

## The Effect of Climate Change on The Performance of Maize Production in Chongwe District: A Case Study of Chansongo, Njamu and Masungaire Villages.

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### **ABSTRACT**

*The study is a descriptive survey done in Chongwe district which is a representative sample for the project as it is affected by climate change and variability. This is evident as there is high level of food insecurity, crop failure, poverty and hunger in some places. Maize is one of the crops that are grown by most farmers in Zambia and it is the staple food for the majority of Zambians. Zambia is subdivided into three agro-ecological zones with varying rainfall patterns. However, despite maize being so important, its production is dependent on climatic conditions. Therefore, changes in climate can affect its production either negatively or positively. The objectives of the study were to identify the impact of climate change on maize production, analysed the effect of climate change on agriculture production and food security and establish measures that can be applied to mitigate the adverse effects. Sample was randomly selected and personal interviews were conducted from farmers and agriculture officers. In fact, it was found that quantifying the effects of climate change on maize production is not easy due to difficulties in quantifying other factors that may also have large impact on maize production. It was therefore, not possible to conclude whether or to what extent climate change has effects on maize production. Adaptation strategies used are; drought resistant varieties, crops diversification, crop rotation, mulching, conservation farming, early planting, late planting and intercropping. Data were analysed using descriptive statistics, the use of tables, charts, Microsoft word and excel and the statistical package of social science (SPSS).*

### **KEY WORDS**

*Climate impacts, Crops, Agriculture Production, Climate Change, Yield, Maize production, Adaptation measures, Mitigation.*

## **ACKNOWLEDGEMENTS**

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## 1.0 INTRODUCTION

Global food security threatened by climate change is one of the most important challenges in the 21st century to supply sufficient food for the increasing population while sustaining the already stressed environment. Climate change has already caused significant impacts on water resources, food security, hydropower, human health especially for African countries, as well as to the whole world. Studies on climate impacts and adaptation strategies are increasingly becoming major areas of scientific concern, e.g. impacts on the production of crops such as maize, wheat and rice, water resources in the river basin catchments, forests, industry and the native landscape. Crop productivity and soil water balance have been studied with crop growth models by using parameters from different climate models. Meanwhile, climate variability is one of the most significant factors influencing year to year crop production, even in high yield and high-technology agricultural areas. In recent years, more and more attention has been paid to the risks. In addition, extensive discussions are taking place throughout the world in all forms of media on the subjects of global warming and climate change. These discussions point to the global dangers posed by the earth's warming.

The purpose of this paper is to provide some education to the members on the effects of climate change with specific focus on maize production. Climate change can no longer be avoided. In fact, it is here. So far, the global mean temperature has increased by 0.3 to 0.6 degrees Celsius since late 19th century, and by about 0.2 to 0.3°C over the last 40 years, though the warming is not uniform globally (Climate Ark, 2007). To make the situation worse, BBC, (2007) reported that global average temperature is predicted to rise by 1.4 to 5.8 degrees Celsius by 2100 and that, in tropical areas, some areas will receive more rainfall while others will receive less. For Zambia specifically, World Bank (2006) indicated that temperature is increasing at the rate of 0.6 degrees Celsius per decade, which is ten times higher than global or Southern Africa rate. Nevertheless, in terms of rainfall, there would be both regional increase and decrease over land areas in the low latitudes (IPCC, 2001).

Although it is still uncertain which effects climate change will have in different localities, most models indicate that they will be stronger near the equator and hence in Sub-Sahara Africa than in most other major regions on earth. For example, since 1970s, intense and longer droughts have been observed especially in the tropics and subtropics (IPCC, 2007). It is also predicted that countries that depend heavily on the primary sector (such as agriculture), are likely to be more adversely hit than countries that have a more diversified economic base (Mitchell and Tanner, 2006).

This study therefore, aimed at: (a) determining the effects of climate change on maize production in Lusaka province in particular Chongwe district.

### 1.0 .1 BACKGROUND.

Some 70 percent of Zambia's working population is engaged in agriculture (Encarta 2009), largely subsistence farming. Beef and dairy cattle are raised for domestic use. The agricultural sector remains underdeveloped and vulnerable to weather fluctuations, and food shortages have occurred in

some areas. Agriculture remains the key priority sector in the growth and poverty reduction agenda of Zambia. Over 60 percent of the population derives its livelihood from agriculture. In order to fully exploit agriculture, Zambia has developed well articulated agricultural policies and strategies which emphasize objectives such as attainment of food security, maximizing farmers' incomes, promoting sustainable agriculture and enhancing private sector roles in input and output markets. Zambia has put in place policies that provide public support and investment in agriculture with a view to creating an enabling environment to attract private sector and smallholder interest in farm production, processing and trade. Generally, Zambia experiences tropical conditions that are moderated by altitude and rainy season that runs from October to April (about.com, 2008). According to Mumba (2002), climatic conditions are influenced by three factors which are Inter-tropical Convergence Zone (ITCZ); which results in Northern part of the country receive more rainfall than the Southern part. Secondly the the altitude; that causes low temperatures in the plateau areas and El Nino which has been associated with drought in Zambia.

## **1.1. STATEMENT OF THE PROBLEM.**

Although lying within the Tropic Zone, much of Zambia enjoys a pleasant subtropical climate because of the high altitude. There are two main seasons, the rainy season corresponding to summer, and the dry season, corresponding to winter. . The modifying influence of altitude gives the country pleasant subtropical weather rather than tropical conditions for most of the year. Annual rainfall ranges from 750 mm (30 in) in the south to 1,300 mm (51 in) in the north. Nearly all of the rain falls between November and April. World Bank (2006) reported that Zambian summer temperature is increasing at the rate of 0.6 degrees Celsius per decade, which is ten times higher than global or Southern African. Thus, due to the expected change in climatic conditions, together with the established increase in atmospheric Carbon dioxide, crop production will be affected world-wide (FAO, 2007). Rainfall intensity results in heavy storms thereby causing floods that cause damage to property and crops.

## **1.4 GENERAL OBJECTIVE**

To investigate how climate change influence crop performance

## **1.5 SPECIFIC OBJECTIVES**

1. To find out the cause of climate change
2. To analyse the effect of climate change on agriculture production and food security
- 3 To establish the measures that can be applied to mitigate the advert effects of climate change

## 1.6 RESEARCH QUESTIONS

1.6.1 What are the causes of climate change?

1.6.2. What effects does climate change have on crop production?

1.6.3 .What measures should be applied to mitigate the adverse effect climate change

## 1.7 STATEMENT OF HYPOTHESIS

1. Ho: there is no relationship between climate change and maize production.

Ha: there is a relationship between climate change and maize production.

## 1.8. SIGNIFICANCE OF THE STUDY.

The information that will come out of this study will add to the body of knowledge on the effects of climate change on maize production. This will prove helpful to the policy makers such as the Ministry of Agriculture, to formulate policies to mitigate these challenges. In addition, other researchers who will carry out a similar study will use the results of this study as part of their literature review.

## 1.9. DELIMITATION OF STUDY

This study was carried out in Chongwe district in three villages; Chansongo, Njamu and Masungaire.

### 1.9.1 LIMITATIONS

Financial resources and time were a limiting factor as it required a lot of movements, stationary, typing and printing which was costly and time consuming.

### 1.9.2 OPERATONAL DEFINITIONS.

**Agriculture:** The production of crops and animals which are of immediate benefit to man.

**Challenges:** Difficulties being faced by farmers

**Impact:** to have an immediate and strong effect on something or somebody

**Mitigation:** to alleviate

**Climate:** the long-term effect of the sun's radiation on the rotating earth's varied surface and atmosphere

## CHAPTER TWO

### 2.0 LITERATURE REVIEW

Climate change is the subject of how weather patterns change over decades or longer. Climate change takes place due to natural and human influences. Since the Industrial Revolution (i.e., 1750), humans have contributed to climate change through the emissions of Green houses gases and aerosols, and through changes in land use, resulting in a rise in global temperatures. Increases in global temperatures may have different impacts, such as an increase in storms, floods, droughts, and sea levels, and the decline of ice sheets, sea ice, and glaciers.

The earth receives energy through radiation from the sun. Green houses gases play an important role of trapping heat, maintaining the earth's temperature at a level that can sustain life. This phenomenon is called the greenhouse effect and is natural and necessary to support life on earth. Secondly, without the greenhouse effect, the earth would be approximately 33°C cooler than it is today. In recent centuries, humans have contributed to an increase in atmospheric Green houses gases as a result of increased fossil fuel burning and deforestation. The rise in Green houses gases is the primary cause of global warming over the last century.

There are three main datasets that are referenced to measure global surface temperatures since 1850. These datasets show warming of between +0.8°C and +1.0°C since 1900. Since 1950, land-only measurements indicate warming trends of between +1.1°C and +1.3°C, as land temperatures tend to respond more quickly than oceans to the earth's changing climate. According Earth's climate is always changing. There have been times when Earth's climate has been warmer than it is now. There have been times when it has been cooler. These times can last thousands or millions of years. (CalCAN 2011).

People who study Earth see that Earth's climate is getting warmer. Earth's temperature has gone up about one degree Fahrenheit in the last 100 years. This may not seem like much. But small changes in Earth's temperature can have big effects.

Some effects are already happening. Warming of Earth's climate has caused some snow and ice to melt. The warming also has caused oceans to rise. And it has changed the timing of when certain plants grow. Many things can cause climate to change all on its own. Earth's distance from the sun can change. The sun can send out more or less energy. Oceans can change. When a volcano erupts, it can change our climate. Apart from that most scientists say that humans can change climate too. People drive cars. People heat and cool their houses. People cook food. All those things take energy. One way we get energy is by burning coal, oil and gas. Burning these things puts gases into the air. The gases cause the air to heat up. This can change the climate of a place. It also can change Earth's climate. Scientists think that Earth's temperature will keep going up for the next 100 years. This would cause more snow and ice to melt. Oceans would rise higher. Some places would get hotter. Other places might have colder winters with more snow. Some places might get more rain. Other

places might get less rain. Some places might have stronger hurricanes. Climate change can no longer be avoided. In fact, it is here. So far, the global mean temperature has increased by 0.3 to 0.6 degrees Celsius since late 19th century, and by about 0.2 to 0.3°C over the last 40 years, though the warming is not uniform globally (Climate Ark, 2007). To make the situation worse, BBC, (2007) reported that global average temperature is predicted to rise by 1.4 to 5.8 degrees Celsius by 2100 and that, in tropical areas, some areas will receive more rainfall while others will receive less. For Zambia specifically, World Bank (2006) indicated that temperature is increasing at the rate of 0.6 degrees Celsius per decade, which is ten times higher than global or Southern Africa rate. Nevertheless, in terms of rainfall, there would be both regional increase and decrease over land areas in the low latitudes (IPCC, 2001). Although it is still uncertain which effects climate change will have in different localities, most models indicate that they will be stronger near the equator – and hence in Sub-Sahara Africa – than in most other major regions on earth. For example, since 1970s, intense and longer droughts have been observed especially in the tropics and subtropics (IPCC, 2007). It is also predicted that countries that depend heavily on the primary sector (such as agriculture), are likely to be more adversely hit than countries that have a more diversified economic base (Mitchell and Tanner, 2006). Africa is one of the continents that are most vulnerable to climate change and climate variability (IPCC (2007). Thus, agricultural production and food security is likely to be severely compromised by climate change thereby putting some regions of marginal agriculture out of production. It is thus, of paramount importance that measures are taken to mitigate the consequences of climate change by way of research, adaptation and domestic resources mobilization since most of agriculture is rain-fed. Climate is a primary factor for agriculture productivity such that any environmental change affects plant and animal production. Climate change has resulted in increased temperatures, which increase transpiration and evapotranspiration rate causing severe water stress as plants lose a lot of water and soil moisture is depleted (Aydinalp & Cresser, 2008). This study therefore, aimed at determining the effects of climate change on maize production in Chongwe district specifically Njamu, chansongo and Masungaire villages. The researcher chose maize because it is the staple food in the country.

## 2.1 THEORETICAL FRAMEWORK

This chapter presents a brief description of agriculture and climate change in Africa, climatic conditions of Zambia, and the effects of temperature and water stress on crop growth will be described. Also, examples of how maize efficiency is likely to be affected due to the predictable change in climate in diverse parts of the world are given. Lastly, the adaptation measures that can be implemented by the government and non-governmental sectors active in agriculture have also been presented.

## CHAPTER THREE

### RESEARCH METHODOLOGY

#### 3.0. RESEARCH DESIGN

The study used both quantitative and qualitative methods of study. The research design has been chosen in order to gain an insight into the factors that lead to the effect of climate change on maize production in Chongwe district. The research relied on the information collected from the library, internet and respondents who included farmers, Agriculture Extension officers.

#### 3.1. TARGET POPULATION

The target population included farmers and agriculture extension officers

#### 3.2. RESEARCH SAMPLE SIZE

The research sample included twenty-five (20) farmers from selected villages and two agriculture extension officers

#### 3.3. RESEARCH PROCEDURE

The sampling procedure used was convenience sampling and systematic sampling. Systematic sampling was used to select the twenty-five (20) farmers from each of the villages. While convenience sampling was used to select agriculture extension officers

#### 3.4. RESEARCH INSTRUMENTS

Structured questions were used as research instruments

#### 3.5. DATA COLLECTION PROCEDURES

The primary data for the study were obtained from households in the selected area. The data were collected using personal interviews with an aid of a semi-structured questionnaire.

Data collected on crops included; (i) Demographic data for the households; demographic data for household head, household size, social institutions and groups, (ii) Field data; types of crops, costs and amount of inputs, soil characteristics (slope, fertility, type), crop yields and cropping systems, utilization of crops produced and household food security, marketing of produce and market systems, storage facilities and post-harvest management, and income sources, extension service

Secondary data for crop yields of dry land crops produced in Chongwe district were obtained from the Ministry of Agriculture and Central Statistical Office and data for monthly and annual rainfall were obtained from the Meteorological Weather Station.

## 3.6. DATA ANALYSIS

The use of tables, charts, Microsoft word and excel and the statistical package of social science (SPSS) were applied

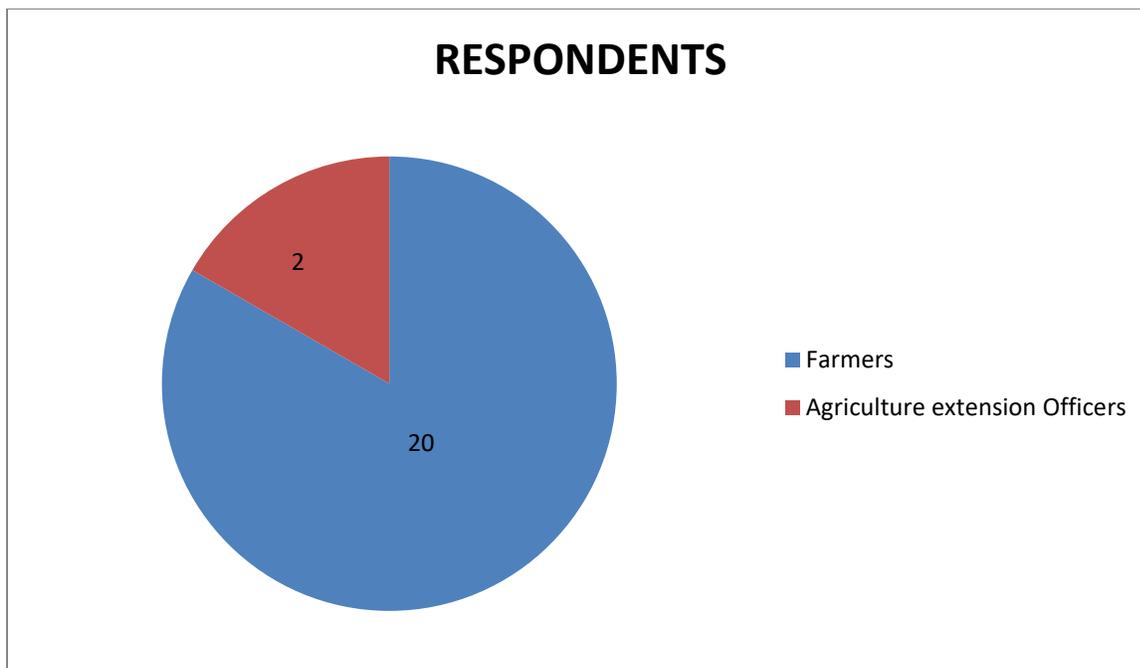
## CHAPTER FOUR

### 4.0 PRESENTATION OF FINDINGS

The chapter gives the findings of various respondents in the research conducted in Chongwe district in selected villages Njamu, Masungaire and Chansongo. The respondent in the research included farmers, agriculture extension officers and agriculture science teachers.

#### NUMBER OF RESPONDENTS BY GENDER

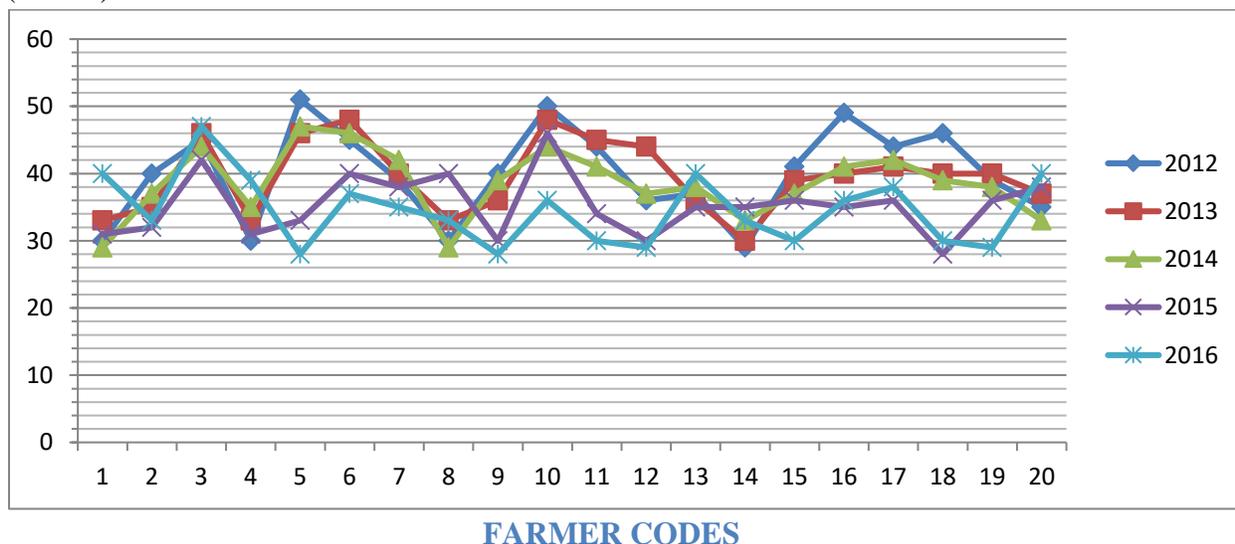
	MALE	FEMALE	TOTAL
FARMERS	10	10	20
Agriculture extension officer	2	-	2
<b>Total</b>	12	10	22



## LIST OF FARMERS AND THE YIELD PER HACTARE (BAGS) HARVESTED IN 2014 AND 2015 SEASON

Farmer codes	2012	2013	2014	2015	2016
1	30	33	29	31	22
2	40	35	37	32	33
3	45	46	44	42	47
4	30	33	35	31	39
5	51	46	47	33	28
6	45	48	46	40	37
7	39	40	42	38	35
8	30	33	29	40	33
9	40	36	39	30	28
10	50	48	44	46	36
11	44	45	41	34	30
12	36	30	37	30	29
13	37	36	38	35	40
14	29	30	33	35	33
15	41	39	37	36	30
16	49	40	41	35	36
17	44	41	42	36	38
18	46	40	39	28	30
19	39	40	38	36	29
20	35	37	33	38	40

**The graph showing the changes in maize yields for the years 2012 to 2016 above YIELDS (BAGS)**



## CHAPTER FIVE

### 5.0. DISCUSSION OF FINDINGS

This chapter discusses the findings of the research study using the identified themes from the research objectives.

This research studied the challenges farmers face in the production of maize'. The following the questions helped the researcher explore the topic area under study.

1. What effects does climate change have on crop production?
2. What measures should be applied to mitigate the adverse effect climate change.

### 5.1 CHALLENGES FACED BY FARMERS IN THE PRODUCTION OF MAIZE

The research findings showed that a lot of farmers have challenges in the production of maize separately from the effect of climate change. The research revealed that most farmers in the district have got enough land for practicing crop rotation. Consequently they are practicing monocropping which has lead to exhaustion of soils leading to reduced yield. The farmers spoken to said that they only grow maize because the government marketing agency (FRA) was biased towards maize purchase only. Furthermore, those farmers who had sufficient land had in short supply of seed to practice crop rotation. Additionally farmer's academic background was another challenge and this lead to most of them using conventional methods of farming which depletes the soil. Inadequate knowledge of modern technique of crop production and lack of farm implements was another challenge. The other challenge was lack of access to suitable seed varieties to plant depending on weather conditions experienced in the area and very few farmers are growing drought tolerant crops such as cassava and cotton apart from the main crop; which is maize. Secondly, most areas had meager agriculture extension advisory services due to big catchment area for Extension officers in some areas and also late delivery of agriculture inputs under farmer input supply programme was another challenge. It was either some farmer planted early or late. Last of all, most respondents had insufficient awareness about climate change due to deprived access to bulletins from meteorological station on climatic information.

## 5.2. CONCLUSION

This paper summarizes the use of climate scenario, climate change impacts on water availability, crop yield, crop water productivity and food security. An effort was made to estimate the impact of temperature and rainfall on maize production. However, since it was not viable to isolate the impact of these variables from the impact of other variables, the results did not show with any implication that either temperature or rainfall has effect on maize production. Additionally, it is not easy to measure the effects of climate change due to difficulties in quantifying other factors that may also have large impact on maize production. Thus, it was therefore, not possible to conclude whether or to what extent climate change has effects on maize production.

Climate change impacts on crop yield are often incorporated with its effects on water productivity and soil water balance. Crop yield is constrained to crop varieties, planting areas, soil degradation, growing climate and water availability during the crop growth phase.

## 5.3 RECOMMENDATION

- 1) Training of members of staff under Ministry of Agriculture at all levels is needed in the area of climate change so that they have a wider knowledge on the issue and are aware of the expected effects. With that in mind, staffs will be able to carry out their duties responsively and in turn be able to educate the public.
- 2) Information centre should be established (if not existing currently) so as to disseminate timely information (in connection with the meteorological department) to members of staff and the farmers on the expected effects of climate change
- 3) Much research should be done in the area of climate change which will open the intellect of people (and the government) of what is anticipated in the country and later on help them plan on how to handle the expected harms.
- 4) Extension must be executed in dialog with farmers and not just imposing information to farmers.
- 5) Sufficient funds ought to be allocated from the government to the metrological department to buy good equipment so that the department is able to produce dependable information to be used by Ministry of Agriculture.
- 6) The non-governmental organization dealing in Agriculture should also be involved on issues of climate change and promotion of other crops apart from maize.
- 7) We need more players in the marketing of farm produce
- 8) The government marketing agent (FRA) should also be purchasing other crops apart from maize to reduce farmers practicing continuous monocropping.

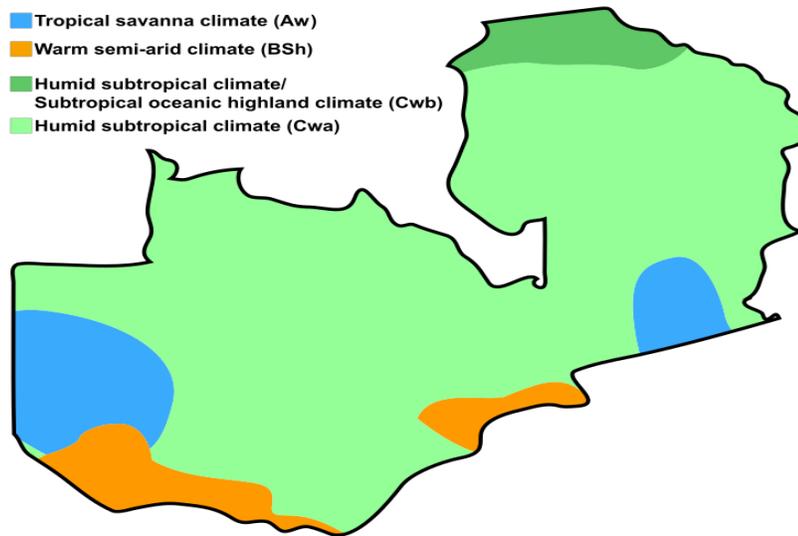
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## APPENDIX: TABLES AND FIGURES

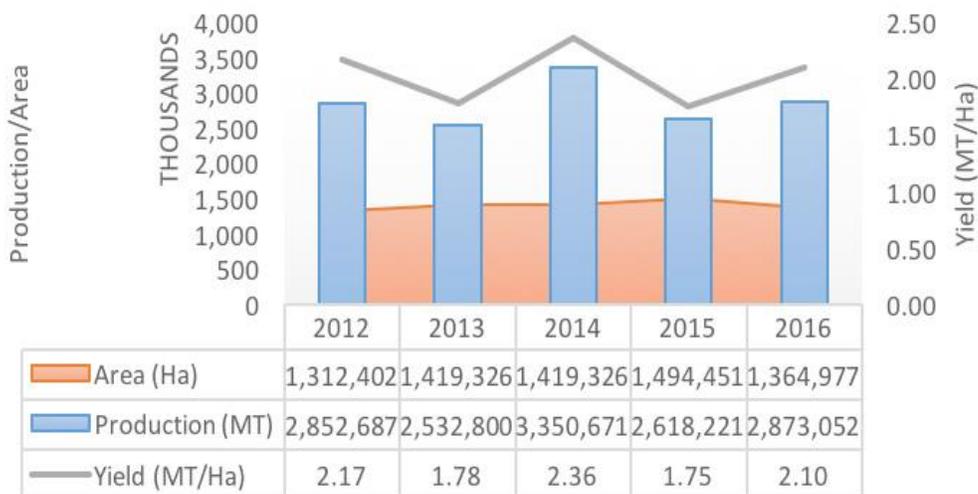
### THE FIGURE SHOWING MAP OF ZAMBIA ON CLIMATE CLASSIFICATION

Zambia map of Köppen climate classification



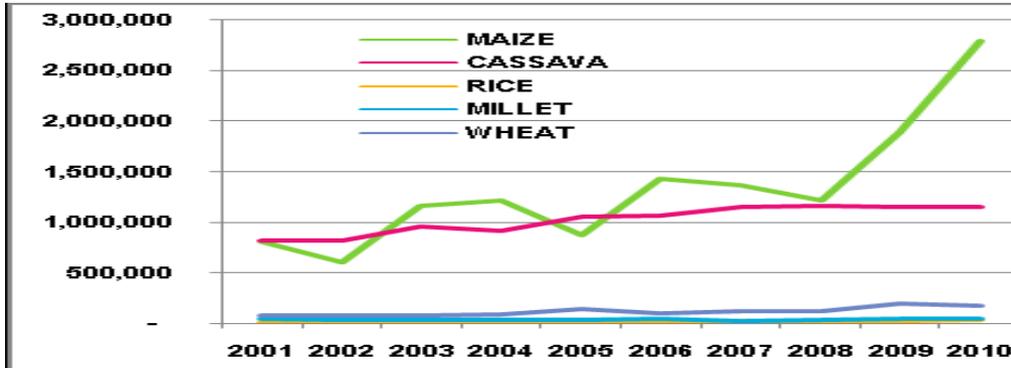
Source: MACO [2010]

### FIGURE BELOW SHOWING MAIZE PRODUCTION IN ZAMBIA FROM 2012 TO 2016



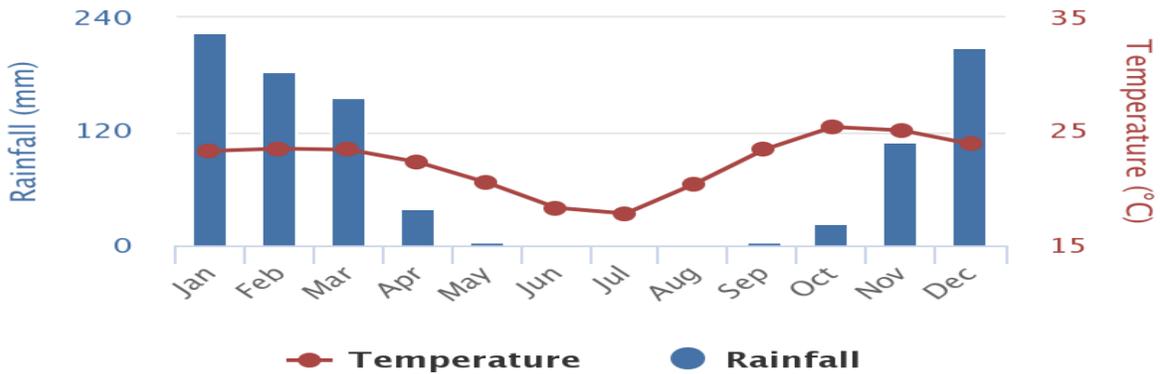
Source: MACO Crop Forecast Survey Data (2012-2016)

THE DIAGRAM BELOW SHOWING THE CROP YIELDS IN ZAMBIA FROM 2001 TO 2010



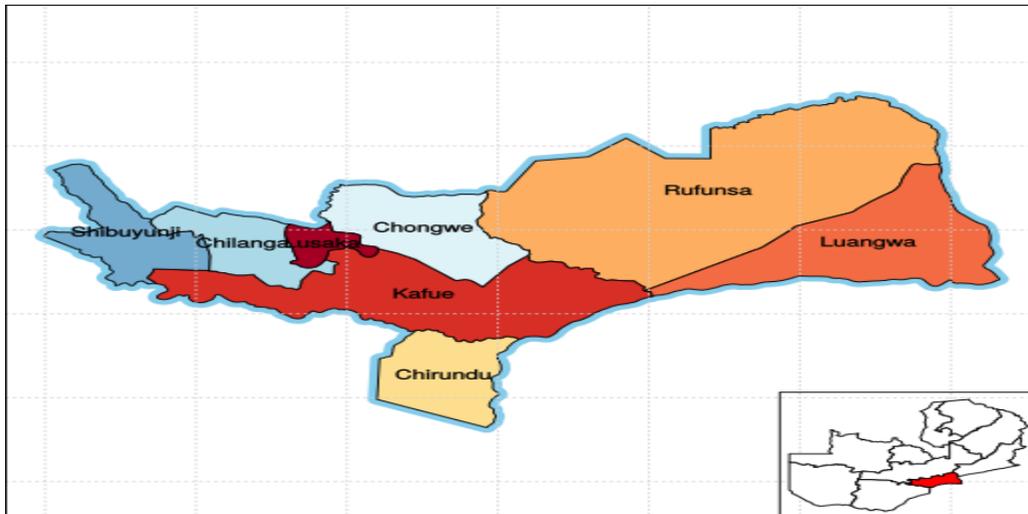
Source: MACO [2010]

Average Monthly Temperature and Rainfall for Zambia from 1991-2015



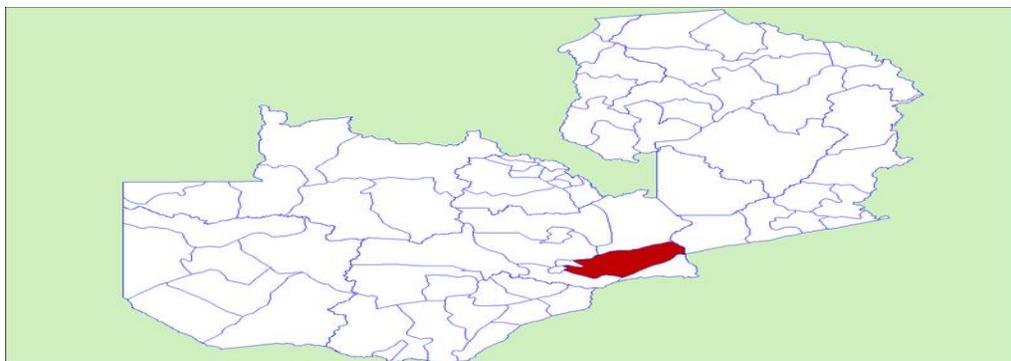
Source: World Bank group (2018)

## MAP SHOWING LUSAKA PROVINCE DISTRICTS



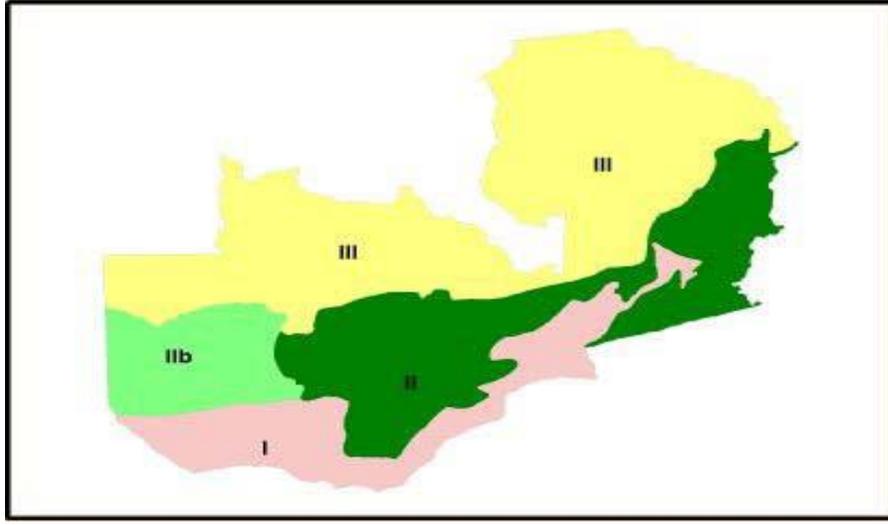
[https://en.wikipedia.org/wiki/Lusaka\\_Province](https://en.wikipedia.org/wiki/Lusaka_Province)

## MAP OF ZAMBIA SHOWING CHONGWE DISTRICT



[https://en.wikipedia.org/wiki/Lusaka\\_Province](https://en.wikipedia.org/wiki/Lusaka_Province)

MAP BELOW SHOWING THE AGRO-ECOLOGICAL REGIONS IN ZAMBIA



Source: MACO [2010]

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## **QUESTIONNAIRE FOR THE AGRICULTURE OFFICERS**

Name of interviewee.....

Province.....

WARD.....

Date: .....

### **Climate change**

1. What problems do you experience in relation to climate in this district?

.....  
.....

3. What is climate change?

.....

8. Do you think you are experiencing climate change in this district? Yes/no .Any observations.....

9. What major effects are you experiencing with climate change in your district?

.....

10. What advice are you giving to farmers regarding climate change?

.....

### **Crop production**

2. What major crops do farmers grow here?

.....

3. How has been the yield in the past five years?

.....

If poor, any causes.....

4. What challenges do farmers face in growing the crops?

.....

5. How have the challenges been addressed?

.....

### **Extension services**

6. How effective is the extension advisory services?

.....

7. What challenges do you face as agriculture officers in information dissemination?

.....

8. How is the marketing system of crops in your area?

.....

### **Challenges**

What challenges do you experience as an extension worker?

.....

---

## **QUESTIONNAIRE FOR THE FARMERS**

Name of interviewee.....

Province.....

WARD.....

Date: .....

Number of years the homestead has been in the village.....

### **HOUSEHOLD DETAILS**

How many are you at home n terms of gender?

.....

### **SOCIAL NETWORK**

Do you have any government support for farm inputs? ..... 2.Do  
you have any NGO's support on crop production?

.....

### **CROP PRODUCTION EQUIPMENT**

What farm implements do you have.....

What farming methods do you use.....

.How have the crop yields been for the past five years

.....

What is the explanation to your results achieved?

.....

### **CLIMATE CHANGE**

What do you know about climate change.....?

If yes, we gave you the information.....

Do you think climate change is bad or good .....

What effects does climate change have on crop production

.....

What are the major crops do you grow here?

.....

.....

What measures should be done to mitigate climate change?

.....

### **CROP PRODUCTION**

What crops do you grow?

.....

.Do you practice crop rotations YES/NO.

.If yes, what are the benefits

.....  
.....  
How have your maize yields been for the past five years  
.....

How has been the income from your harvests?  
.....

What challenges do you face in growing the crops?  
.....

## **AGRICULTURE EXTENSION SERVICES/FARMER GROUPS**

Do you have extension services.....

Which institutions offers extension services in this area.....

Do you have farmer groups in the villages? Yes/no. If no, how do you share information?  
.....

## **SOIL EROSION AND CONTROL MEASURE**

i) Are there any signs of soil erosion on your cropping land? Please tick. ( ) Yes ( ) No

ii) If yes,, what extent were the signs and extent of soil erosion.....  
.....?

iii) What are the soil conservation measures do you apply  
.....

iv) What costs are associated with applying these soil conservation measures techniques?  
.....

## **GRAIN STORAGE**

How do you store your produce?  
.....  
.....

What challenges do you experience in storage of crops?  
.....