



**ASHESI UNIVERSITY**

**CLIMATE INFORMATION SYSTEMS FOR MITIGATING CLIMATE  
CHANGE IN LIVESTOCK PRODUCTION IN GHANA**

By

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Undergraduate thesis submitted to the Department of Business Administration, Ashesi University College. Submitted in partial fulfillment of the requirements for the award of the Bachelor of Science Degree in Business Administration

**Supervisor: Dr. Kwami Justina Morris**

**April 2022**

## DECLARATION

I hereby declare that this undergraduate thesis paper is the outcome of my own work and that no part of this work has been presented for another degree in this university or elsewhere.

Candidate's Signature .....

Candidate's Name: Marie Amoah

Date: April 2022

I hereby declare that preparation and supervision of this thesis was in accordance with the guidelines and supervision of undergraduate thesis laid down by Ashesi University

Supervisor's Signature .....

Supervisor's Name: Dr. Kwami Justina Morris

Date: April 2022

## ACKNOWLEDGEMENT

*What shall I say unto the Lord?*

*All I have to say is thank you Lord.*

First, I thank God for his mercies and his protection throughout this study. For providing me with the strength and intelligence to complete this paper.

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## ABSTRACT

As the earth's temperature changes throughout time, climate change has been a worldwide fight. The progression of climate change is likely to affect food security and promote poverty. Although there are several research papers on the effects of climate change on agriculture and the adaptation policies required to curb the effects on the industry, there is barely any research on the effect of climate change on livestock production. Therefore, this paper assesses the effects of climate change on livestock production in Ghana, determines the knowledge level and perceptions of smallholder farmers on the topic, and recommends how climate information systems can be used in creating policies and information dissemination to aid the mitigation of climate change.

The research was sourced primarily from Tua and Yong in the Northern region of Ghana. Findings were analyzed using qualitative analysis. From the analysis, it was identified that climate change negatively impacted the socio-economic activities of livestock production by causing diseases in animals. These diseases cause a strain on the income of these smallholder farmers. Findings in the study suggest that climate information services are a highly effective method in combating climate change and promoting sustainable food security. Farmers, however, had little to no knowledge of climate information services. This study concluded then that the impacts of climate change could be curbed by providing information about climate to livestock farmers and ensuring proper information dissemination. Policymakers such as MESTI and NCCC should integrate climate-smart agriculture into livestock production in Ghana and give farmers technologies to help with their operations while lowering greenhouse gas emissions.

## Table of Contents

<b>DECLARATION .....</b>	<b>ii</b>
<b>ACKNOWLEDGEMENT .....</b>	<b>iii</b>
<b>ABSTRACT .....</b>	<b>iv</b>
<b>LIST OF FIGURES.....</b>	<b>vii</b>
<b>CHAPTER ONE .....</b>	<b>1</b>
<b>INTRODUCTION.....</b>	<b>1</b>
<b>1.1 Background .....</b>	<b>1</b>
<b>1.2 Livestock Production and Its Economic Benefits in Ghana.....</b>	<b>4</b>
<b>1.3 The Effect of Climate Change on Livestock Production in Ghana .....</b>	<b>5</b>
<b>1.4 Problem Statement.....</b>	<b>6</b>
<b>1.5 Research Objective .....</b>	<b>9</b>
<b>1.6 Research Question/Hypothesis .....</b>	<b>9</b>
<b>1.7 Relevance of the Study.....</b>	<b>10</b>
<b>1.8 Overview of Research Methodology.....</b>	<b>11</b>
<b>1.9 Outline of Thesis .....</b>	<b>12</b>
1.9.1 Chapter 1: Introduction .....	12
1.9.2 Chapter 2: Literature Review .....	12
1.9.3 Chapter 3: Methodology .....	13
1.9.4 Chapter 4: Results and Discussion.....	13
1.9.5 Chapter 5: Conclusion and Recommendations .....	13
<b>CHAPTER TWO .....</b>	<b>14</b>
<b>LITERATURE REVIEW .....</b>	<b>14</b>
2.1 Overview.....	14
2.2 Knowledge and Perceptions of Local Farmers .....	14
2.3 Climate mitigation strategies .....	16
2.4 Implementation of Climate Information Services in mitigation policies.....	18
2.5 Conclusion .....	19
<b>CHAPTER THREE .....</b>	<b>20</b>
<b>METHODOLOGY .....</b>	<b>20</b>
3.0 Introduction.....	20
3.1 Overview of Methodology .....	20
3.2 Population of Study.....	20
3.3 Sample Selection.....	21
3.4 Data Collection Methods .....	21
3.5 Data Analysis .....	22
3.6 Ethical Considerations .....	23

<b>CHAPTER FOUR.....</b>	<b>24</b>
<b>RESULTS AND DISCUSSION .....</b>	<b>24</b>
4.0 Introduction.....	24
4.1 Demographics of respondents.....	24
4.1     Presentation & Analysis of Results .....	25
4.3 Discussion of results .....	34
<b>CHAPTER FIVE .....</b>	<b>34</b>
<b>CONCLUSION .....</b>	<b>38</b>
5.0 Introduction.....	38
5.1 Summary of Findings.....	38
5.2 Conclusions.....	39
5.3 Recommendations.....	39
5.4 Limitations .....	40
<b>Appendix.....</b>	<b>41</b>
<b>Figure 3 .....</b>	<b>Error! Bookmark not defined.</b>
<b>Figure 4 .....</b>	<b>Error! Bookmark not defined.</b>
<b>References .....</b>	<b>42</b>

**LIST OF FIGURES**

Figure 1- Trend of Carbon Dioxide concentration in the atmosphere .....	2
Figure 2 - graph of livestock index for 10 years .....	5
Figure 3 - pie chart showing the percentage age representation of respondents .....	25
Figure 4 - skin disease in goats .....	41
Figure 5 - runny nose disease in livestock .....	41

## LIST OF ABBREVIATIONS

1. GDP – Gross Domestic Product
2. MESTI – Ministry of Environment, Science, Technology & Innovation
3. GNCCC – Ghana National Climate Change Policy

**Keywords:** climate change, climate information systems, livestock production, animal husbandry



## CHAPTER ONE

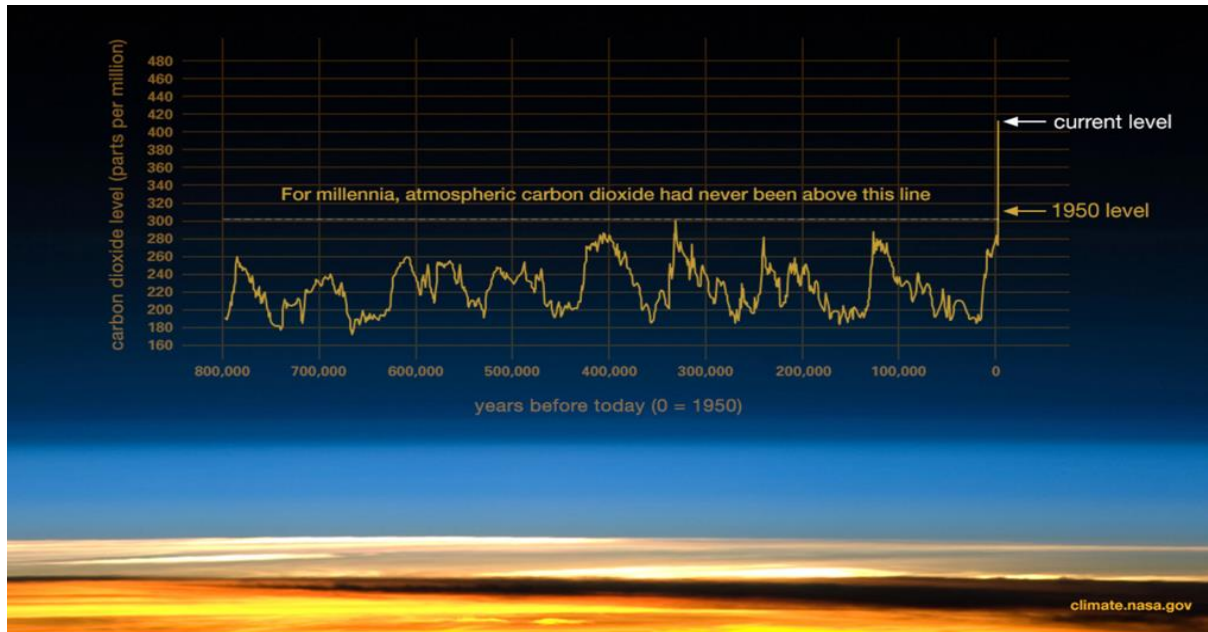
### INTRODUCTION

#### 1.1 Background

In recent years, the issue of climate change and its effects on the environment, particularly on the production of food and the global economies, has heightened. In 2016, the world saw extreme weather events, with every month being hotter than the previous and temperatures soaring above normal. Droughts broke out in Brazil, and Southern Africa, Arctica and Asia experienced the most heat they had ever experienced, and the Great Barrier reef suffered its worst bleaching episodes in history, killing large swaths of coral (Plumer & Popovich, 2017). In May 2018, in Karachi, Pakistan, a sweltering heatwave claimed the lives of at least 60 people. Severe flash flooding displaced hundreds of thousands of people throughout East Africa. At the same time, a tropical depression off the coast of Mexico grew into a Category 4 storm just days into this year's hurricane season. These effects are likely to force more than a hundred million people into poverty by 2030 (Carter et al.,2018). This number is alarming as it constitutes a substantial amount of the world's population.

Consequently, in recent news, it was mentioned that Madagascar is on its way to experiencing the world's first climate change-induced famine due to years without rainfall (Harding, 2021). Owing to the intensity of climate change and its effects, it is often referred to as the biggest humanitarian crisis since the Second World War in 1945 (Schamek & Harmeling, n.d.). In the past, most of the causes of climate change were attributed to natural factors like volcanic eruptions, ocean currents, and solar variations. However, human activities and negligence have heightened the effects of climate change in recent times.

There have been seven glacial advance and retreat cycles in the last 650,000 years, with the abrupt end of the last ice age signifying the start of the present climatic era – and human civilization (NASA, 2021).



*Figure 1- Trend of Carbon Dioxide concentration in the atmosphere*

**Source from [climate.nasa.gov](https://climate.nasa.gov)**

*This data represents the trend of carbon dioxide concentration in the atmosphere of the years. From the graph above, it is evident that before 1950 the level of carbon dioxide in the atmosphere was steadily below 300 parts per million. However, from 1950, there has been an upward trajectory in the quantity of carbon dioxide with the current level at about 410 parts per million. This indicates the rapid increase the amount of carbon dioxide in the atmosphere within a short time.*

Climate change, according to YouMatter, is "a broad spectrum of global phenomena mostly caused by the combustion of fossil fuels, which add heat-trapping gases to the Earth's atmosphere" (2020). Increased temperature trends, changes such as sea-level rise, ice mass loss in Greenland, Antarctica, the Arctic, and mountain glaciers worldwide,

variations in flower/plant blooming, and extreme weather events are all examples of these occurrences (YouMatter, 2020). Unfavourable temperatures, rise in sea levels, and extreme weather events have proven to be very detrimental to the health of the environment, the livelihood of living species, and the growth of the economies of many countries, if not all. In 2018, 70.8 billion dollars were lost to storms, 19.7 billion to floods, 22.8 billion dollars to wildfires, and 9.7 billion dollars to droughts, resulting in approximately 131.7 billion dollars (Fawzy et al., 2020).

Agriculture is a global necessity and one of the most important sectors. It provides food and jobs, contributes significantly to countries' GDPs, and ensures the continuity of life of living species. In Africa, agriculture constitutes 70% to 90% of the total labour force, making it one of its biggest assets (Palacios-Lopez et al., 2016). However, this is one of the most affected sectors by climate change. This could be due to the sector's high dependence on climate conditions like rainfall and sunshine to thrive. In Ghana, agriculture contributes to 54% of the country's GDP, amounts to about 40% of export earnings while providing approximately 90% of the country's food needs (FOA, 2021). Agriculture is one of the most lucrative businesses in Ghana, and one of the major sources of income for local Ghanaians, as many Ghanaian animal farmers amass thousands of cedis every year. The sector has created jobs and many other opportunities for the youth in Ghana. However, one of the threatening factors to this sector is the emergence of climate change. Historical data from 1961 to 2000 across Ghana's six ecological zones shows a progressive rise in temperature and a drop in average rainfall. In December 2015, precipitation dipped to 0.74mm, down from 39.85mm in November (Adzitey, 2013). The reduction in rainfall and rise in temperatures greatly affect the livestock industry. Due to the high heat and humidity,

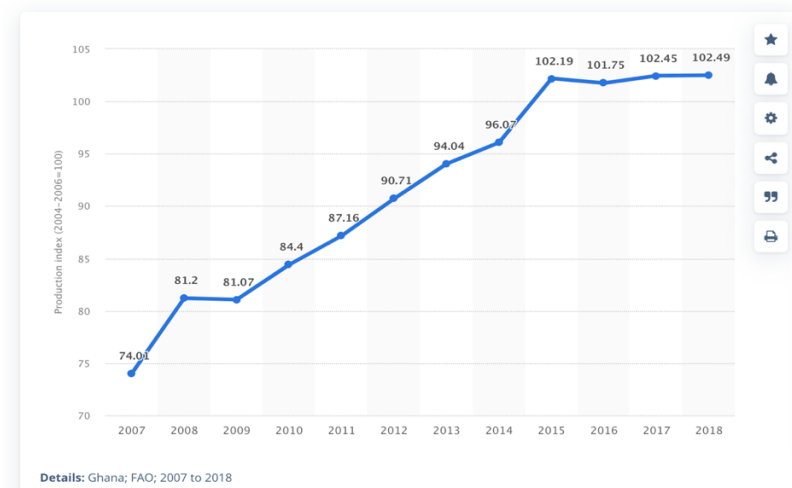
animals burn more energy than they absorb, weakening their immune systems. Similarly, when there is low rainfall, the animals' feed faces stunted growth, hence less food, and rivers and other water bodies start to dry up, which is not ideal since animals need water to survive.

## 1.2 Livestock Production and Its Economic Benefits in Ghana

Livestock farming is a 1.4 trillion-dollar global asset that employs over 1.3 billion people and directly supports 600 million smallholder farmers in underdeveloped nations (Thornton et al., 2006). There are three methods used in animal production - intensive, semi-intensive, and extensive. In Ghana, farmers use more of the extensive system, which involves rearing cattle and animals in areas with low agricultural productivity. This method uses less capital and labour. Animal production is very popular in Ghana, especially among the locals in Upper West, Upper East, and Northern regions. As the main occupation of most of the residents in the regions mentioned above, it is one of Ghana's most important industries as it provides jobs for many locals and serves as a source of food. Over the years, there has been a steady increase in the production of livestock in Ghana, which contributes positively to the country's economy. This growth promises the nation several economic benefits like a reduction in poverty level, increased food security gains, improved human nutrition, and enhanced agricultural expansion. According to Adzitey (2013), between 2001 and 2010, the average animal production in Ghana was 3,958,560 goats, 3,269,460 sheep, 1,373,700 cattle, 404,600 pigs, and 33,252 chickens. From the statistics of this data, an increase in goat and sheep production was identified. This further indicates that the livestock industry is continuously growing.

Furthermore, the graph below showed a steady increase in the livestock production index from 2007 to 2018 (Statista, 2021). This increase in production indicates an increase in jobs, higher income for locals, and a greater share of the country's GDP. Furthermore, animal production in Ghana provides socioeconomic benefits such as hide, manure, a source of medium-term savings, crop failure insurance, and cultural functions such as presents and festivals, to name a few. In rural areas, livestock is the major form of savings, food, and insurance to pay debts.

**Livestock production index in Ghana from 2007 to 2018**



*Figure 2 - graph of livestock index for 10 years*

**Retrieved from Statista (Statista, 2021)**

From this graph, we can see an increase in the livestock index from 2007 to 2018 with predictions that it would keep rising.

### 1.3 The Effect of Climate Change on Livestock Production in Ghana

Ghana's latitude is 5 degrees 36 minutes north, and its longitude is 0 degrees 10 minutes east (Adzitey, 2013). Animal production is influenced by Ghana's geographic position, market size, and climatic considerations (Adzitey, 2013). Climate change is likely

to strengthen seasonal and inter-annual rainfall variations. According to historical data, the average rainfall in Ghana's six ecological zones decreased from 1961 to 2000. Precipitation fell to 0.74mm in December 2015, down from 39.85mm in November (Adzitey, 2013). This is terrible for the livestock production industry because this would mean less water for the animals, but it also means less feed since the feed needs rainfall to grow. Less feed would lead to malnutrition of the animals, which would, in turn, lead to the death of the animals and less income for the farmers. In addition, climate change causes natural disasters like floods, leading to increased exposure of livestock to diseases and destroying feed produce. The lignification of plant tissues would be accelerated by higher temperatures, lowering digestibility. People in rural areas in the Upper East, Upper West, and Northern regions are more vulnerable to these effects since they indulge heavily in livestock production.

#### 1.4 Problem Statement

As climate change worsens and weather events get dangerous, survival for animals becomes more and more difficult. From intense heat waves to bushfires to droughts, there is no doubt that there will come a time when animal extinction will be more rapid. According to Cahill et al. (2013), the anthropogenic climate is likely to contribute heavily to the extinction of animals in the next hundred years. There have been debates around the 'overkill' hypothesis that humans are responsible for the extinction of megafauna in Northern Asia and Northern South America. Recent research confirms that climate change was a major contributing factor (White, 2014). Since the mid-twentieth century, the current warming trend has been undeniably caused by human activity, and it is occurring at a rate

never witnessed in millennia. The atmosphere, oceans, and land have been unquestionably warmed by human activity, resulting in widespread and rapid changes in the atmosphere, ocean, cryosphere, and biosphere (NASA, 2021). This revelation is alarming as it implies that climate change poses a threat to the livelihood of animals which in turn affects the socio-economical activities of the animal production sector as the operations of the animal production industry involve rearing, breeding, and feeding livestock to make a profit. Due to the severity of the issue of climate change and its global impact, there have been several conversations on the topic and ongoing research on ways of mitigating it. Several studies have proven that although climate change is a global phenomenon, the poor and people who least contribute to it are greatly impacted by climate change's adverse effects (Schamek & Harmeling, n.d.). This makes developing countries like Ghana more vulnerable.

Climate change impedes the activities of livestock production in Ghana. Yet, the majority of the livestock farmers are oblivious to the causes and effects of climate change on their business and how to mitigate it. From the research conducted, the researcher realized that although there are various studies on the effects of climate change on agriculture, most of these papers emphasize the production of crops, with few of these papers centered around livestock production in Ghana. There is little information on the effects of climate on livestock production. Therefore, the researcher believes that a part of why local farmers have little knowledge on the topic is due to the absence of information on the topic, lack of resources, and low news coverage on climate change. Sraku-Lartey et al. discussed the perceptions of the local farmers in Ghana on climate change. In this study, the authors mentioned that due to the low literacy levels of farmers in Ghana, combined

with their superstitious mindset, local farmers in Ghana do not believe that climate change is a result of human actions but rather based on God's actions (2020). Research carried out by Yaro (2013) confirms this averment. This is a problem because you can't fix what you do not know. For climate change to be eradicated, the farmers would have to understand the depth of climate change, its impact on their business, and measures to mitigate it. In addition, policies that are created either do not fully address the challenges that these farmers face firsthand concerning climate change, or the farmers find it hard to implement the passed policies due to their little knowledge of the topic. As a result, climate information plays a critical role in climate change adaptation and mitigation.

This study, therefore, seeks to determine how climate information systems can be used to mitigate climate change and reduce its impacts on the socio-economic activities of livestock farming. For context, climate services information systems (CSIS), as defined by the Global Framework for Climate Services (GFCS), "is a mechanism through which climate information – past, present, and future – is archived, analyzed, modelled, exchanged, and processed" (GFCS, n.d.). The value of climate information lies in its accuracy, timeliness, and user-friendliness. This system would help educate farmers in the Northern part of Ghana and make them more aware of climate change by readily making the resource available to them and advising them on how to use them to mitigate climate change. The study also contributes to the body of knowledge on climate change by discussing the adverse effects on livestock production in Ghana.



### 1.5 Research Objective

This research aims to find out how climate information systems may be utilized to minimize climate change and its effects on livestock farming's socio-economic activities. It also aims to determine the degree of knowledge and perceptions of livestock farmers in Ghana about climate change in order to supplement the little literature on the subject and improve policy development.

1. To determine the perceptions and knowledge level of farmers on climate change and its impact on their business.
2. To examine the effects of climate change on the socio-economic activities of livestock industry.
3. To determine the social and economic benefits of using climate information to mitigate climate change in the livestock industry.

### 1.6 Research Question/Hypothesis

To fully understand the topic of climate change, the operations of the animal production industry, the impact of climate change, and ways to mitigate it, I seek to answer the questions,

1. What knowledge and perceptions do livestock farmers in Ghana have on climate change?
2. How is climate change affecting the socio-economic activities of livestock production in Ghana?
3. How can climate information systems be used to mitigate climate change in Ghana?

4. What are the benefits of using climate information systems to mitigate climate change in livestock production?

### 1.7 Relevance of the Study

This research is significant because it will bring more attention to the importance of climate information services to mitigate climate change issues in Ghana, particularly in the livestock industry, and will hopefully spark important discussions about the topic. Over the years, research on the effects of climate change on agriculture has been skewed towards crop production with little to no information on the impacts on animal husbandry. Also, climate information systems have been exclusive to developed countries while developing countries continue the traditional methods to mitigate climate change (Gunasekaran et al., 2010). These traditional methods have proven to be less effective without reliable climate information. Therefore, the significance of this research is amplified as it will steer the livestock production industry in Ghana in a positive direction. It is also important because it would provide local farmers with enough knowledge and resources to mitigate climate change, reducing the impact on their business and further increasing profit. The motivation of the researcher to undertake this study stems from the researcher's passion for alleviating poverty in Ghana and the world at large. Agriculture contributes largely to the country's GDP and employs about half of the nation's population. Hence, enhancing and progression in this industry would be a step in the right direction. With a boom in agriculture, Ghana is likely to grow economically, reducing the poverty level.

### 1.8 Overview of Research Methodology

In this study, the researcher employed the cross-sectional studies technique of research. With this research technique, the results and exposure of this study were studied on the research participants simultaneously. This method was less expensive and time-consuming, yet it allowed the researcher to collect data from many people. Information gathered and used in this paper was sourced from both primary research and secondary research. However, data was mainly sourced through primary research, and the study's main findings were derived from primary data. To obtain primary data, the researcher drafted open-ended interview questions for smallholder farmers in the livestock production industry in the Northern region of Ghana. This provided the researcher with more insights into the industry's operations and the perceptions that livestock farmers in the region mentioned earlier have about climate change and climate information systems.

Consequently, to obtain secondary data, findings and information were derived from news articles and similar research papers, which were used to establish relationships, identify trends, and derive hypotheses from gaining deeper insight into the impact of climate change on livestock production in Ghana and how climate information systems can be used to mitigate it. Furthermore, qualitative analysis was employed to analyze the data gathered. The researcher used the qualitative method to gain deeper insights into the topic by assigning codes to data and identifying recurring themes. Thematic inductive analysis was employed to identify, analyze, and interpret patterns relevant to this study. Using the inductive approach ensured that themes were derived from findings, making the findings flexible. In sampling the research participants, the researcher used the stratified sampling method where livestock farmers were grouped based on demographics and age group to

better give me an understanding of their knowledge and perception of climate change. The stratified method was used in this study because from research conducted, it was found that the perceptions of local farmers differ based on demographics. As such, research participants were grouped in strata based on demographics. Purposive sampling was then conducted to develop each stratum. This helped the researcher make precise analysis by ensuring that every subgroup was represented in the sample.

## 1.9 Outline of Thesis

### 1.9.1 Chapter 1: Introduction

This chapter provides an overview of the study, and the problem statement highlights the research objectives and the questions this topic seeks to answer. It also entails an overview of the methodology used to conduct the research.

### 1.9.2 Chapter 2: Literature Review

Chapter two of this paper discusses findings from similar topics to establish differences, similarities, and relationships. It highlights studies on the perceptions of livestock farmers in Ghana on climate change, explores gaps in existing adaptation and mitigation policies related to climate change, and discusses the importance of climate information systems. This section also identifies gaps present in similar research studies and suggests ways to fill those gaps.

### 1.9.3 Chapter 3: Methodology

This section of the paper provides more details on how the research was conducted and how data was collected and analyzed. Justifications were made for techniques used and based on findings, relationships, hypotheses, and conclusions. The population and sample size of the study are also mentioned in this section, alongside the sampling method.

### 1.9.4 Chapter 4: Results and Discussion

Key findings are discussed in this section based on the analysis and conclusions drawn from the data obtained. Using charts and themes, findings are represented to back the research question. I would use cohort analysis to analyze the different findings from the stratum.

### 1.9.5 Chapter 5: Conclusion and Recommendations

This chapter summarizes the research paper, highlights findings, and makes recommendations and suggestions for future studies and usage. Based on the results, recommendations for possible solutions will be made. In this chapter, the limitations and ethical considerations of the study will also be discussed.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Overview

This chapter focuses on insights derived from existing literature on the perception of livestock farmers on climate change, focusing on farmers in Ghana. In this chapter, the researcher will identify trends, similarities, and differences between different papers and this study and critique the authors' findings of similar works to fill any loophole in this study. The first part of this section accesses the perceptions and knowledge levels of smallholder farmers on climate change and how that was considered in creating mitigation policies. The second part discusses the mitigation methodologies and policies, focusing on the use of climate information services in those policies.

#### 2.2 Knowledge and Perceptions of Local Farmers

In the past, many researchers have used statistical methods to mitigate climate change while disregarding local farmers' perceptions and knowledge levels on climate change. However, scientific models that exclude local people's perspectives of climate change have been acknowledged as irrelevant and incomplete in recent years, as local knowledge can be useful for building adaptation plans and dealing with climate change impacts. (Teye, 2014). Teye et al. mentioned that due to the belief that local farmers' perceptions of climate change do not correlate with the scientific record, local farmers' knowledge of climate variability was not adequately explored in the earlier studies (2014). From the authors' perspectives, they believed that this was because it is often argued that the local farmers' past experiences, cultures and superstitious beliefs influenced their perceptions of the theory of climate change. Sofoluwe et al. (2011) also stated that climate change is difficult

to detect accurately based on local farmers' experiences because the farmers' perceptions are clouded by past experiences of farmers, which can be faulty. Yaro affirmed this in his paper, saying, "the perceptions of local farmers about climate change tend to strongly influence their willingness to accept adaptation strategies" (2013). The researcher believes that though the existing ideologies of local farmers played a role in why earlier researchers disregarded the perceptions of the local farmers in making policies, the main reason was that earlier researchers did not believe that the knowledge and perceptions of local farmers on the topic were relevant in developing solutions. However, recent research has proven this to be futile, and as such, some current research studies have incorporated the perceptions of local farmers on weather patterns to mitigate climate change. For example, Ronocoli et al. (2002) studied how farmers in the Sahel use a range of local indicators to forecast rain and adjust their resource management techniques.

Similarly, Yaro (2013) conducted a study in Ghana examining climate change perceptions among farmers in Southern Ghana. This is a step in the right direction because by examining the perceptions and level of knowledge of local farmers, educating these farmers on climate change becomes easy, and implementation of policies becomes more effective. Researchers who believe that education is critical for eliminating climate change suggest that effective adaptation is contingent on farmers' views and officials' abilities to integrate scientific knowledge systems. (Teye, 2014). In examining the perceptions of local farmers, Teye et al. and Sofoluwe et al. (2011) found that farmers' views and level of knowledge differed based on geographical location, age, and gender. The research that Teye et al. conducted showed that the older farmers were more inclined to change rainfall patterns and temperature. In contrast, the study conducted by Sofoluwe et al. showed that

the younger farmers had more knowledge about climate change and were more liable to adapt to innovative farming techniques. Based on Sofowule et al.'s findings, one of the major limitations that the farmers in Nigeria were facing was the lack of information on climate change which he attributed to the lack of resources on climate change and adaptation policies. The researcher believes that some of these perceptions can be demystified through education, where this study comes in.

From reading similar research papers, it was identified that although the authors acknowledged the importance of local farmers' perceptions of climate change, they failed to demystify any false perceptions by educating the farmers on the topic and providing them with resources. This research paper will fill this gap by exploring how climate information systems can be used as a tool to mitigate climate change. As farmers acquire more information, their ability to obtain, process, and use information improves, and hence education is key to ensuring the economic progression of the livestock production industry. This would also provide policymakers with relevant resources to make informed adaptation policies. Contrary to many research studies on climate change that use qualitative analysis, this research would employ the mixed method. This helped the researcher quantify the findings and graphically represent the findings to provide a new perspective on the topic.

### 2.3 Climate mitigation strategies

Mitigating climate change has become more necessary than ever due to the rapid spread of climate change. There have been several policies and measures that have been put in place over the years to mitigate or reduce climate change however it only seems to worsen. Many organizations and researchers have made conscious efforts to lessen



humans' contributions to climate change by adopting and encouraging environment friendly strategies. To reduce carbon emission, which would in turn reduce climate change, some renowned companies including BMW, Honda, Google, Amazon, and IBM have donated millions of dollars to climate change reduction foundations and are slowly transitioning to low carbon operations. For example, Walmart's stores use 100% renewable energy sources and have cut ties with all manufacturers that contribute to carbon emissions (Morgan, 2021). One of the most popular strategies that many researchers suggest in combatting the effects of climate change is adaptation. In a paper written by Wreford et al., it was stated that there are two major strategies in combatting climate change. The first strategy is by reducing human causes and the second by adaptation. He went on to discuss the major types of adaptation which he listed as reducing the sensitivity of the affected system, altering the exposure of a system to climate change, and increasing the resilience of social and ecological systems. Similarly, Pathak et al. (2012), highlighted in his paper that adaptation is relevant in dealing with climate change. He also, mentioned a few adaptation strategies that can be employed to deal with climate change. I agree with the authors in the above cited works that adaptation is essential in curbing climate change. Even so, I questioned why climate information systems was not discussed. Perhaps, that is why the numerous strategies employed to mitigate climate change have not been very effective. Maybe if researchers discuss the importance of resource banks like climate information systems and how farmers and policy makers can have access to it, the implementation of mitigation policies would be more effective.

## 2.4 Implementation of Climate Information Services in mitigation policies

Climate services are decision-making support tools generated by translating climate data into useful advisory services that aid individuals and organizations in making decisions (Tall et al., 2018). They equip smallholder farmers with short- and long-term climate change information to help them adapt to changing climatic conditions. Due to the rapid increase in climate change and its potential to destabilize food security, climate information services have grown increasingly significant. It has significantly enhanced climate-smart agriculture (CSA), which is transforming the agriculture sector and reducing climate change in the sector. Climate-smart agriculture has emerged as a game-changing strategy for agriculture that reorients the industry to meet climate change while assuring long-term food security (McKune et al., 2018). Climate-smart agriculture thrives on improving agricultural output and incomes sustainably, adapting and strengthening climate change resilience, and lowering and eliminating greenhouse gas emissions (McKune et al., 2018). Interest in establishing climate services for consumers has developed quickly over the last decade and a half, owing to enhanced forecasting capability after the 1997/98 El Nino (Tall et al., 2018). Since the Global Framework for Climate Services launched in September 2009, the application of climate services to support climate risk management in agriculture, disaster risk reduction, health, water management, energy, and several other susceptible sectors has grown in popularity (Tall et al., 2018).

Despite the growing acknowledgement that climate services are a key part of the climate adaptation plan, little progress has been made in proving the usefulness of customized climate information in the hands of users. In a paper dubbed “*Do climate services make a difference? A review of evaluation methodologies and practices to access*

*the value of climate information services for farmers: Implications for Africa*”, the author highlighted that for climate information services to be effective, appropriate engagement, effective access and delivery mechanism is important. Daron et al. (2016) mentioned that the barrier to managing climate change in Africa is the limited availability of accessible, reliable, and relevant weather climate information. He went on to say, “There are often remains of mismatch between available information and what is needed to support on-the-ground decision making (Daron et al., 2016). This affects decision and policymaking. I believe that if smallholder farmers and policymakers get access to climate information systems, creating and implementing climate mitigation policies would be more effective.

## 2.5 Conclusion

From the data above, gathered that the perceptions and knowledge levels of farmers are not fully considered when making policies and hence the policies are less effective. This is because policy makers need reliable information to properly make policies and the farmers who are the primary stakeholders require enough education on the topic to properly implement policies. I also found that accessing climate information services is very difficult and hence it is important that the study recommends easier ways that the relevant stakeholders can access the information.

## CHAPTER THREE

### METHODOLOGY

#### 3.0 Introduction

This chapter discusses the research scope, research process, data collection tools, data analysis methods, ethical considerations, and limitations of the study.

#### 3.1 Overview of Methodology

##### *3.1.1 Research Design*

The research seeks to determine the perceptions and level of knowledge of local livestock farmers on the topics of climate change and suggest how climate information systems can be used as a method to mitigate it. The research methods employed in this research were one on one interviews and focus group discussions on collecting data. These will be fully expanded on in the latter part of this chapter.

#### 3.2 Population of Study

The main participants for this research are smallholder farmers in the Tua and Yong in the Northern Region. In a paper written by DAI in association with Nathan Associates (2014), it was stated that about 600,000 households in Northern Ghana own, rear, or breed livestock, with the Northern ecological zones contributing to about 84% cattle, 60% sheep, and 60% goat of the nation's production. To ensure that the data collected is as controlled and reliable as possible, the data would be collected from smallholder farmers in just two towns in the region, as mentioned earlier.

### 3.3 Sample Selection

The smallholder livestock farmers sampled in this research aged between eighteen and fifty-one years old. These farmers' minimum years of experience was three years, with a maximum number of years of experience of forty-five years. The total number of respondents used in this study was thirty-two livestock farmers who rear goats, local fowls, sheep, ducks, and guinea fowls. In sampling the research participants, the stratified and purposive sampling methods were employed. With these methods, participants were intentionally selected. They were grouped based on demographics to give the researcher a better understanding of livestock farmers' knowledge and perception levels on the topic of climate change. The stratified method was used because, in conducting research, it was found that the perceptions of local farmers differ based on demographics. As such, research participants were grouped in strata based on demographics. This helped me make precise analysis by ensuring that every subgroup was represented in the sample and provided a foundation to compare results with the works of other researchers.

### 3.4 Data Collection Methods

Information gathered and used in this study was sourced from primary and secondary research however, data was mainly sourced through primary research. The researcher drafted open-ended interview questions for smallholder livestock farmers in the Tua and Yong to obtain primary data. The responses provided by the respondents gave the researcher more insights into the operations of the industry and the perceptions that livestock farmers in the regions named above have about climate change and climate information systems. Due to the language barrier and the inability of the farmers to read

and write, short interviews, and focus group discussions were conducted orally. The interviews were recorded with permission from respondents for future reference. This captured any relevant information that may not have been captured in the previous studies because farmers could express themselves freely without any restrictions on the communication. Because primary study took place in a physical setting, the researcher ensured that the Covid guidelines were followed to prevent the virus from spreading. All individuals taking part in the study were required to wear nose masks, wash their hands before and after touching research items, and maintain social distance.

Consequently, to obtain secondary data, findings and information were derived from news articles and similar research papers to establish relationships, identify trends, and derive hypotheses to gain deeper insight into the impact of climate change on livestock production in Ghana. Furthermore, in analyzing the data gathered, the researcher employed the qualitative research method to perform the necessary analysis. Although the analysis of this study was done using qualitative analysis, the ages of livestock farmers were presented using a pie chart.

### 3.5 Data Analysis

To graphically represent the age dynamics of respondents, Excel was used first to sort out and organize data. After the data was organized, it was used to draw a pie chart. This helped me visualize the percentage ages of the respondents to provide a better understanding of the findings and enable the researcher to identify trends that may be useful in this study. For qualitative data, inductive thematic analysis was used. Themes were

derived based on recurring responses, and analysis and conclusions were drawn based on literature review and research objectives.

### 3.6 Ethical Considerations

The participants of this study were thoroughly educated on the objectives and process of this research to ensure that they fully understood the extent of the research and their role in the research. Participants were made aware that they had the liberty to stop the interview if they felt uncomfortable with no repercussions. The confidentiality of the participants' information was duly observed to ensure transparency. Due to the language barriers and the interview format, audio recordings were collected for future reference. Participants' permissions were asked before any recording was done. The research was conducted with professionalism and respect to provide an environment where the participants could feel comfortable providing information. Furthermore, it was ensured that no participant gets harmed physically, emotionally, or psychologically throughout the study.

## CHAPTER FOUR

### RESULTS AND DISCUSSION

#### 4.0 Introduction

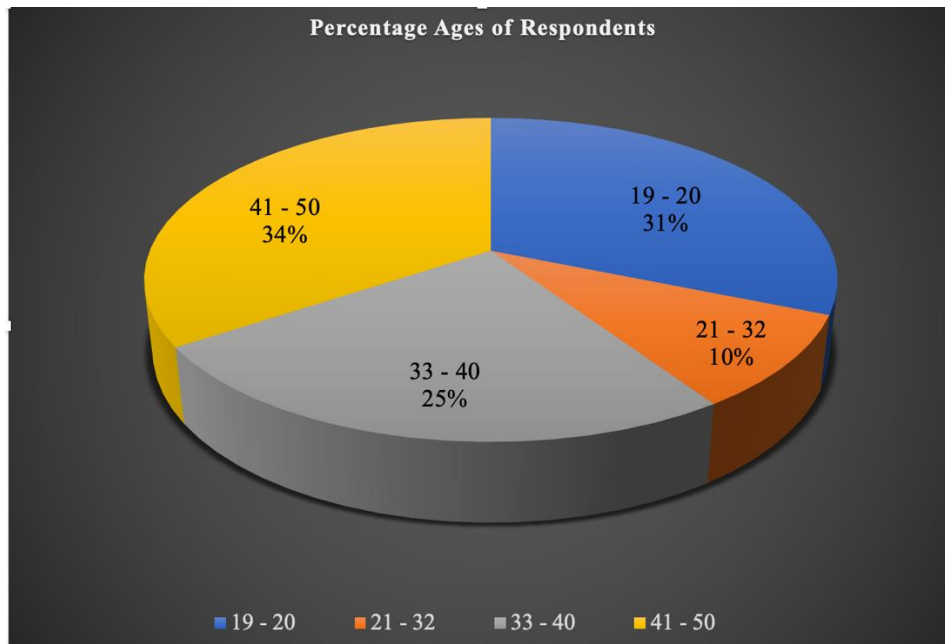
This chapter discusses and analyzes the responses and findings gathered from the study. The findings of this study seek to address the research questions and objectives stated in chapter 1. The main objective of this study is to measure the perceptions and knowledge levels of smallholder livestock farmers in Ghana and determine how climate information systems can be used to mitigate the impact of climate change in the livestock industry. Data was collected on the field from two villages in Tamale, in the Northern part of Ghana. Focus group discussions and one on one interviews were used as tools to collect the data. After data was collected, qualitative analysis was used to analyze the data by drawing themes from responses. The specific thematic analysis employed was inductive because themes were derived based on the respondents' responses, and no prior knowledge of the responses was established. Themes were derived based on recurring information provided by the different respondents. The data was collected from thirty- six smallholder livestock farmers. However, only thirty-two responses were used in the analysis due to discrepancies in four responses.

#### 4.1 Demographics of respondents

Respondents for this study were smallholder livestock farmers between the ages of eighteen and fifty-one years who live in Tua and Yong in the Northern Region of Ghana. Out of the 32 respondents, 10 of the respondents ranged from eighteen to twenty-five years,



three ranged from twenty-six to thirty-two years, eight ranged from thirty-three to forty years, and eleven ranged from forty-one to fifty years.



*Figure 3 - pie chart showing the percentage age representation of respondents*

From this data, I deduced that majority of the respondents ranged from 41 years to 50 years, thus occupying 34% of the respondents. 31% ranged from 19 to 20 years, 25% ranged from 33 to 40, and 10% ranged between 21 to 31 years. The minimum years of experience among the respondents were three years, and the maximum was 45 years. All the respondents in the study were males because the industry is male-dominated, and hence it was extremely hard to find a woman involved in livestock farming.

#### 4.1 Presentation & Analysis of Results

***Question: What is the typical weather like during the year?***

Research participants were asked the above question to help the researcher articulate the normal weather pattern during the year. Participants from Tua mentioned that in a typical year, there are three seasons. These are the warm season, harmattan season, and

rainy season. According to them, the warm and harmattan seasons last for three months each, and the rainy season lasts for six months. However, the people of Yong mentioned that there are four seasons during the typical year. Three months of the warm season, three months of harmattan, three months of heavy rain, and three months of light rain.

***Question: What has the weather pattern been in the past two years? How about the past six years?***

Participants of this study were asked what the weather has been for the past two to six years to determine if there has been a change in the weather pattern. Based on the responses given, the themes below were derived.

#### *Unstable weather*

There has been a shift in weather patterns in the last two to six years, according to 100% of participants. They described the weather as "very unpredictable." According to the farmers, it was easier to predict the weather in earlier years, but it has become difficult to predict the weather in the last six years due to its instability. The inclement weather hampers their regular efforts. The animals are usually kept inside their pen during rainy seasons until the sun shines again. They do this because when it rains, the earth becomes flooded, and as animals walk through it, insects from the ground enter their feet, causing an infection. Unfortunately, because of the unpredictable nature of the weather, they may forecast sunny weather and therefore allow the animals to free graze, only for it to rain heavily the whole day.

*Less rainfall*

The livestock farmers noted that there had been a decrease in the number of rainy days every year. The rainfall pattern has been inconsistent in recent years, with temperatures rising even during the wet season.

***Question: Describe your daily activities and the role/impact of the weather on your daily routine.***

**Daily Activities***Feeding the Herd*

Farmers' everyday activities revolved mostly around livestock feeding. The farmers normally feed the animals twice a day during the warm and harmattan seasons. The routine they follow every day involves feeding the animals their first meal in the morning and then letting them roam about the neighbourhood or go to the nearest water source to drink. At about 1 p.m., the animals return home for their second feeding every day. During the rainy season, the animals are fed and watered in their enclosures, and they are not allowed to graze freely. During the wet season, the animals are permitted to go for supervised walks around the neighbourhood on certain days.

*Mating animals to reproduce*

All the participants in this research reared animals for economic reasons, therefore, reproducing the animals was a necessary element of their activities to maintain a steady stream of income. They engage in actions such as detecting animal heat phases, cross-mating animals, and more to increase the size of their existing herd.

*Socioeconomic activities*

The animals are then sold to butchers and villagers as the final step in raising. They earn money by selling the animals, which they use to support their family and pay school tuition, among other things. A farmer in Yong indicated that he does both livestock and agricultural farming and that he normally uses a portion of the money earned from animals to raise certain crops. Furthermore, the majority of farmers stressed the societal advantages of cattle-raising. According to them, animals are utilized in feasts, marriages, funerals, and other events. When friends and loved ones come to visit, the animals are given as presents and as a meal.

**Impact of Weather on Activities***Rainfall as a source of water*

Rainfall is a critical component in cattle production, according to the participants in the study. It not only provides water for the animals to drink, but it also aids in the growth of the feed they consume. Low rainfall implies animals will have less water to drink, and plants will be unable to develop. Malnutrition in animals is caused by a lack of enough feed and water. Because butchers (who make up a large portion of their clients) would purchase the meat at a reduced price if the animals were malnourished, it impacts their income. Additionally, the animals die in severe cases, further affecting the farmers' revenue.

*Unsafe feed-in rainy season*

Farmers in Tua have voiced concern that the grass that emerges in the early days of the wet season is unhealthy for animals to eat. Most of the farmers mentioned that allowing

animals to graze on the grass that sprouts at the early stages of the rainy season causes the animals to fall ill and, in extreme cases, die. The farmers also highlighted that animals suffer runny noses throughout the summer, especially when the heat is harsh. This response prompted the follow-up question, "Aside from the runny noses, have there been any illnesses or occurrences in animals in the past year?" to which the farmers provided examples of other illnesses that occur in the animals.

***Question: Aside the runny noses have there been any illnesses or occurrences in animals in the past year?***

#### *Skin diseases*

Skin disease was the most prevalent illness mentioned by all the responders. Per their response, this is most common in goats and sheep. They described the condition as having rashes that cover the entire body of the sheep or goat and cause the skin to stiffen. The animals' fur begins to come off as a result of this. Animals can die in severe conditions if they are not treated appropriately. See **Figure 4** for a visual example.

#### *Asthma*

According to the responses, asthma-like disorders are a prevalent sickness among animals, particularly during the summer. They said that animals struggle to breathe owing to the intense heat.

#### *Runny stools*

The farmers mentioned that when animals feed on the grass that springs during the early days of the rainy season, they end up having runny stools. Their anus swells and becomes crimson because of this.

#### *Insects in their feet*

Another recurring illness in the respondents' answers was the insects that attack the feet of animals. This happens mainly during the rainy seasons. When animals walk through the dump and flooded areas, insects penetrate their feet. This creates wounds and sores, and sometimes the wounds get infected. They mentioned that this disease is hard to notice and hence would not be treated, resulting in animals' sudden death.

***Question: What is the impact of these illnesses and occurrences on you and your business?***

#### *Extra costs (Treatment)*

The most common solution that smallholder livestock farmers resort to when animals get ill is to book the services of a veterinarian. The cost of the service per animal is five Ghana cedis. When large numbers of animals are infected, a large amount of money would be needed to treat the animals. There are instances where farmers who cannot afford the services of a veterinarian purchase relevant drugs from a drug store to treat their animals. The process of buying drugs and booking the services of a vet means these farmers need to incur extra costs. The farmers stated that there are even times when they do not have the financial means to take the necessary steps to treat the animals.

*Death of animals*

One of the extreme effects of the illnesses and diseases stated above is death. When not treated early or properly, the animals can die.

*Income decline*

As the main source of income for 90% of the respondents, income decline is one of the unfortunate effects of the illnesses mentioned above. When they must incur extra costs or lose their animals, this affects the revenue they make from the business. The farmers at Yong mentioned that they tend to throw a lot of dead animals away during the warm season. They mentioned that they prevent selling certain animals because they do not want to spread diseases to humans. In circumstances where the animals can be sold, the butchers buy them at low prices, affecting their income. They further expressed how this affects their plans to expand their businesses, stating that they do not have the financial means to realize those plans.

*Emotional Stress*

The loss of animals and the financial stress of incurring extra costs to treat animals pose emotional stress to farmers. This demotivates them from farming and venturing into other activities.

***Question: Have you heard of climate change? If yes, what do you know about it?***

The livestock farmers were well informed on the topic of climate change. They described it as the changes in weather patterns over the years.

***Question: What do you think about information about climate change being made accessible to you?***

When asked if they would like knowledge on climate change made widely available to them, the farmers indicated their delight and satisfaction. According to the translator, one farmer stated he would be delighted if the information on weather changes was made accessible to them since it would save them a lot of money, even on their agricultural fields.

***Question: How would you like to receive this information?***

*Audio and voice memos*

The farmers suggested that the information be given to them in audio and voice recordings. This is because most of them are illiterate, and hence they cannot read or write. During one of the focus group discussions, one farmer mentioned that out of the eight people present, only one could read, hence sending audios would be the most effective way.

*Educational visits from trained professionals*

Another suggestion was to train and equip young people with the relevant information about climate change to visit their farms from time to time to educate them on the current trends and what to do and what not to.

***Question: Is this the first time you have been interviewed on this topic? How do you feel about being interviewed on this topic?***



*Skepticism*

Skepticism was a frequent reaction among farmers to the interview. They were apprehensive about participating in the study because of the numerous useless interviews with previous researchers. They have no faith in the study's validity or applicability. They even questioned the credibility of researchers. One responder stated that he feels "learned" individuals take advantage of them by exploiting these interviews to gain money for themselves.

*Frequently*

Respondents mentioned that they had been involved in similar interviews, yet nothing was being done to help them.

*Frustration*

The respondents expressed frustration that they had been interviewed several times, yet nothing had been done to help them. They mentioned that the only reason they agreed to participate in the interview was because of their relationship with the translator.

### 4.3 Discussion of results

The study discovered that the influence of climate change on the socio-economic activities of cattle production is more severe than expected after assessing the responses. Farmers have expressed how they cannot accurately anticipate the weather, which has a significant impact on their operations. One of the farmers stated that it had been difficult to secure forage for their livestock owing to minimal rainfall in the previous two years, particularly during the hotter months. They give them dried cowpea leaves from their fields after harvesting as an alternative. This is not ideal since it impacts the animals' nutrition. This is a danger to the profitability of an expanding sector like the cattle industry. In answering one of the objectives of this study which seeks to examine the perceptions and knowledge levels of smallholder livestock farmers in the Northern Region, it was identified that the farmers had a good knowledge level of climate change and its impact on their businesses. In the literature review, Teye et al. said in their literature review that smallholder livestock producers' perceptions of climate change are clouded by superstitions, prior experiences, and culture (2014). However, the researcher discovered that this was not the case with Tua and Yong's smallholder farmers. They were aware of climate change, which they defined as variations in weather patterns throughout time. The disparity in findings between this study and Teye et al.'s study might be attributed to the period in which the research was done.

Another objective of this research was to see how climate change affects the livestock industry. The unpredictable and harsh nature of the weather was discovered to be damaging to their everyday agricultural efforts and the socio-economic benefits they gained from the enterprise. Extreme weather conditions create odd diseases and ailments in animals, such as skin infections and runny noses (**See Figure 5**). Animals perish in severe circumstances. The diseases that plague the animals put a financial hardship on the farmers since they must pay extra expenses to either hire a veterinarian or buy medications for the animals. Because of the animals' poor condition, they are often forced to sell the animals to butchers at a discounted price. Their intentions to expand their business or fund their personal needs are hampered by the economic downturn. They are also experiencing emotional stress because of the financial slowdown. They tend to lose interest in cattle farming. This poses a danger to Ghana's agriculture sector since the cattle business accounts for a significant portion of the country's agricultural earnings. The study's goal was to identify the benefits of climate information systems in the livestock industry as a way to combat climate change. The purpose of this objective was to develop a practical way of adding to the existing body of knowledge stored in climate information services, disseminating relevant information to livestock farmers, and assisting in the development of policies that take livestock farmers' perspectives into account. To ensure an effective use of climate information services to combat climate change in livestock production, the information must a) address farmers' climate information needs, provide access and support c) provide co-production services (Hansen et al., 2001). Farm decision-makers are starting to employ scalable technologies for providing more locally relevant historical and future climatic information (Hansen et al.). Farmers were asked how they would want to receive information on climate change

to do this. Most of the farmers stated that they could not read or write and would prefer to acquire knowledge via audio or physical information sessions. This would be a game-changer for them, as they would be more aware of the changing environment, the steps they need to put in place to mitigate the impact on their businesses, and how to avert the advancement of climate change in general. Policymakers can also use the information gained to develop effective policies to solve the issues that these farmers face. According to Teye et al.'s literature study, local farmers' knowledge of climate variability was not thoroughly examined in previous climate change research because local farmers' views of climate change do not correlate with the scientific record. (2014). This, according to him, made the policies less effective.

Policymakers and organizations such as National Climate Change Committee (NCC) can leverage climate information services to create effective and sustainable policies that would address climate change in livestock production in Tua, Yong and other parts of Ghana. In addition, the Ministry of Agriculture, in conjunction with The Ministry of Environment, Science, Technology, and Innovation (MESTI), can encourage climate-smart agriculture among farmers and provide farmers with technology that reduces the emission of greenhouse gases. The United Nations Development Programme (UNDP) can also provide financial support to enable the nation to organize regular workshops for farmers to educate on climate information.

Based on studies employed in the literature review of this study, it was revealed that the perceptions and knowledge levels of farmers were greatly affected by their locations. This finding influenced the choice of the location of respondents for this study. After collecting the data, I found that the perceptions and knowledge levels of the farmers in the two communities, Tua and Yong, were practically the same. To conclude, it can be said that climate change does have a huge impact on the socio-economic activities of livestock farming, and proper analysis, storage, and dissemination of climate information systems can help curb these effects.

## CHAPTER FIVE

### CONCLUSION

#### 5.0 Introduction

This chapter presents conclusions on research findings and answers the research objectives of this study. In this chapter, the researcher also makes recommendations for future studies.

#### 5.1 Summary of Findings

The study sought to assess the perceptions and knowledge levels of smallholder livestock farmers, determine the impacts of climate change on the livestock production industry, and determine how climate information systems can be used to mitigate climate change in livestock production. The data was collected primarily from two towns in the Northern Region of Ghana. After data was collected, thematic analysis was performed on the data to establish relationships, derive conclusions, and make recommendations. After analysis, it was observed that smallholder livestock farmers were well-versed on the topic of climate change as they described it as the changes in weather patterns over the years. The researcher also found that smallholder livestock farmers believed that climate change affected their socio-economic activities. The farmers identified strange diseases such as runny noses, runny stools, skin diseases, and asthma in animals. This affects their income as they must pay for veterinary services, buy drugs, sell animals for relatively low prices to butchers or discard animals. To determine how climate information systems can be used as a solution, participants were asked whether they would want climate information to be accessible to them. All participants stated that they would want climate information to be

made accessible to them. Participants also suggested that information be made accessible to them through audio and voice memos.

## 5.2 Conclusions

From the findings, the researcher can conclude that climate change has a negative effect on the daily activities of livestock farming. The diseases and illnesses that the farmers identified were attributed to extreme and unstable weather conditions. The researcher also identified that climate information systems would positively impact the social and economic facets of the livestock industry. By making climate information systems available to smallholder farmers, they would be able to correctly predict weather patterns and put in place activities to prevent animals from getting sick. For example, farmers mentioned that during the rainy season, animals walk in flooded areas, and this causes tiny insects to penetrate their feet and further cause sores. In situations like this, if farmers are aware of the climate conditions and weather trends, they can predict the weather more effectively and prevent animals from leaving their pens.

## 5.3 Recommendations

This research focused on the impact of climate change on livestock production in Tua and Yong, villages in the Northern Region of Ghana. However, future researchers could capitalize on the findings to further explore the impact in other regions in Ghana, like the Upper West Region, or even conduct similar research on the impact of climate change on crop production. The study could also be of significance to policymakers. Policymakers can use these findings to create efficient policies that would properly incorporate the

perceptions and views of smallholder livestock farmers. Government bodies, especially the ministry of agriculture, can train individuals to educate farmers on climate change from time to time or organize an effective way to disseminate information about climate change efficiently.

#### 5.4 Limitations

The main limitation of this study is the language barrier. Most of the farmers in Tamale and Bolgatanga may not be fluent in English. This may lead to miscommunication or misinterpretation of information. In some situations, it may be almost impossible to communicate with the farmers. To curb this limitation, I would use very basic English words that I believe the majority of people may understand and omit the use of jargon.



Appendix



*Figure 4 - skin disease in goats*



*Figure 5 - runny nose disease in livestock*

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