger seasons, or they have a variety of non-communicable nutrition issues, or they spend the bulk of their money on low-quality diets (2010).

3.3. Sustainable Livelihoods Approach

According to Ashley and Carney (1999), one of the most important theories in developmental and poverty studies is the sustainable livelihoods approach (SLA). To guide policy formation and development practice, the SLA blends a theoretical basis with a set of practical principles. The SLA's primary backers include DFID, Oxfam, CARE, and the UNDP. They emphasize the notion and apply it to a variety of projects and activities throughout the world. The livelihoods method can be used in a variety of ways, but the methodology's key principles must be followed.

Chambers and Conway (1992) define a sustainable lifestyle as the capabilities, assets (both physical and social resources), and activities required for a way of life. A livelihood is sustainable if it can withstand and recover from disasters and pressures while also maintaining and improving its assets and capabilities in the present situation, all without jeopardizing the natural environment. At both the global and national levels, and in the short and long term, sustainable livelihoods for one group can contribute to net benefits for other livelihoods.

Complexity, flux, and unpredictability are all part of a long-term existence. As a result, community-based or local adaptive methods are being emphasized. This concept is crucial to our research because it aims to increase people's ability to earn wages in order to fulfill current and future economic and social demands while also reducing their vulnerability to external shocks. In order to attain community goals, the method aids in the identification and development of people's assets, plans, and capabilities across all sectors. When it comes to food safety, the goal is to feed all members of the community and homes.

3.3.1. Livelihood assets

The sustainable livelihoods approach is primarily concerned with how people may improve their living conditions. To put it another way, the approach focuses on the assets listed below (Department for International Development, 1999):

- Human capital includes skills, education, the capacity to work, and good health.
- Networks and connection, membership in formalized groups are examples of social capital.
- Available stocks and frequent money inflows are examples of financial capital.
- Physical capital includes fundamental infrastructure as well as producer items (tools and equipment) that help businesses run more efficiently.
- Natural capital refers to natural resources such as land, water, air quality, and storm protection that can be exploited to construct livelihood options.

The method focuses on bolstering livelihood assets through a variety of strategies, including the formation of grassroots organizations, the transformation of community-local government relations, and the enhancement of people's knowledge and skills (Salvestrin, 2006). The strategy could lead to enhanced food security, better pay, less susceptibility, better health, and increased basic humanity, among other things. The approach's strength is that it concentrates on local techniques and context-specific enjoyment of things, which is why community development projects were implemented.

The method, however, has been criticized for downplaying the impact of macroeconomic trends and war on people's incomes. The method has also been critiqued for its belief that investments can be grown in a systematic & highest performance. Inequalities of power aren't given much attention in this method. The method also ignores the fact that improving the fortunes of one cluster can jeopardize the livelihoods of others. It’s critical that we comprehend vulnerability. Although it might not be equal to poverty, primary poverty makes many households more vulnerable. As a result, impoverished families are more exposed to food insecurity than wealthy homes. Other definitions of livelihood place a greater emphasis on individuals and are less concerned with specific language for various types of goods. They bring up concerns about ownership, access, and decision-making.

Regardless of where different practitioners place their attention, the livelihoods framework aids us in identifying (and valuing) what individuals are already doing to manage with jeopardy and indecision. Second, it aids us in establishing links between elements that limit or promote their incomes on the one hand, and strategies and institutions in the larger setting on the other. Finally, they assist us in identifying actions to reinforce assets, improve capabilities, and reduce vulnerability.

The Sustainable Livelihoods method, which recognises the impacts of strategies, establishments, external shocks, and developments while also noting the effects of policies, institutions, outside shocks, and drifts, helps people to build on their strengths and achieve their potential. The technique sets the basis for identifying the obstacles to livelihood eradication and poverty eradication in a specific setting. This method can assist individuals in

comprehending the complexities of food security. As a consequence, the inventory of the community will be improved or expanded in terms of the five capitals: physical, personal, ecological, societal, and financial riches. If a project can improve food security while also improving these other capabilities, it can be considered a win-win situation for the community. In a nutshell, increased livelihood security equates to increased food security.

People use a variety of capital assets, which is at the heart of the sustainable livelihoods concept. Social, human, natural, physical, financial, and natural assets are all types of assets. In other words, given people's sensitivity to food insecurity as a result of exterior actions and other causes, it is unavoidable that it affects other advantages.

The capability approach is widely utilized in the development and refinement of developments and programs (Gilling, Jones and Duncan, 2001). As a result, SLA has resulted in a steady increase in the excellence and potential influence of donor aid and projects. Furthermore, the SLA promotes key development ideas such as the necessity for high levels of engagement, a multi-level focus and long-term growth (Ashley and Carney, 1999). The SLA has a wide range of applications and is adaptable to a variety of settings, but it is not a magic tool that can solve poverty problems with one indication, is it also not a totally new concept to revolutionize development study and cooperation, as Kollmair and Juli contend (2002).

As noted by Kollmair and Juli (2002), the approach's virtues are frequently accompanied with its drawbacks. A differentiated livelihood examination necessitates a significant investment of money, time, and personal resources, which are frequently absent in practical initiatives. Furthermore, the claim to be holistic necessitates the evaluation of numerous factors, which eventually results in a deluge of data that is difficult to manage. A normative issue arises when deciding what should be considered first. One such limitation is the examination of livelihood assets, such as the challenges of gauging and equating social capital. The degree to which a person is reliant on a certain resource is strongly linked to his or her asset status, which varies based on the local context. According to Kollmair and Juli, certain actors may be able to meet their requirements with a modest degree of financial principal, whilst others with more monetary resources demonstrate significantly less ability (2002).

Furthermore, as previously said, Goldman (2010) also agree that the well-being of the poor is a consequence of their total livelihood, not just their money. Regardless of the multi-dimensional structure of poverty, what is critical is that the lives and incomes of the poor may be enhanced, particularly if poor people are considered as protagonists with support rather than passive beneficiaries of development. Even if the SLA aids in comprehending the complexities of poverty, it fails to address the localized aspect of addressing food insecurity, which is common, particularly in pastoral regions, where the majority of the poor live. Agriculture is extensively recognized as the backbone of the rural economy, particularly in Africa, where communities, households, and people, despite their differences, work together to combat food poverty. Individuals, households, and communities are all involved in local activities that supplement their income.

Despite the fact that relationships between persons and households within a community constitute an outlet for changing development from transactional (dependency) to transformational (empowerment), which is crucial in localizing growth, the SLA remains mute on the subject. Local development goals usually revolve around a set of related issues such as job creation, emancipation, agricultural output, community engagement, and instituting the "local area" as a resilient and sustainable economic force, all of which have been typically addressed by the World Bank in a global context (2001). A crucial concept in the community-driven development plan looks to address the location component of growth.

The importance of relationships among the community, family, and individuals appears to be taken into account by the community driven development (CDD) method. When these three layers come to an understanding, rural and agricultural development will have a faster and more favorable influence on the lives of the poor, because development will no longer be from above to below, but from within. Taylor and Mackenzie (1992) argue that, like development from above, growth from within focuses on the relationship between personal efforts, arguing for tractability as a philosophy and a tactic in which the village poor's priorities and needs are at the frontline of rural and agricultural advancement. Based on the SLA's shortcomings, a more affluent picture emerges, one where rural people use agricultural methods to combat food insecurity, which is the economy's foundation. Localisation of development is exemplified by

community-led development projects or programs, which promote and encourage regions, households, and persons to form their own plans, which are then funded and implemented (Goldman, 2010). Poor people are key participants in the development phase, according to community-driven development, rather than targets of externally devised poverty reduction initiatives (CDD).

3.4. Community driven development (CDD) theory

Agriculture remains the backbone of most sub-Saharan Africa economies, and it provides the primary source of income for poor rural people. Individual and household changes within a community are better understood using community-based theory. The definition of development initiatives is "the use of community structures to address social requirements and empower a group of people" Cavaye (2008). In essence, it aims to make use of existing community structures while also ensuring that people are properly involved and empowered. Community organizations have power over development decisions and resources as a result of this method. Communities, in a sense, receive funding for them to use, design and implement local projects, and oversee their execution. The necessity of empowering communities is implied in the notion. To put it another way, community developments should do more than just give material benefits such as income; they should also permit people, as powerlessness is a sign of deficiency.

The limitations of earlier approaches to alleviating poverty, such as integrated development projects for a specific region and the sustainable livelihoods strategy, gave rise to community-driven development. Community driven development (CDD) allows community organizations to have a role in choices and money, according to Alkire et al (2001:2). These groups frequently collaborate with demand-responsive support organizations and service providers, including such elected local governments, the business sector, non-governmental organizations, and federal government agencies. CDD is a strategy for delivering social and infrastructural services, integrating economic activity and resource management, strengthening the poor, building institutions, and expanding the sanctuary of the world's poorest people (Alkire et al, 2001).

Alkire et al., 2001 divided the potency method among these categories:

- Matches activity in the private and public sectors.
- Enhances long-term viability
- Enhances productivity and efficiency
- Allows for the expansion of poverty-reduction programs.
- Interest groups and vulnerable groups are more included in development.
- Communities are empowered, social capital is built, and governance is strengthened.

Unlike many methods that see disadvantaged people and communities as objectives for programs, they and their establishments are treated as assets and participants in the development method by the CDD. It trusts people and societies to coordinate themselves efficiently in order to supply commodities and services that meet their immediate needs. If a community is facing food insecurity, for example, the community must take steps to remedy the problem. Because the process is in the control of the people, they recognize that putting resources to good use to address food security issues will substantially benefit them.

According to Alkire et al. (2001), CDD is an operational strategy for reducing poverty and delivering long-term outcomes from the grassroots level. It improves the demand responsiveness of interventions and increases their long-term viability. They further claim that CDD has been demonstrated to improve the efficacy and efficiency of a variety of therapies. Another advantage of the CDD is that it is inclusive of poor and vulnerable people if it is well-organized. In this way, CDD-led programs or projects tend to develop positive social capital and give communities a stronger expression.

Many local government entities, NGOs, and funders are spending significantly in community-driven projects around the world due to the need for increased transparency and performance (Casey et al, 2010). In this sense, the World Bank is an anomaly, allocating 9% of its overall lending credibility to CDD initiatives (World Bank, 2007). Local participation in project execution is emphasized as a way to offer social infrastructure through a democratic process that benefits the poor. CDD has become one of the most popular approaches among donors looking to enhance local democratic institutions while also encouraging grassroots localisation.

In essence, CDD entails a degree of delegation of responsibility for philosophy development to communities. This comprises a wide range of development activities, including project planning and implementation. To put it another way, communities must be capable of taking on responsibilities. The method also emphasizes the need of viewing societies not as receivers of goods but as development allies. Community-driven development is defined as a method of planning and implementing policies and programs that help impoverished people get access to different types of capital.

Community-driven development has become a crucial development method, according to Nkonya et al (2009). The CDD approach's attractiveness stems from its ability to create long-term programs and projects that meet local needs, enable local governments to manage and control their own development strategies, and more precisely serve poor and vulnerable people. Nkonya et al. claim that (2009). The rural poor, who are primarily women, girls, youth, and the elderly, make up the poor and vulnerable category. These vulnerable people tend to live in pastoral areas, where cultivation is the main source of income. As a result, it is critical that the role of farming in the food security challenge, which has a rural aspect. As a result, the section that follows examines the role of agriculture in maintaining food security, notably at the community, home, and individual levels.

3.4.1. Agriculture's contribution to food security

Despite the fact that "enhancing agriculture alone would not result in a reduction in hunger and food insecurity," Agriculture has played an important role in the past and continues to do so (Wiggins, 2004). The majority of commentators and policymakers view agriculture's role in terms of two primary criteria: increasing food supply at reasonable prices for the poor, and boosting opportunities for work and wages to enable the poor to obtain food. These two factors are concerned with food accessibility, two critical aspects of food security. Amounts raised through agriculture programs can be used to purchase other foods. As a consequence, improving a community's productivity benefits the following three factors: greater farmer incomes, improved rural employment (that is, job opportunities and rural salaries for

individuals working in the non-farm rural sector), and broader implications for general growth and poverty reduction.

Agricultural growth, according to Wiggins (2004), enhanced farmer income and supplied processing firms with additional downstream advantages. According to Dev (1998), improving productivity increased small-scale farmers' yearly real income by 90% in India (quoted in Wiggins) (2004). Furthermore, during the 1980s, Zimbabwe is reported to have seen a "smallholder green revolution" in maize and millet production, with yields more than tripling and 95 percent of crop land being planted with superior varieties (IFPRI, 2005). In Bangladesh, the expansion of small-scale agriculture has resulted in an increase in off-farm employment (Mandal, 2002).

Another advantage of expanding agriculture is that it provides more employment and increases rural incomes. Depending on employment and underemployment levels, more agricultural development, particularly greater agricultural productivity, typically produces more jobs and boosts wage rates both on and off the farm. As hunger drives community-driven growth, agricultural expansion raises the demand for labor in preparation, planting, pruning, and harvesting, which can lead to increased pay rates. While certain labor-saving technologies may be used in deepening, it has been demonstrated that the capacity to double- or even triple-crop the land increases labor demand with time, even if unit labor consumption falls (Binswanger, 1986). During the 1970s and 1980s, all of this occurred in India, as well as Bangladesh at the time. In the following years, it led in greater food security in the individual countries. Furthermore, it has been proven that when farmers get wealthier, they are more likely to swap domestic labor for hired labor, increasing job opportunities. According to Leavy and White (2000), employment possibilities in rural Africa exist not just on big farms, but also in the farming industry, which has a flourishing labor market.

More evidence may be found in Dev (1998), who claims that gains in agricultural production resulted in a 125 percent rise in the average income of India's landless (quoted in Wiggins) (2004). As a result of the connections between agriculture and the larger rural economy, agricultural expansion creates more and better-paying jobs for the poor off-farm. Additional jobs in and out of agriculture may have a big influence on rural labor markets, raising wages and making it easier for the poor to buy food. This increase in earnings helps to give funds for people in need to purchase food.

When looking at the larger economic impact, cross-country comparisons show a significant link between agricultural development, broader economic growth, and progress in eliminating poverty throughout the economy (Wiggins, 2004). In general, the countries with the greatest increases in agricultural output have also had the greatest decreases in poverty. According to Ashley and Maxwell (2001), boosting yields by a third can alleviate poverty by a quarter or more, citing Datt and Ravallion (1996). To summarize, agriculture output is essential to overall economic growth and benefits the poor more than other industries. No other industry, according to Wiggins (2004), has the same potential to create jobs and raise people out of poverty, therefore policymakers should pay special attention to agriculture. Agriculture, on the other hand, is moving in a different direction. While it is commonly acknowledged that agricultural expansion aids in the reduction of poverty, there is disagreement over the importance of these distinctions in terms of their impact on the poor.

3.4.2. Agriculture Growth, Development and Food Security

Agriculture stands out as the most evident industry with the capacity to improve rural incomes, according to Davis (2003), because of the large number of people directly involved in the activity and its production connections. The importance of agriculture in ensuring food security in Africa has sparked heated discussion, especially in light of the continent's severe poverty, food insecurity, and malnutrition. Fighting food insecurity and poverty reduction on a continent plagued by frequent food shortages, chronic poverty, and limited financial resources is a challenging task for most African countries (ldasa, 2009). As a result, the Committee on Agriculture (2010) emphasized agriculture's role in the development cycle, with small-scale farmers usually regarded as the engine of economic growth, poverty reduction, and food security. Smallholder farmers are a unique aspect of African agriculture, and they rely on subsistence farming for a living. They're more common in rural regions where poverty and food insecurity are common. Agriculture makes a substantial contribution to Sub-Saharan Africa's economy, accounting for about 30% of the continent's GDP and 50% of overall export profits (lPNI, 2007). Around 70% of Africans reside in rural areas, including roughly 80% of the continent's impoverished, and rely primarily on agriculture for a living (UNESCO, 2007). Over 60% of the workforce is employed in the sector, which accounts for 20% of total export value (CAADP, 2003).

Despite the fact that urbanization has been increasing at a rate of 4.9 percent per year in recent decades, agriculture continues to provide a considerable share of total jobs (UNESCO, 2007). As a result, agricultural development is commonly regarded as a way to alleviate the global food problem while also decreasing poverty, hunger, and malnutrition, especially in Africa (NEPAD, 2003). Agriculture must be encouraged if the Sustainable Development Goal (SDG) of halving poverty and hunger by 2015 is to be achieved. The quantity of increase and whether it is based on quick agricultural expansion are both important factors in poverty alleviation. Agriculture works in three separate domains, according to a 2008 World Bank study: agricultural-based, agriculture-in-transition, and agriculture-in-urbanization. According to the World Bank Report 2008, these three worlds are as follows: Agriculture and related sectors are critical to growth and the reduction of severe poverty and food insecurity in the agriculture-based region, which encompasses most of Sub-Saharan Africa (SSA). A productivity revolution in smallholder farming is required if farming is to be used as the foundation for economic growth in agricultural nations. Rapidly growing rural-urban economic disparities and persistent rural poverty are key drivers of social and political instability in developing nations such as South and East Asia.

Transitioning to elevated agriculture, decentralizing nonfarm economic activity to rural regions, and giving assistance to those who choose to leave agriculture are all part of a multifaceted strategy to close income inequalities in developing nations. Agriculture can help reduce remaining rural poverty in urbanised countries like most of Latin America and much of Europe if smallholder agriculture becomes direct providers in modern farmers markets, good workers work in agriculture and agro industry, and markets for ecosystem resources are introduced. Despite the fact that the worlds of agriculture are large, diverse, and continuously changing, agriculture now presents fresh chances for hundreds of millions of rural people to escape poverty. Agriculture now presents fresh chances for tens of millions of rural people to overcome poverty by implementing the proper policies and promoting investment at the local, national, and international levels (WDR, 2008). Smallholder agriculture has traditionally been recognized as the most effective sector for reducing poverty and ensuring household food security in rural regions.

Agriculture is the major source of income for poor rural households in Sub-Saharan Africa; yet, smallholder farming concerns have received little attention and are generally neglected in

global debates. If the required resources are available and the government and other important actors understand the role smallholder agriculture can play in development and food security, farming can provide a route out of poverty and food insecurity. Smallholder agriculture is essential for food security, but its production has been falling, resulting in increased food costs and insecurity. The phrase "smallholder" or "small-scale irrigation" is used in South Africa to describe irrigated agriculture done by people of color. There are between 200 000 and 250 000 smallholder irrigators in South Africa, according to estimates (Van Averbeke and Mohamed, 2006).

Because the phrases "smallholder farmer" and "subsistence farming" are frequently interchanged, it's important to clarify and separate the two meanings. Although subsistence farming refers to rural communities with land access who rely primarily on family labor for farm production in order to produce for self-sufficiency, smallholder farming refers to farm households with land access who rely primarily on family labor for farm production in order to produce for self-sufficiency (Todaro, 1995). (Ellis 1998). Smallholder farmers, according to Todaro (1989), are people who own small pieces of land and rely almost entirely on family labor to cultivate subsistence crops and one- or two-income crops. Smallholder agricultural output has shaky, unreliable market linkages, but subsistence agricultural output is not sold and eaten only inside the home (Waugh, 2000).

Much of Sub-Saharan Africa's agriculture, according to Todaro and Smith, is still in the subsistence stage (2009). Because the majority of production is done by hand, there is no surplus output that can be sold for money to help the poor meet other requirements, such as educating their children and improving productivity. These farmers' food security will be threatened in some way if they do not improve their production. The sluggish growth in agricultural productivity and food production, according to Ukeje (undated), has resulted in growing food imports and food insecurity. According to Kirtsen and Van Zyl (1992), the agriculture sector's most essential duty is to produce adequate food at reasonable costs.

As a result, unless smallholder agriculture becomes more commercialized, agricultural expansion will have a limited influence on food insecurity and poverty reduction (Machete, 2004). Smallholder agriculture is much too essential in Sub-Saharan Africa for job generation, human well-being, and political stability to be disregarded as a minor adjusting sector in a market economy (Delgado, 1995). Furthermore, according to Ashley and Maxwell (2001),

resource flows to the rural sector have decreased, which applies more to agriculture than other sectors, posing a severe danger to food security, particularly at the family level. Smallholder farmers' profits must be raised in order for agriculture to contribute more to poverty alleviation (Machete, 2004). As a result, it's critical to discuss South Africa's agricultural condition and how it's hurting food security.

3.5. Conclusion

This chapter covered Sen's entitlement method, sustainable livelihoods approach, food systems theory, and CDD methodology, which are the four key ideas that underpin this study. It then went on to examine agricultural development and expansion, as well as how agricultural growth addresses the problem of food insecurity. The current status of agriculture in Sub-Saharan Africa was also examined, as well as the role of the state in ensuring food security throughout Africa, particularly in Sub-Saharan Africa. Several of the framework's characteristics have previously been brought to the attention of others, notably in the development community. Addressing climate change in isolation from other major drivers of change for efforts aiming at improving people's lives, decreasing poverty, and boosting food security makes little to no sense. The Food and Agriculture Organization, the World Bank, and the Consultative Group on International Agricultural Research (CGIAR) Research Program on Climate Change, Agriculture, and Food Security (CCAFS) all use the "climate-smart agriculture" framework, which aims to increase agricultural production sustainably while adapting to climate change and mitigating greenhouse gas emissions (FAO 2013; Neate 2013). Recent IPCC assessments show similar patterns, while the major focus remains on agriculture harvests and productivity.

The framework's main purpose is to guide empirical research, especially at the community level. It's utilized to demonstrate how the findings of a variety of empirical case studies in Sub-Saharan Africa fit within the framework. More than a scholarly requirement, improving our understanding of the relationships between climate, food, and livelihoods is also required to guide practical initiatives, such as policies, programs, and actions (including climate change adaptation), aimed at sustaining or improving the livelihoods and food security of people in Sub-Saharan Africa as the climate changes.

Chapter 4

Methodology

4.1. Introduction

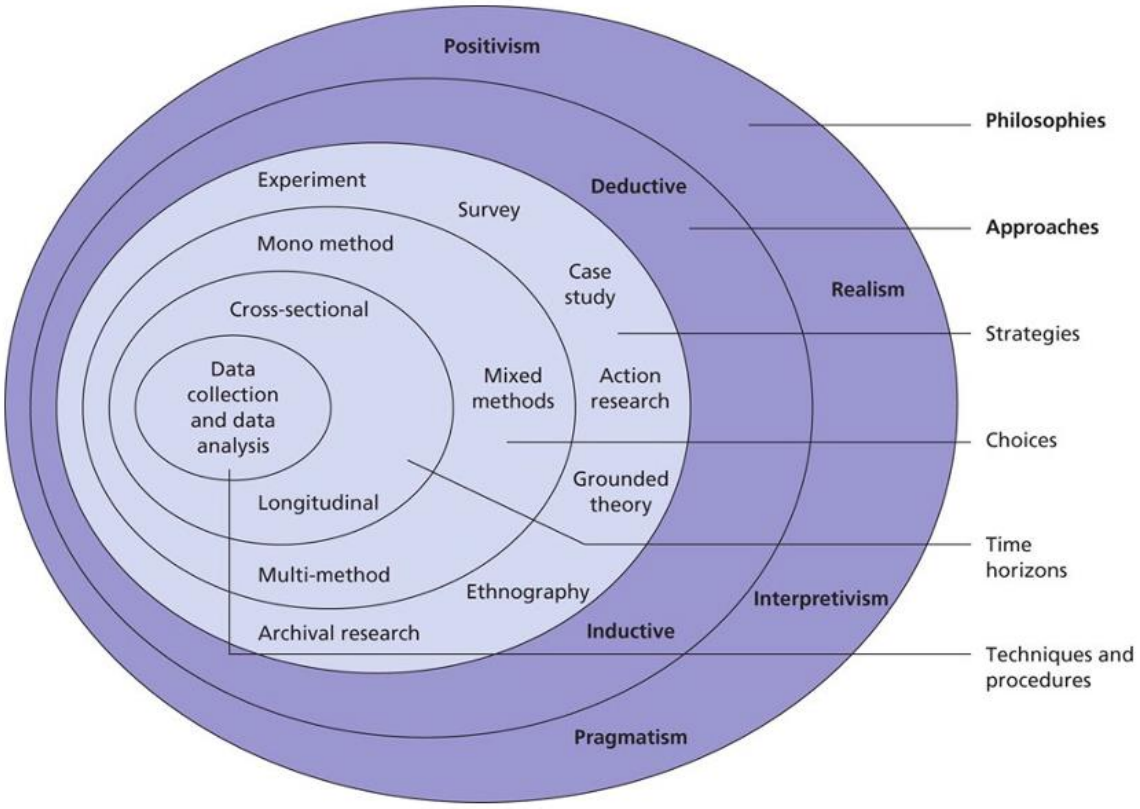
The methodology used in this thesis will be discussed in detail in the next chapter. This chapter covers the study's research design, research instruments, data collecting technique, and data examination processes. Instead of emphasizing actual fact, the realist method is founded on systematic review principles. Compared to other types of reviews, realist reviews have stricter inclusion requirements and include fewer papers because they place more emphasis on depth rather than breadth, and they tend to employ more qualitative critical appraisals. Because food security is linked with social, cultural, and ecological systems that all have an effect on how vulnerable or adaptable a society is, this approach is useful for understanding food security. A qualitative secondary research technique was employed in this study. Defining words is followed by an examination of how these terms are employed in the study.

4.2. Definition of Research

Research is described as a methodical examination of a specific subject or problem using scientific methodologies. Research is a methodical effort to characterize, explain, forecast, and manage the observable event according to Cook and Campbell (1979)

Much of today's social research is focused on determining if a program, treatment, or manipulation is responsible for a particular end or result. For example, a particular researcher would want to know if a new educational program leads to increased attainment scores, if a unique work release program for inmates leads to decreased recidivism rates, if a new medicine leads to symptom reduction, and so on. Before there is an inference that such a cause-effect relationship does indeed exist, Cook and Campbell (1979) suggest that three conditions must be met:

Figure 9: The research onion (Saunders et al, 2008)



Covariation Changes in the presumptive cause must be linked to changes in the presumptive effect. As a result, if we add, eliminate, or vary the degree of a handling or program, the outcome measurements should alteration. Temporal Priority. Prior to the anticipated consequence, the presumed cause must occur.

There are no plausible alternatives. The only reasonable explanation for changes in the outcome measures must be the hypothesized cause. We can't be sure that the claimed cause-effect link is right if there are other issues that could be causing variations in the outcome measures.

The third requirement is the most hardest to meet in most social studies. Changes in outcome measurements could be caused by a variety of causes other than the therapy or program. Cook and Campbell (1979), as well as Campbell and Stanley (1966), provide a variety of possible alternative hypotheses (or, threats to internal validity). For example, it's possible that the change in outcome measures was caused by a historical event that occurred at the same time as the program or action was implemented; or that changes in record keeping or capacity systems that occurred at the same time as the program were mistakenly credited to the program. For a more extensive consideration of challenges to validity, the reader is directed to conventional research techniques texts.

The objective of this work is essentially heuristic. Cook and Campbell (1979) and other standard social science methods textbooks often include a variety of research designs as well as the alternative hypotheses that these projects rule out or limit. This encourages a "cookbook" approach to research design, with a focus on selecting an existing design rather than developing an acceptable research strategy. While standard designs may match real-life scenarios in some cases, it is often required to "tailor" a study strategy to reduce unique threats to validity. Furthermore, even if typical textbook designs are utilized, a general understanding of design construction logic will aid comprehension of these standard approaches. The study design in this paper is based on a structural approach. While this isn't the only way to build research designs, it does assist to highlight some of the fundamental ideas of design logic.

4.3. What are Research Methods and Methodology?

According to Fielding (2000) Methods for collecting and analyzing data are referred to as research methodologies. A vital component of your research plan is establishing your research technique. You must make two important considerations while designing your tactics. First, determine how you'll collect data. The type of data you require to answer your research topic will determine your methods: Quantitative vs. qualitative research. Primary vs. secondary education. Experimental vs. descriptive.

The researcher conducted a comprehensive review of peer-reviewed literature on agriculture and food security. The manner of review was realistic. The realist approach is based on the Cochrane standard evaluation principles, but instead of objective fact, it seeks interpretation. Realist reviews are distinguished by stricter inclusion criteria and a limited portion of papers than other types of reviews, as well as a concentration on depth rather than breadth and the use of largely qualitative critical assessments. Because food security is connected with complex social, cultural, and ecological systems, all of which have an effect on susceptibility and adaptability, this method is an excellent way to study it.

The following keywords (in all categories) were used to conduct a keyword search within the Google/ Google Scholar electronic databases: nutrition, food security, global warming, climate change and sub-Saharan Africa. Articles that were not published in English, or that were published prior to 2005, were excluded at first however, there was a great deal of information that was being left out so all years were considered. This date was picked in order to ensure

that the study was up to date. Articles, reviews, and meetings were the only things that were included. There were 113 results.

To narrow documents based on the inclusion and exclusion criteria, all publications titles and abstracts were examined where necessary, the complete text was assessed to validate relevance.

Table 3: summary the inclusion and exclusion criteria.

Included	Excluded
• English only	• Adaptation strategies for environmental, economic or political reasons (no explicit discussion of food security)
• Published from 01 January 2005 to 01 February 2010	
• Available in ISI Web of Knowledge	• Technical analyses of climate change projections, theoretic models and simulations
• Articles, reviews, meetings	• Impact of climate change upon vector-borne infectious diseases and chronic diseases (non-nutritional in origin)
• Adaptation for reasons of food security	• Food security as a marginal or absent feature of the article
• Alternative food sources	• Impact of climate change on non-food source animals
• Impact of climate change on crop productivity	• Human evolution/historic climate change
• Impact of climate change upon land degradation (soil fertility, desertification) and implications for food security	• Non-health related climate change adaptations
• Country and multi-country studies; Africa as major focus	

4.4. Characteristics of Research Design

A researcher's research design, according to Fielding (2000), is the structure for the methods and techniques he or she will utilize. Researchers may focus on research techniques that are relevant to the topic matter and set up their studies for success because of the architecture. The kind of study (experimental, survey, correlational, semi-experimental, review) and its sub-types are determined by the design of a research topic (experimental design, research problem, descriptive case-study). Your study will be more effective if you use the proper research design. The results of successful research inquiries are reliable and unbiased data. You must develop a survey that satisfies all of the design's main requirements. According to Fielding (2000), there are four distinct characteristics:

Neutrality: When planning your research, you may need to make assumptions you expect to collect. The findings of the study should be objective and unbiased. Consider all who concur with the outcomes, and obtain multiple perspectives on the final scores and findings.

Reliability: When a researcher conducts research on a routine basis, he or she expects consistent results. Your strategy should demonstrate how to construct research questions in order to assure the quality of your results. Only a reliable design will help in achieving your objectives.

Validity: A wide range of measurement instruments are accessible. The only accurate measurement instruments, on the other hand, are those that aid a researcher in assessing outcomes in line with the study's objectives. The survey that results from this design will be accurate.

Generalization: Your concept's outcomes should apply to the entire population, not just a tiny sample. A generic method allows that your survey can be conducted on any segment of the population with the same level of accuracy. Because the above characteristics affect how respondents answer to research questions, an effective design must balance all of the above traits.

4.4.1. Explorative Study, Descriptive Study and Causal Study

Our mental models or reference points, which we use to organize our thoughts and observations, have an impact on how we plan and conduct research. Paradigms are the terms used to describe mindsets or frameworks (belief systems). Thomas Kuhn popularized the word "paradigm" in his book The Structure of Scientific Revolutions (1962), which examined the history of scientific technique to uncover fundamental patterns that govern scientific progress. Similar ideas apply in the social sciences, where a social reality might be perceived in a number of ways by different individuals, restricting their capacity to evaluate and reason about it. Conservatives and liberals, for example, hold very different perspectives on the role of government in people's lives, and as a result, they disagree on how to address social issues. Tax cuts, critics claimed, are the most effective method to revive a stagnating economy since they raise people's disposable income and spending, boosting business production and employment. On the other hand, liberals may argue that governments should spend more directly in job-creation programs such as infrastructure upgrades and infrastructure projects, which would result in more jobs and increased people's capacity to consume, therefore boosting the economy.

Table 4: adapted from Research Methods course lecture slides

Question type	Question	Examples
Exploratory questions	What is the case? What are the key factors?	**What are the critical success factors of a profitable company?** **What are the distinguishing features of a good leader?** **What are the reasons for the carnage on South African roads?**
Descriptive questions	How many? What is the incidence of x? Are x and y related?	**How many people died of AIDS in South Africa last year?** **Is there a correlation between parental support and scholastic achievement?**
Causal questions	Why? What are the causes of y?	**What are the main causes of malnutrition in a rural community?** **Is smoking the main cause of lung cancer?**
Evaluative questions	What was the outcome of x? Has P been successful?	**Has the new TB awareness programme produced a decline in reportable TB cases?** **Has the introduction of a new refrigeration technology led to more cost-effective production?**
Predictive questions	What will the effect of x be on y?	**What effect will the introduction of a new antibiotic have on population P?**
Historical questions	**What led to y happening?** **What were the events that led up to y?** **What caused y?**	**What caused the demise of socialism in Central Europe during the late eighties?** **What led NATO countries to decide to start aerial bombing of Kosovo?**

In Western culture, personal liberties such as the right to privacy, freedom of expression, and the right to keep and bear arms are becoming increasingly important. In Asian nations, individual rights are weighed against those of families, organizations, and the government, resulting in policies that are more communal and less individualistic. As a result of these disparities in viewpoint, Westerners commonly criticize Asian governments of being authoritarian, while Asians blame Western societies of being affluent, having high crime, and establishing a "cult of the individual." Our personal paradigms govern how we perceive the world and arrange our thoughts about what we see.

4.5. Choice of Research Methodology

The research used a qualitative approach. Qualitative research, according to McMillan and Schumacher (1993), is "mainly an inductive process of organizing data into categories and discovering patterns (relationships) among categories" (McMillan and Schumacher, 1993: 479). This theory contends that the study's data and interpretation develop "organically" from the research setting. The benefit of qualitative methodology is that it is a system of inquiry that

aims to give a comprehensive, primarily narrative description to inform the researcher's understanding of a social or cultural phenomena, and it is this system of inquiry that is at the core of this study. Qualitative technique was justified since it matched a liberal approach to research that allowed for flexibility in the study process. According to Wiersma (1995), a more flexible research strategy is necessary.

Figure 10: Secondary research (QuestionPro, 2021)

Secondary research, also known as data analysis or desktop research, is a type of research that draws on previously collected data. To increase the overall efficiency of the investigation, existing data is summarized and collated. Research material published in research papers and other comparable resources are examples of secondary research. These resources can be obtained, among other places, in public libraries, on the internet, and in data from previously completed surveys. Some government and non-government organisations can also retrieve data and utilize it for research purposes. Because secondary information employs data that already exists, it is far less expensive than primary research, which requires organizations or enterprises to acquire data themselves or hire a third party to do it on their behalf.

In qualitative research, researchers look for solutions in "natural" (Wiersma, 1995). He continues, "Researchers don't push their assumptions, boundaries, delimitations or definitions, or research designs on emergent data," implying that the researcher's duty is to document what he or she observes and/or obtains from individuals in their natural surroundings (Wiersma, 1995). Participants were able to contextualize the research topic, which was a rapidly changing environment with severe consequences for crops and people's lives.

The use of previously gathered data to answer problems that were not addressed in the original research is known as secondary data analysis (Hinds et al., 1997). In many organizations, secondary analysis of numeric datasets is well-established in quantitative social research, policy analysis, and corporate decision-making (Corti and Thompson, 1995; Fielding, 2000), but this has not been the case with qualitative data until recently. The discipline of repurposing saved datasets and secondary analysis has risen in popularity over the years as academics have discovered that many qualitative datasets include narratives that highlight themes relevant to the basic research issues but have never been investigated. Secondary analysis is distinct from approaches like meta-study of qualitative data (Paterson et al., 2001), meta-ethnography (Noblit and Hare, 1988), meta-sociology (Furfey, 1953), and meta-study (Zhao, 1991), which aim to critically evaluate the theory, methods, and findings of existing qualitative research in order to generate and synthesize meanings from various studies.

Heaton (1998) advises noting the original study, the data collecting technique, and the analytical processes performed on the data when conducting secondary analysis of source datasets. Secondary evaluation should have the goal of making public the interpretive processes of knowledge creation by addressing methodological and ethical concerns, as well as any judgments formed in the lack of data. In reality, this means that a match between the original datasets and the secondary research questions must be identified before undertaking a secondary analysis (Thorne, 1994; Heaton, 2004). It is suggested that the secondary analysis research questions, as well as the data collecting and analytic techniques used in the original dataset and those used in the secondary analysis, be sufficiently similar to those used in the primary study. The previous concepts will now be used to demonstrate the secondary analysis approach discussed in this paper.

It is feasible to get a more in-depth understanding of complicated conditions and processes when qualitative research approach is used. According to Bamburger (2000), qualitative paradigms are sometimes seen to have a micro rather than a macro emphasis, implying that

they seek to explain processes at the individual rather than aggregate level. Qualitative techniques are particularly valuable because they capture underlying meanings and uncover unexpected and delicate themes. According to Bamburger (2000), the framework and analysis are also interpretive, with the research depending on naturalistic observation to represent the limits of ordinary life.

Here are some of the benefits that this study has found as being useful in employing a secondary research approach:

- For the most part, secondary research information can be found rather quickly on the internet. Instead than starting from begin with primary research, where relevant data must be gathered, secondary research uses data from multiple sources.
- A less expensive and time-consuming approach due to the widely available and low-cost nature of the essential data when gathered from trustworthy sources. The price of obtaining data is fixed.
- Organizations and businesses can use secondary research data to determine whether or not initial study was a success. As a result, businesses and organizations can come up with hypotheses and calculate the cost of conducting primary research.
- Because of the easily available data, secondary research takes less time to perform. According to the purpose of the company and the amount of data required, secondary research could be completed in a few weeks or months at most.

Some the shortcomings that were identified in carrying out in conducting this research include:

- There's no way to know for sure if the data is accurate until you undertake a credibility assessment.
- In some cases, secondary data sources may not be up to date with the newest reports and statistics. There is a chance that the data is accurate, but out-of-date if you take into account current occurrences.
- The conclusion of secondary sources is produced from a compilation of primary

research facts. The success of your research will be determined more by the quality of the original research that has previously been conducted.

Table 5: Primary vs Secondary research (QuestionPro 2021)

Primary Research	Secondary Research
Research is conducted first hand to obtain data. Researcher "owns" the data collected.	Research is based on data collected from previous researches.
Primary research is based on raw data.	Secondary research is based on tried and tested data which is previously analyzed and filtered.
The data collected fits the needs of a researcher, it is customized. Data is collected based on the absolute needs of organizations or businesses.	Data may or may not be according to the requirement of a researcher.
Researcher is deeply involved in research to collect data in primary research.	As opposed to primary research, secondary research is fast and easy. It aims at gaining a broader understanding of subject matter.
Primary research is an expensive process and consumes a lot of time to collect and analyze data.	Secondary research is a quick process as data is already available. Researcher should know where to explore to get most appropriate data.

4.6. Types of Data Sources

One of the most frequent strategies for obtaining secondary data is through the use of the internet. The internet makes data readily available, and it only takes a single click to download it. You can obtain this data for free, or for a small price if it's already available. A company or organization can use the internet to suit its research needs by looking for material on the web. For their part, organizations should only use reliable and trustworthy websites to gather information. Agencies of the state and non-state Secondary research can benefit from data that is available from government and non-governmental organizations.

Using or downloading data from these organizations costs money. These organizations have provided accurate and dependable information, so it may be trusted. Public libraries: a public library is a good source of secondary data. Key studies from the past are available in public libraries. As a result, they act as a safe haven for critical information and documents. These public libraries have a wide range of services to choose from. Government publications that

provide market information, as well as a wide number of company directories and newsletters, are commonplace in library collections. It is important to collect secondary research data from educational institutions because this source of information is often overlooked in primary research. When it comes to research, colleges and universities are head and shoulders above the competition.

Universities gather data largely for the sake of doing original research. Educational institutions can also request data from businesses and organizations. These data are freely available to enrolled students at universities like the University of the Western Cape, which makes it available to the public. Market research, demographic segmentation, and other issues are all topics that these commercial information sources are well-versed in.

A company or organization may ask for the data it requires for its investigation. Due of their wider reach, businesses can use these sources to not only identify potential clients but also learn about new ways to sell their products or services.

4.7. Data Collection Process

The researcher performed a thorough examination of studies on climate change and food insecurity. The South African Weather Services provided meteorological data to demonstrate long-term trends and variations in climatic patterns. By relying on scientific data that was already accessible, this avoided the onerous task of scientifically establishing climate environment's existence and verifying information provided by respondents. FAO, WFP, and DAFF all provided food security reports.

4.8. Ethical Consideration

While confidentiality, non-malfeasance, and integrity (Thorne, 1998) remain pertinent to a secondary investigation because of the restricted space provided, the problem of informed consent necessitates further attention due to its critical role in research.

The researcher can't rely on the vagueness of the consent form because informed consent can't be assumed in secondary analysis, according to Heaton (1998). To evaluate whether data reuse violates the contract between participants and the primary researcher, Heaton (1998) and

Thorne (1998) say a professional judgment may be required. Determining whether the primary and secondary research topics are compatible is critical, as is determining whether or not new questions have a bearing on the research's overall focus. It would be unethical, for example, to look for words or phrases in narratives obtained from participants who agreed or declined organ donation that suggest support for an opt-out system, because whether participants support or reject ideas of presumed consent – opt out – was not a focus of the primary study.

4.9. Data Analysis

Take into account whether or not a dataset is able to address secondary research questions when undertaking secondary analysis. For an assessment to be effective, more information must be gathered in the substantive area of interest, such as data with "enough depth" and "relevant detail" (Hinds et al., 1997: 412; Charmaz, 2006: 18). We consider this to mean that the source transcripts must include sufficient information about the subject of interest for the secondary research questions to be legitimately presumed to be addressed. How much new knowledge may be gleaned via secondary analysis is heavily influenced by the primary data's level of detail.

This research analyzed the existing literature on current and future climate variability, as well as the potential implications of climate change on agricultural productivity in Sub-Saharan Africa, as well as the adaptation challenges that may arise. Climate change was defined as changes in temperature, altering rainfall patterns, and extreme weather events such as droughts and floods. There are several conclusions that are universal across all investigations, according to the review. Climate change is already occurring in Sub-Saharan Africa, as indicated by changes in average temperature, rainfall quantities and patterns, and the frequency and intensity of weather extremes like droughts and floods. Furthermore, climate change will have a negative influence on the potential for food production, resulting in poorer yields and a higher danger of famine. The area appropriate for agriculture, the length of growing seasons, and production prospective, for example, are predicted to diminish, particularly near the edges of semi-arid and arid areas. These changes will have an impact on all aspects of food security, including

food supply, accessibility, consumption, and stability, increasing long-standing development difficulties such as poverty reduction, food security, and meeting the SDG's

The assessment also indicated that the degree of expected climate change bearings on agriculture in Sub-Saharan Africa differs greatly amongst studies. The magnitude of climate change impacts will differ for each area or country in Sub-Saharan Africa. There are certain parts of Africa that are hot and dry are likely to be badly affected. The numerous climatic scenarios and crop models utilized, as well as the diverse analytical approaches used to estimate current and predicted consequences, result in different impact distributions. The magnitude of climate change and the regional patterns of its effects, on the other hand, are largely unclear. Despite the many uncertainties surrounding climate change and damage projections, the study shows that Africa is one of the most vulnerable continents to climatic variability and change due to numerous stressors and insufficient adaptive capability.

Furthermore, while specific projections of climate change's magnitude, rate, and regional patterns are uncertain, its consequences will affect the fate of many generations to come, with a particular impact on the poor if no appropriate measures are taken. Farmers are currently using farm-level adaptation methods, but these are insufficient to mitigate the detrimental effects of climate change. As a result, incentives for adaptation must be created and included into current and future development programs in a way that helps to poverty reduction at all scales.

4.10. Conclusion

Secondary analysis has the potential to have significant ramifications for qualitative researchers looking to examine sensitive health themes, not least in terms of facilitating researcher training at all stages. Making prevailing qualitative information accessible for secondary analysis has the potential to help new researchers get experience.

Knowledge of how to collect, analyze, and synthesize data, as well as how to deal with the epistemological and ontological challenges produced by this methodology, these are the issues

that need to be addressed: (*) Use of primary research data to answer secondary research questions: ethical or unethical? In other words, is there enough material in the primary transcripts to warrant believing that the secondary research questions may be satisfactorily addressed? (*) How will the primary dataset be judged based on the criteria you specify? The key datasets' data collection and processing methods are symmetrical, aren't they? (*) In which way will the epistemological issues surrounding the background of data collection be handled?

The concerns raised here need to be resolved before implementing this technology, notwithstanding advantages of fully making use of present resources. Additional development and definition can be achieved by secondary analysis of qualitative datasets. The purpose of this research was to shed light on the processes involved and to encourage academics to adopt this approach.

Chapter 5

Discussion of climate change and food insecurity in sub-Saharan Africa

5.1 Introduction

Due to the small number of works, articles and books judged appropriate for enclosure and evaluation, this process is prone to bias and inaccuracy. The 113 papers/articles should be viewed as a representative sampling of the entire collection.

Only peer-reviewed studies authored between 2005 and 2010 are included in the literature on the subject and so older materials for the literature component of the study. Additional literature may exist beyond these parameters. For this thesis review, the literature from West and Central Africa may be underrepresented due to Google's low indexing of non-English materials. This will not be a major deterrent, however. This review, on the other hand, ignores the long-term effects of climate change on food security, such as the effect of changing scalar disease pressures on agricultural labor and healthcare, the influence of climate-induced conflict on food security, and the circulation and intensity of agricultural pest species, to name a few. There will very certainly be significant, intricate, and challenging secondary consequences that are outside the scope of this study.

The study utilized a systematic realist method, according to Pawson et al.,(2005) to guarantee that the causal link between climate change and food security was thoroughly investigated in the present literature, focus on the fundamental principles of availability, accessibility, and use. This is a good example. A realism assessment also necessitates a thorough examination of the mechanisms that impact the causality connection of interest on a much more concentrated level.

5.2. Other factors that intensify the climate change and food insecurity nexus in sub-Saharan Africa.

Climate change has a significant impact on food security, but it must also be balanced against the growing global population. By 2050, the population of Sub-Saharan Africa is expected to increase by nearly a billion people (UN DESA, 2008). Because of this, particularly in light of

climate change, the demand for scarce natural resources will rise. Adaptation methods will be needed in the context of both subsistence farming and rising consumer needs in the region since a larger population will boost demand for crop and livestock products. The effects of climate change will be felt in concert with concurrent transformations in health, the environment, and society caused by the change, rather than separately. In Sub-Saharan Africa, for example, the impact of AIDS on population demography and health will influence the sensitivity and adaptation of communities, people, and methods of food to climatic shocks and volatility. Regional cuisines, food demand, and trade links will all be affected by rising urbanization, migration, and globalisation. Achieving global and regional food security targets while reducing carbon emissions is also a significant global issue.

With the rising occurrence of severe climatic conditions, reactive coping methods that have been emblematic of past weather inconsistency, according to Osbahr et al (2008) will become less viable, emphasizing the significance of preemptive intervention. As shocks continue to stress subsistence societies, their ability to recover will be limited. There will be a greater need for long-term remedies that require behavioral modifications, either in anticipation or aversion as according to (Ziervogel et al 2006). (2008). The literature has described a number of potential strategies. At the top of the list of challenges of adaptation is that it usually demands both economic resources and a desire to shift a deeply ingrained cultural and historical way of living. This will particularly be difficulty in Sub-Saharan Africa, because it has been identified as having a low adaptation capability based on these criteria, argues Cooper et al (2008).

A significant obstacle to adaptation among agricultural producers is a lack of financial capital. Adaptive solutions that require irrigation and biochemical fertilisers to improve yields may be good, but they will only be available to those who can afford them. According to Tingem (2009) the bulk of individuals who live a pastoral, agricultural lifestyle have little purchasing power and, as a result, low levels of climate change mitigation inputs. As a result, technologies must be small-scale and suited to the location, as well as long-term sustainable (Brown, 2009). Several failed ventures established by the international aid sector demonstrate the importance of this. The introduction of irrigation to the area is one such example.

Quantity and quality can be used to frame food security nutritional concerns. Micronutrient deficiencies has long been considered the most pressing problem facing the region's poorest people (Wlokas, 2008). Low calorie intake and a deficiency in essential minerals are two ways

it shows up in the body. Africans are classed as protein deficient for the most part, according to Odeny (2007), who claims that protein is particularly low in the diet of much of the population. Both a calorie and protein deprivation are thought to be a direct cause of death by Blössner (2009) who also claims that both can significantly reduce ability and labor potential.

5.3. Ways in which communities (farming communities) mitigate risks

According to Ziervogel et al (2006), irrigation improved yields initially in farming communities in Sub-Saharan Africa, but was not long-term viable due to a lack of essential technical inputs and maintenance skills. As a result, the technology was abandoned and local farmers relied solely on rain-fed crops to feed their families (Ziervogel et al 2006). Where there is an absence of outside support, Verdin (2005). propose using low-cost inputs to improve soil quality and increase productivity. The utilization of natural, locally sourced resources in organic agriculture makes it a cost-effective method of farming. In Ethiopia, manure has been proven to be more efficient in refining agricultural yields than synthetic fertilizers, with the added benefit of reducing long-term soil degradation (Edwards, 2007). Organic farming methods have also been shown to have increasing amounts of microbial activity and productivity, as well as higher amounts of carbon stocks, than conventionally managed systems.

It has been suggested that these traits have the potential to increase food and water security while also reducing greenhouse gas emissions and slowing down desertification, according to Verdin et al (2005a). There are consequently cheaper inputs available that increase soil eminence and may even assist the maximizing of water supplies. However, if food is not properly washed or handled, microbial contamination in manure may be passed to food products and create health concerns.

Soil quality and water resources can be conserved while still meeting water needs thanks to no-tillage farming, according to Lal (2009). Soil organic matter is maintained, crop yields are reduced, and carbon sequestration is increased because of the lack of soil disturbance (Lal, 2009). Poor farmers could benefit greatly from this technology because to its low cost, but it

would require weed management, which could be done organically or chemically, with the former being preferable due to the financial consequences of the latter. Nevertheless,

Discovery or identification of drought-resistant or soil resilient crops is a top goal in adaptive solutions, according to Cooper et al (2008) However, there are limited financial and economic incentives in today's globalized agriculture and food system to support such innovation at a scale judged appropriate for adaptive demands. To find crops that are well-suited to a certain place, Azam-Ali (2007) suggests combining research efforts by uniting domestic institutes.

5.4. The role of community participation in mitigating risks

There are two ways in which increasing agricultural prices affect farmers: either as net sellers or buyers of food. If food prices go up, it benefits the farmer who has a surplus of food to sell, but it damages the person who buys it. Most farmers in South Africa are net buyers, so rising prices hurt their bottom lines. Customers are clearly harmed by high prices, on the other hand. Due to high prices, households with limited purchasing power cannot afford food, which reduces the number of calories available to each member. Due to excessive prices, families may be coerced to limit the quality and/or quantity of food they ingest, eat lesser-favored meals and allocate food to specific family members in order to save money. High food costs affect human capital over the long term. Homes may be coerced to reduce spending on health & nutrition or withdraw children from school to make up for the loss of purchasing power caused by high prices. Malnourished children have a 10% lower lifetime earning capacity due to bodily and mental deficiency, according to research (World Bank, 2011). In the Sub-Saharan area, where this is especially true, a substantial level of income is spent on sustenance.

In general, community involvement is viewed as essential for successful adaptation. Sub-Saharan Africa is a varied region both in natural and traditional traits. Food insecurity therefore can't be tackled by a single geographical procedure, say Gregory and colleagues (2005). To generate culturally relevant and long-term solutions for local capacity, including the community in the development of adaption strategies is essential. Organised agriculture helps communities by strengthening social networks and providing a platform for the development of human potential (Ziervogel et al 2006). Agriculture experiments and attempts to identify

new machineries or drought-resistant yields, or to apply other adaptation approaches, are easier to carry out when there is community cooperation (Ziervogel et al 2006). It's considered that this is because people are more engaged and there are support networks available, according to Osbahr and colleagues (2008).

According to Brown (2009), farmers are compelled to buy back the same sort of food they previously cultivated and sold during the "hungry season," when agricultural production are down, in order to fulfill subsistence needs when market prices and demand are low. Prices have risen as a result of the increasing demand, resulting in a loss for the farmer. Building warehouses in rural regions might be one solution for ensuring that crops do not decay as fast and can be stored for later use.

Use as a determinant of future food insufficiency is crucial, yet it goes unnoticed. Many people in Sub-Saharan Africa are considered to be destitute and do not have access to nutritious food. Due to decreased labor productivity and the resulting poverty and starvation, this is an enormous hindrance to progress. To avoid future social and economic development limits in the region caused by increased food insecurity, it is imperative that health issues be addressed.

Large-scale and capital-intensive changes may be desirable, according to Wlokas (2008), but they will necessitate government involvement. Access to markets for rural farmers would be greatly improved with better infrastructure, such as roads (Bryan et al, 2009). There aren't adequate storage spaces for extra harvests in many regions of Sub-Saharan Africa. Farmers who are having financial difficulties are compelled to sell their excess product.

For example, lack of variety in the diet might lead to undernutrition since some essential nutrients aren't being consumed. There are micronutrients that the body needs in very little amounts to generate enzymes, hormones, and other molecules important for proper development according to WHO (1998). Vitamin A, iodine, and iron deficiency are especially widespread in Africa, where they have been linked to a wide range of diseases. Drought or low crop yields make food supplies scarcer and the options available to the poorer population more limited, which increases the danger of nutritional deficiencies.

As a result of climate change, yield failure and reduced access to food are the most significant concerns for those with micronutrient deficiencies. Only a few foods contain vitamins and

minerals, and the amounts vary from one to the next. Because of this, while programs to increase the nutritional value of staple foods like grains and legumes are in the works (FAO, 2006), a balanced diet is still required to meet the dietary requirements for all micronutrients. Because of rising market prices and dwindling financial resources due to climate change, many people will be forced to eat diets that include only the most basic foods with little nutritional value. If this is true, it could have a significant influence on the subsistence population, hence further research is needed.

To fight malnutrition, only providing food will not suffice; the meal must also have a good nutritional content. It's critical to assess the nutritional value of new crop varieties before promoting them. Bambara groundnut and pigeon pea are underutilized crops with enormous potential because of their high protein and carbohydrate content, as well as a variety of essential vitamins and minerals (Odeny, 2007). This makes them valuable as drought-tolerant crops when faced with expected climate change due to their high yields on poor soils.

Traditional drought crops must also be recognized and their contribution to a healthy diet evaluated. During times of famine, some crops may be the only source of food. This is critical. It is well-known in Africa as a famine reserve crop and feeds 500 million people worldwide (Bruyn, 2003). There have been links found between consuming too much of this caloric meal and the extremely debilitating illness konzo, which is caused by cyanide poisoning from processing and boiling done incorrectly (Tylleskar, 1994). As a result of the stress of devouring what little food is available during a drought, people's diets tend to become dominated by cassava. Due to this, Sub-Saharan Africa has seen an increase in the number of konzo outbreaks, which have had devastating effects on the health of large segments of the subsistence population. Fighting hunger necessitates not only having enough food, but also having enough nutritious food.

Adaptation strategies can have both planned and unintended effects on how people conduct their lives. Small reservoirs and rainwater stowing facilities (made for household and agricultural use) in East and West Africa have unquestionably assisted in dealing with rainfall variability, but they have also led to an increase in the prevalence of water-related diseases like

malaria and schistosomiasis due to their proximity to people (Boelee et al. 2013). Because of the impermanent exodus of mostly man workers from northern Mali, women now have to take on chores that were previously assigned to men in addition to their responsibilities. This increases their workload, surges their vulnerabilty, and diminutions their level of happiness all at the same time (Djoudi et al. 2013). In places like Wenchi, Ghana, where soil fertility has changed and the growing season has been shorter, people have had to respond by switching from cash crops (like cocoa) to less lucrative but more drought-tolerant crops like maize and yam (Adjei-Nsiah et al. 2010).

5.5. Impacts from sub-Saharan Africa

Simulations of future climate change scenarios on food production are the most popular tool used in Sub-Saharan Africa for analyzing climate change and food security. Food security also presents concerns of food accessibility and consumption, even though this knowledge may be used to forecast future yields and levels of production in a changing environment. Food security is inextricably linked to people's happiness. Other significant variables that impact people's well-being, such as revenue, health, and belongings, have also been acknowledged by sustainable livelihood approaches.

An integrated climate, food, and livelihoods model shows the qualities that climate change IVA, food security, and sustainable living contribute in the conceptual framework below. In other places, many of the framework's components and interrelationships have been identified (and sometimes investigated); in this notion, climate change and food security are brought together with an emphasis on. It's important to note that climate change is just one of the numerous stressors mentioned in the framework. A number of factors influence how well people adapt, and this understanding acknowledges this. Resources like as environmental, social, monetary, and human capital have a significant impact on people's potential and ability to use adaptation strategies. Strategies for adapting emerge in all shapes and sizes as sociopolitical and economic frameworks change, and they are the visible expressions of adaptive capacity. When it comes to livelihood and natural resource outcomes, adaptation initiatives have (often unintended) consequences. Assets and people's vulnerability may benefit or be harmed as a result of these consequences.

5.6. Conclusion

Climate change is occurring, and it is wreaking havoc on poorer communities and agricultural minorities, according to the conclusions of this thesis. In general, results showed that, as a result of the severe impacts of these climatic risks, rainfall, heat, and other factors have grown more unpredictable over the last two decades, and temperatures have risen to levels that make agricultural production difficult.

Looking at space, expanding and reducing space, seasonal planting, selling off things, and so on were all mentioned in the preceding chapter as methods that might be adopted/adapted. These are some of the methods that people who have been impacted by climate change have decided to use in order to overcome the obstacles that have arisen.

Small-scale farmers more especially are unable to adjust to climate change due to a lack of sufficient financial resources and other capacities. Adaptation to climate change initiatives and/or strategies require strong collaboration among all stakeholders, and the gap between policy and execution on the side of the government continues to stymie small-scale farmers' adaption efforts.

Chapter 6

Conclusions and recommendations

6.1 Summary

This thesis evaluated the available literature on present variability and projected changes in climate, as well as the potential implications of climate change on agricultural output in Sub-Saharan Africa (SSA) and the adaptation difficulties that may arise as a result of these impacts. Changes in temperature, changing rainfall patterns, and extreme weather events such as droughts and floods were all taken into consideration while assessing the effects of climate change. There are several findings that can be drawn from the evaluation that are applicable to all research. Of particular, the climate in Sub-Saharan Africa (SSA) is already undergoing major changes, as evidenced by changes in average temperature, changes in volume and pattern of rainfall, and the occurrence of and intensity of weather extremes like as droughts and floods, among other indicators. Furthermore, climate change will have a detrimental impact on agricultural production potential, resulting in significant yield reductions and an increase in the danger of famine. As a result, the amount of land suitable for agriculture, the duration of harvesting seasons, and the amount of yield potential available, particularly around the edges of semi-arid and arid regions, are all anticipated to diminish. Food supply, accessibility, utilisation, and stability will all be impacted by these shifts, worsening long-standing development issues such as poverty reduction, guaranteeing food security, and attaining the Millennium Development Goals, among other things.

The analysis also found that the severity of anticipated climate change impacts on agriculture in Sub-Saharan Africa differs significantly amongst various research. For every area or nation in Sub-Saharan Africa, the degree of the consequences of climate change will be different from one another. The hot and arid regions of Africa are anticipated to be particularly hard hit. The numerous climatic scenarios and crop models that have been employed, as well as the varied analytical approaches that have been used to analyse present and future consequences, have resulted in different distributions of impacts. The magnitude of climate change and the regional patterns of its consequences, on the other hand, are quite unclear. Despite all of the

uncertainties surrounding climate change and impact projections, the review confirms the general consensus that Africa is one of the most vulnerable continents to climate variability and change due to a combination of multiple stresses and a limited ability to adapt to these stresses. Aside from that, while there is some uncertainty in climate change projections regarding the precise magnitude, rate, and regional patterns of the phenomenon, its consequences will alter the fate of many generations to come, with particular consequences for the poor if appropriate measures are not taken. Some evidence of farm-level adaptation methods being adopted by farmers now exists, but these are insufficient to mitigate the detrimental effects of climate change. It is necessary to create and implement adaptation-promoting incentives into present and future development programs in a way that helps to poverty reduction on a global scale, as opposed to a local scale.

6.2 Conclusion

Overall, the connection between climate change and food security in Sub-Saharan Africa is undeniable, notwithstanding uneven research. Agricultural availability has had the most research done on it, with a plethora of information on how climate change and rain shortages effect crop yield. As food prices rise and a shift in livelihood becomes more likely, accessibility has also been widely examined. Yet there is a dearth of scholarly research connecting climate change to an increase in the regularity and severity of nutritional diseases. Major illnesses that affect many people in Sub-Saharan Africa have been studied extensively, however, there is nothing that has been done in order to ascertain whether some conditions would be excessively impacted by climate change or if others will arise as a more extensive issue. The utilization mechanism for food security, as a result, suffers from research gaps.

In Sub-Saharan Africa, the high percentage of people who are food insecure now is obviously connected to the continent's development status as a whole. To make progress, Sub-Saharan Africa must strive to get out of the cycle of poverty and hunger into which it presently locked. Climate change can be perceived as a barrier to Sub-Saharan Africa's complete development, but it may also serve as an impetus for advocating for adaptation measures that not only prevent future food hardship, but also help alleviate current food insecurity. However, despite the fact that food insecurity appears to be a given for Africa, it isn't.

Reducing greenhouse gas emissions from agriculture is critical for maintaining global food security. This study shows how population expansion outpaces food supply, resulting in a food deficit, and how food insecurity is compounded. Sub-Saharan Africa is very probable to experience very serious food insecurity as a result of a lack of rainfall and a drought. The high unemployment and poverty rates in the country are also a source of concern, as they make it difficult for many families to afford food. As a result, there's a risk that food poverty will become even worse. That's why a multifaceted approach to alleviating poverty and unemployment is needed, according to this paper. The susceptibility of food security to climate change varies by country, according to the study.

Sub-Saharan Africa can adapt and maintain food security as a consequence of knowing risks and climate change sensitivity of certain food commodities. This is critical in light of the present drought in Sub-Saharan Africa, which has left rivers dry, cattle starving, and agricultural output plummeting. Agriculturally suitable land is becoming increasingly scarce due to climate change, according to this study. If agriculture products are to endure the consequences of global warming, then technological intervention is required. Because institutions are weak and technological resources are scarce, climate change adaptation is more perplexing in underdeveloped countries like Sub-Saharan Africa. Furthermore, the huge disparity between the expenditure of climate change adaptation and essential government financial and learning assistance is a cause for worry in addition, investments in climate-related food security concerns and food system vulnerabilities and faults management solutions are required.

Non-climate factors like food price volatility, violence, and market interdependence can all have an effect on how fragile a population's food security is, and this should be noted. Regardless of climate change adaptation efforts, national development is likely to improve food security. It is of great importance to be mindful that this index can be used with other models to guide climate change and food security procedure.

6.3 Overview of chapters

Chapter one consists of the main introduction of the thesis which is part of the originally submitted proposal for this thesis. It also comprises of the contextualization and background

of the research topic. It also comprises of the contextualization of food security and the contextualisation of Climate change and Food security in the Southern Africa region. This chapter also consists of the original definition of terms, assumptions and biases that the researcher entered the research field with.

Chapter two consists of the literature review. This is where the literature surrounding this topic is reviewed and discussed in length. A comprehensive definition of terms, guided by literature. The chapter also focuses on the impact of climate change on the availability of food, the impact of climate change on the accessibility of food and the impact of climate change on food utilization. Contrary to the originally proposed structure, this chapter also presents definitions and contextualization of newer themes such as adaptation, vulnerability, climate change policy and food security and livelihoods.

The third chapter consists of the theoretical framework of this thesis. It explores the grounding theories of this research it investigates the food systems theory, Entitlement Approach and Community driven development. It no longer investigates Modernization theory as one of the main theoretical frameworks as it does not capture the necessary essence of the theory. This chapter is also where suitable theories are matched to contemporary challenges.

The fourth chapter of this thesis comprised of the methodology undertaken to carry out this research. It looks in-depth at what the definition of research is in order to have a deeper understanding and carry out this out at the highest level of comprehension. It also distinguishes the differences between the different ways in which research can be carried out, defines explorative studies etc. It also explores the different data sources that were used in order to compile this research. It presents the ethical considerations and finally the data analysis. This chapter is also where the problem statement is located along with the goals and purposes of the study.

Chapter five presents the main discussions of this thesis. This chapter presents the complexities that this research entails and also brings out the main arguments and merits of this research. This chapter also discusses climate change and food security in SSA while also looking at the factors that intensify climate change and how communities can mitigate these risks and discusses the main impacts derived from sub-Saharan Africa.

Finally, chapter 6 is the chapter the that looks at the recommendations and conclusions which present the concluding arguments and looks at the potential of future research.

6.4 Recommendations

This document summarizes the several effects of climate change on agricultural output and food availability in Sub-Saharan Africa. Agricultural yields have been found to be significantly reduced as a result of climate change, which will put many people's livelihoods and food security at risk. Food imports would rise, and the number of people without access to enough sustenance to meet their nutritive needs could rise as a result. Other issues like market access affect food accessibility, and the inability to get food leads to malnutrition, which has ramifications for human capital and productivity.

Adaptation options that not only avoid further food insecurity but also alleviate existing food insecurity should be pursued, embraced, and advocated for by the relevant governments and related stakeholders, even if climate change is viewed as a barrier. This is crucial, because poor farmers are less able to adapt to climate change as a result of their financial situation (Thompson 2010). Farmers may be able to adapt to climate change by diversifying their sources of income. However, not every revenue is affected equally by climate change (for example, off-farm jobs). Governments, without a doubt, must act and invest in effective adaptation strategies. It is necessary to develop infrastructure in order to make food more readily available to the general public. Improved roads and storage facilities for surplus crop produce could be part of this plan. As far as agriculture is concerned, governments can support the creation of crops that can withstand both biotic and abiotic stressors. In order to assist farmers in developing their own mitigation and adaptation strategies, it may be necessary to enhance agricultural management skills while also making essential data available to key stakeholders strong social safety net, like weather-based crop protection schemes, should be implemented by governments in the respective SSAs. Property rights must be created in order to execute economy freshwater environment and project services.

It's also possible to improve water management methods, as well as IT systems and services provided to rural resource farmers. There should be a free-trade policy that allows countries to share climate risk and reduces climate change's negative impacts on commerce. Finally, the

negative consequences of climate change in SSA need to be mitigated through increased commitment from a wide range of stakeholders, as well as noteworthy reserves and expenses in the agricultural subdivision.

Recommendation 1: Preventive Climate Change Policy is Required

Increasing the ability of vulnerable groups to adapt to the effects of climate change necessitates a more proactive approach. There have been many good ideas for mitigating climate change, but they have all remained on paper. With the present uncertainties regarding the location-specific consequences of climate change, sound development guidelines and programs are the best investments to adapt to climate change (Nelson et al, 2009). Strengthening policy competence is critical in combat against climate change's most disastrous consequences. As a result, when people and communities have the resources to adapt to climate change, it is conceivable.

Recommendation 2: Investment in small-scale farming should be increased.

Lack of funds has been cited as a huge barrier to production and adaption struggles. Additional scientists argue that if climate change does not occur. To fulfill the demands of a planet's population estimated to reach over 9 billion people by 2050, we must therefore spend more in agricultural research and machinery. In 2008, the World Bank published this report: Small-scale farmers are critical to global food security, and increasing their production capacity will have a significant impact on family and local food security. According to the lessons of the Green Revolution, increasing agricultural production, even if it isn't targeted at the poorest people, may be a strong mechanism for reducing poverty inadvertently by creating employment and lowering price of food (Nelson et al, 2009).

It is critical to invest in irrigation systems, specifically to advance water effectiveness, investing in dwellings where water obtainability is expected to decrease should be done with prudence (Nelson et al, 2009). Drizzle irrigation is a critical strategy for effectively watering

crops but also conserving limited water resources, as should be emphasized. However, for something to be a success, a significant amount of money must be put into it.

Recommendation 3: Research and Extension Programs are being restructured.

To ensure that we respond to effectively combat climate change, research extension programs must be revitalized. As a result, if consequences of climate change can be reduced, continuous research focusing on alternative options and best practices is necessary. It's worth noting that extension programs can help farmers share information through transferring technology, fostering interaction, improving farmer capacity, and reassuring farmers to collaborate on nationwide research projects (Nelson et al, 2009).

A functioning information exchange system can be provided by small-scale farmers, as well as low-cost connections between government determinations and farmer actions. Their own networks play a crucial part in creating capacity building that especially deal with climate change adaptation, such as growing local varietals of drought-resistant agricultural types, teaching improved management methods, and gathering data. By raising awareness of climate-related hazards and their worth in mitigating them, extension services can support farm households in adopting and implementing coping strategies. They can also help them gain the knowledge and skills necessary to do so effectively.

Recommendation 4: Climate change adaptation ought to be a key priority in national policies and budgets.

Adaptation to climate change will require substantial investment, thus it's in the government's interest to fund it adequately. Climate change threatens food security on a national and global scale, and has far-reaching repercussions. As a result, farmers and other individuals will need a lot of political will to be successful in their adaptation efforts.

6.5 Future research

This research examined the connection between food security and climate change in Sub-Saharan Africa. The annual temperature increased by 1.5 degrees Celsius on average between

1993 and 2020. As time went on, the amount of precipitation fell, and floods and droughts became more common. There was also an increase in erratic rainfall. Households' views on climate change were shaped by historical climatic records. To help communities cope with climate change, indigenous knowledge must be incorporated as soon as possible into climate change adaptation initiatives.

Future research should focus on more innovative techniques to manage low-input agricultural productivity in smallholder systems, which is a major element of crop production in SSA. Researchers will need to understand crop variety (both intraspecific and interspecific) as well as management diversity in order to establish innovative low-input cropping systems in SSA. Large-scale agro-ecological trials in farmers' fields are frequently more expensive and complicated than greenhouse research, therefore additional funding is required. New ideas and technology that integrate current agricultural research with indigenous knowledge, as well as local farmers as essential stakeholders, are more likely to give realistic solutions to Sub-Saharan Africa's food crisis.

Other field of research which can be considered in future are:

- The impact of indigenous knowledge on the adaptability of rural agricultural households in sub-Saharan Africa to climate change can be investigated.
- The effectiveness of adaptation strategies used by rural agricultural households in sub-Saharan Africa response to climate change is to be researched.
- Development of early warning systems at the local level that might minimize the susceptibility of rural agricultural communities to climate change can be pursued.
- Gender analysis is important in understanding the impact of climate change on the food security of rural farmers' households and their livestock.
- What policies and institutions are required to assist rural agricultural communities in their efforts to adapt to climate change on a local level?

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Appendix 1: Ethical clearance letter

UNIVERSITY of the WESTERN CAPE

60 YEARS of hope, action & knowledge

16 July 2021

Ms Z Royi
Institute for Social Development
Faculty of Economic and Management Sciences

HSSREC Reference Number:	HS21/5/17
Project Title:	The relationship between climate change and food insecurity in sub-Saharan Africa.
Approval Period:	24 June 2021 – 24 June 2024

I hereby certify that the Humanities and Social Science Research Ethics Committee of the University of the Western Cape approved the methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report by 30 November each year for the duration of the project.

The permission to conduct the study must be submitted to HSSREC for record keeping purposes.

The Committee must be informed of any serious adverse events and/or termination of the study.

Ms Patricia Josias
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FROM HOPE TO ACTION THROUGH KNOWLEDGE.