Investigating the Impact of climate change on the hunger crisis in Rwanda.

Case Study: Bugesera district

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Abstract- Climate change or climate variability is one of the big challenges facing the world development. If this climate variability increases, it is negatively affecting people's livelihood in Rwanda. This paper revaluates the impacts of climate variability analysing in Bugesera district and propose solution to hunger crisis and migration of the local population of Bugesera district. The first data have been collected in Meteo Rwanda for analysing air temperature, Rainfall in Bugesera district then this paper will conduct to analyse on the three kind of crop production like Maize and Rice and Beans production this will be analysed referring on the longest period of past years. The last data is to analyse how the local population survive referring on meal par\day, this will be achieved using interview in Bugerara district. In addition, a household survey of 400 households was conducted in 3Sectors (Mayange, Nyamata, Gashora.) to examine socio-economic characteristics that influence the choice of actual adaptation measures. To analyze the impacts of climate variability of the crop production, regression model was used after obtaining lagged values of model variables. The results from the analysis of time series data show that area harvested and annual rainfall are positively and significantly related to the yields of selected crops while maximum air temperature had a negative effect of the beans, maize and rice. Climatic variable like minimum air temperature founds to have the effect on maize, and beans production. Micro-level findings substantiate that farming experience and access to information on climate variability have a positive and significant influence on farmers‟ perceptions of climate variability at one percent level of denotation. Other variables such as education, farm size and livestock ownership are positively and significantly related to the choice of adaptation measures. Further interception should focus on how the knowledge of farmers about climate variability can be increased and the established adjustment measures by government can be owned and maintained by farmers through their different mechanisms such as farmer cooperatives and other social capital mechanisms.

Index Terms- Migration, Rainfall, air temperature, Farmer.

I. INTRODUCTION

Since 28 years ago, Bugesera district has been characterized by deteriorating trend with an exceptional variability long sunny season and rainfall constancy and strength which resulted into serious floods in 1997-1998 and a prolonged dry season in 1999-2000. This study is oriented to reveal the negative impacts of climate variability or climate change on different crop production like maize, Beans and rice productivity in Bugesera District. Rainfall and temperature patterns have been evaluated using the closest meteorological station (**Kanombe Airport**) that represents the study area[1, 2]. Referring to the results, the climb in air temperature and changes in the amount of rain Season and its distribution have altered the availability of water resources, consequently affecting the productivity of maize, Beans and Rice. This climate variability in the onset of the rainy season has led to variation in the start of the planting season which has negatively impacts to the crops production.And this problem was caused a big number of populations to migrate to other different districts or in some border's countries like Burundi, Uganda, Congo and Tanzania. Assessment of people's perceptions progress of change on rainfall and air temperature patterns, and their adaptation systems has been made. The respondents have accepted that there is a change happening in their area and have already started to feel its impacts. Flooding in lower zones of altitude along river **Akanyaru** have been reported for many times in the study area as causing the floods of maize and Beans fields there by desecrating the growth and diminishing the productivity of maize, Beans and rice[3]. In adaptation to climatic variability effects, farmers have started to take on some adaptation measures[4].Periodic drought incidence over the past decade, between 1998 and 2000, and annually from 2002 to 2005, has caused a serious deterioration in food security. A long period of dry season has caused crops failures and severe food deficits, threatening the most vulnerable farmers with malnutrition and famine. Bugesera district has trained with severe longest dry season in 1999 and 2000 and in 2007[5, 6]. The livings of people in Bugesera are relying on agriculture. So long dry spells have great impacts on their source of income and wellbeing. The climate variability or climate

change is now a well-accepted reality and there is emerging evidence that climate variability poses a threat for development in Rwanda**.** comprehension of the appearing trends of climate variability and its impacts in Rwanda is a main for starting point in addressing the negative impacts of climate change[6, 7]. Prediction of future climate variability for Rwanda indicate a trend towards a warmer, wetter climate. Increases in mean air temperatures have projected under all models and all emissions scenarios, while the majority of models also demonstrate increases in annual rainfall totals, though a few show small reductions, this problem is highly deteriorating Bugesera district[7, 8]. Downfall totals for the two rainy seasons are projected to increase, though as with annual changes, the increases in rainfall are generally small relative to the inter-annual variability currently experienced in Rwanda. This paper is presenting the problem of local population of Bugesera district, this is caused by a longest dry season which affect agriculture and how people can be adapt on this climate variability in this district[8, 9]. This will present the results through the graphs referring on analyzing the productivity of maize, beans and rice [10]. This will display also the results referring on Air temperature and Rainfall in Bugesera district[8]. After this, it will present with the recommendation thinking how the local population can adapt on this climate variation in Bugesera district.

Country Rwanda is forming with five provinces: Kigali City, Eastern, Northern, Western and Southern province. This study focused on the Eastern province, which is located at 1E45' 00" S latitude and 30E30' 00" E longitude. It is the largest, most populous and the least densely populated of the five provinces of Rwanda[9]. The lowly inclined hills and the dry valleys characterized the province, a long dry period (June to October), hot air temperature and little rainfall. The monthly distribution of the rainfall varies from one year to another. The annual rainfall is about (**827 mm/year**). In this study, one district of the Eastern province where case study was taken is Bugesera district. It's comprises areas south of Kigali, which were formerly in the **Kigali Ngali** province, around the town of Nyamata. The area is prone to dry season, and has been designated as the location for a possible new international airport to serve Kigali, 40 km away, and the rest of the nation. The area has a higher average daytime air temperature than the Rwandan average, and lower precipitation in atmosphere, which sometimes lead to droughts.

This map shows a part of Eastern province where Bugesera district located (Selected area)

Problem statements

- In Rwanda we have dry Season and rain season, where we have a long dry season in which affects eastern province of Rwanda especially Bugesera district.
- Soil desiccation
- Irregular or Inadequate germination of seeds or grain.

- The deterioration of aquatic ecosystems (**Rivers, Lakes)** in which lead to sediments.
- All these factors contribute to serve droughts which is worth known to cause **food insecurity,** Poverty, Children drop out, malnutrition, Diseases and Migrations of local population to other area near f our Country.

Research Objectives

Main Objective

- Analyzing Climate variability in Bugesera district and propose solution to hunger crisis and Migration of the local population.

Specific Objectives

- Analyze the variability of climate indicators (Air temperature and rainfall) in Bugesera District from 2000 to 2020.
- Analyze impact of Climate indicators changes on maize and rice from 2000 to 2020 (deal with agriculture production).

II. Research Methodology

Gathering person data from Government Institutions:

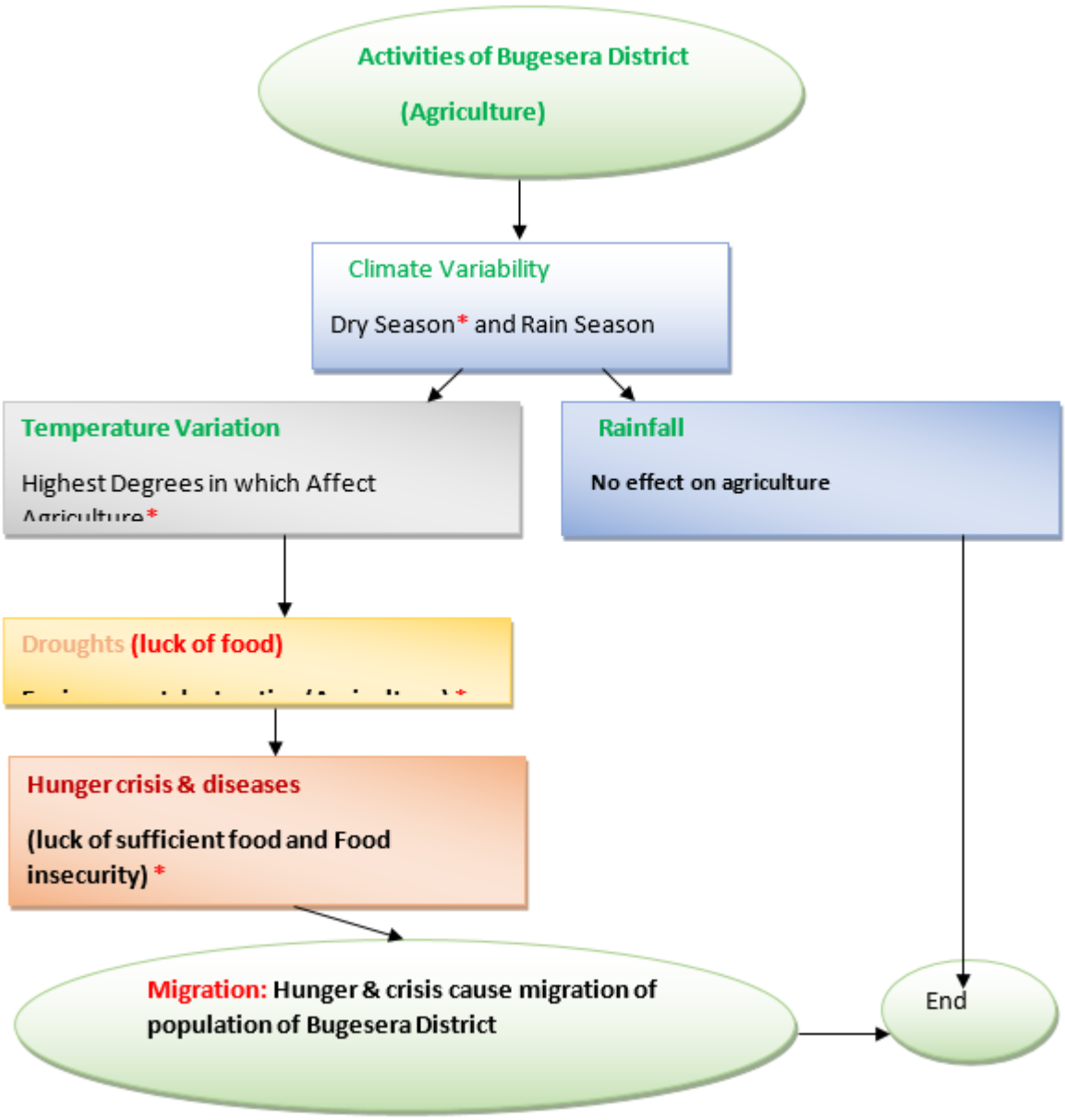
Secondary data

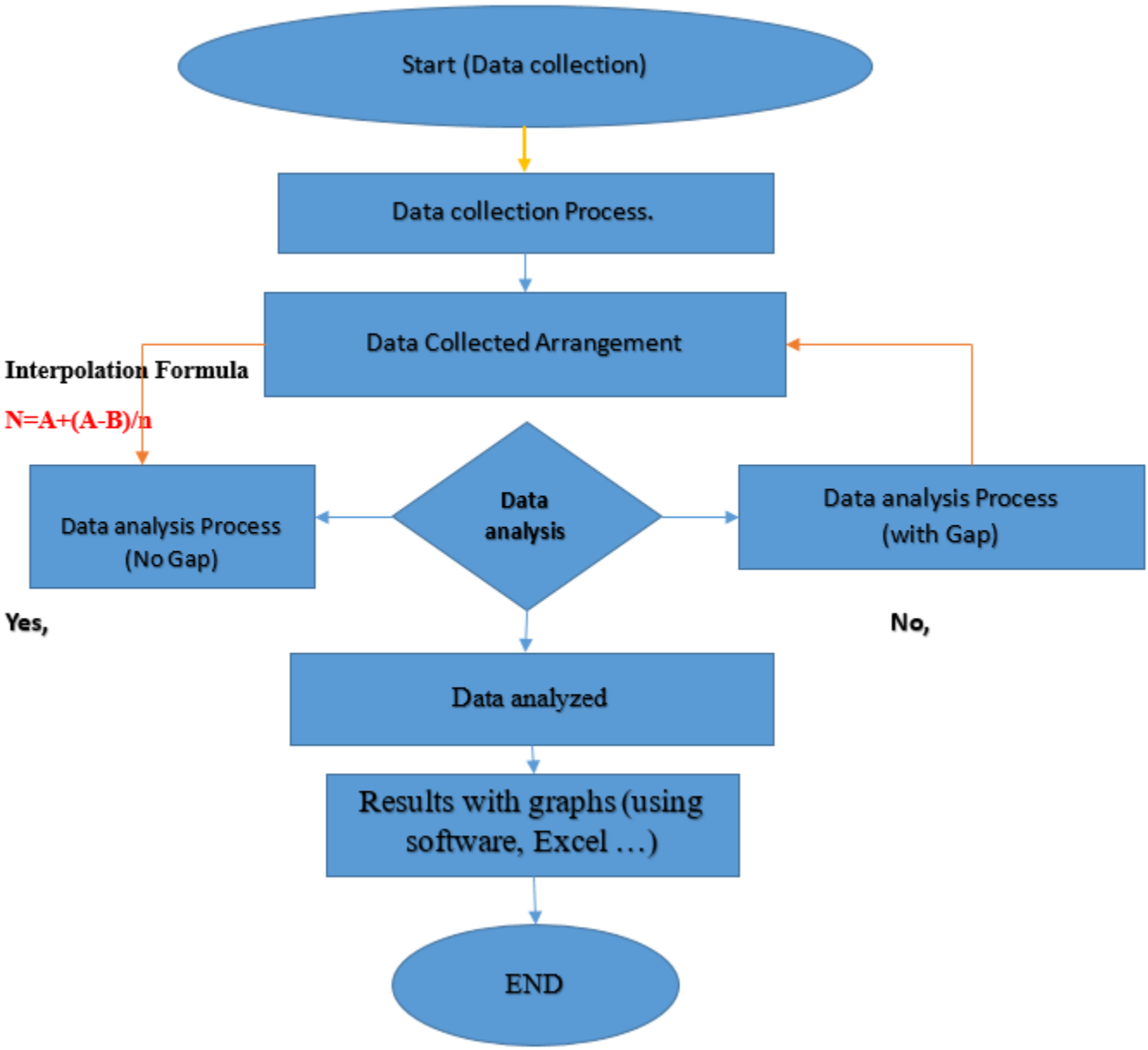
- ❑ Analyze the variability of climate indicators (Air temperature and rainfall) in Bugesera district.
  - Source of data will be in "METEO Rwanda".
- ❑ Analyze impact of climate indicators changes on maize and rice.
  - Source of data will be in National Institute of Statistics of Rwanda (NISR) and Bugesera district Office.

Primary data

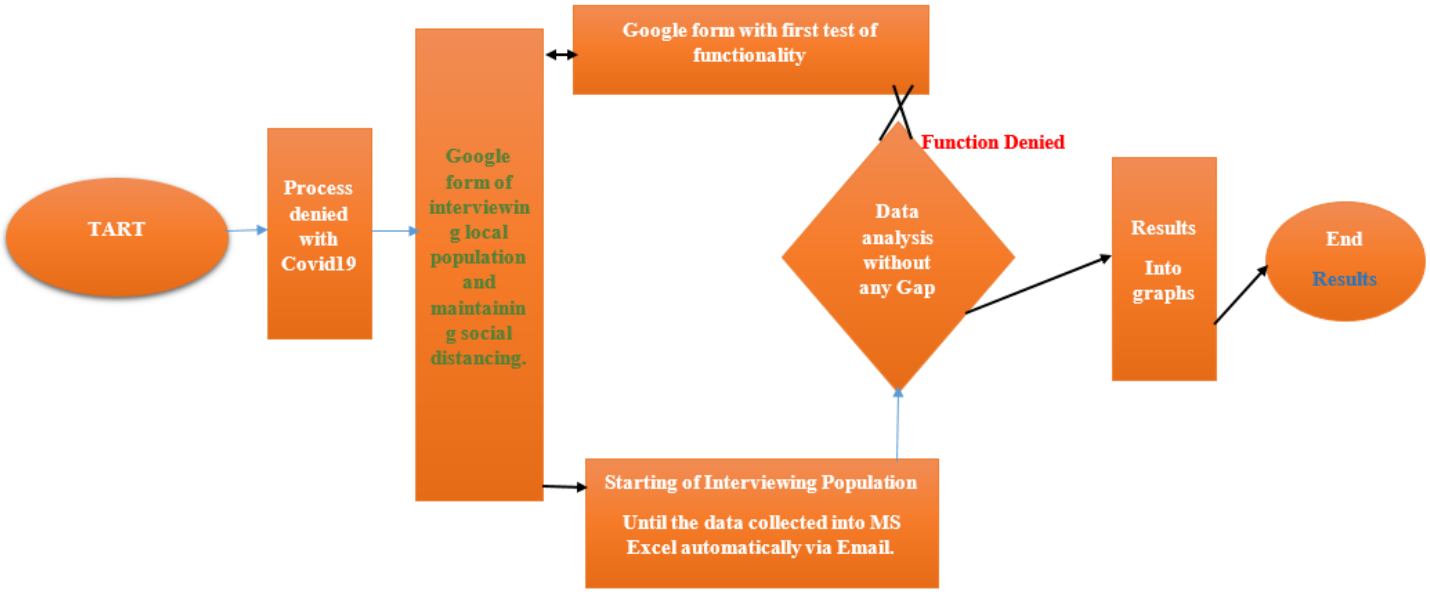
- ❑ Investigating the situation on food security of Migrants from Bugesera District (Meal par day).
  - Source of Data we will Use of questionnaires for interviewing a sample of population in Bugesera district.
- ❑ During Surveying we have to use questioners in which can show as how the people survive per day, the calculation will refer to the sample Size of the Total population in Bugesera district in year 2020 which is 300000 habitats on 1,334km ^{2}. The population/ households by applying cooper and Schindler's formula.
- ❑ **n**=N/1+N(e)2
  - Explanation of each letter appeared in this formula and their meaning, **n**= Sample Size
  - **N**=Population Size, For 95% level of confidence, **n**=N/1+N(e)2
  - **e**=level of precision or Margin on error +(-) 5%, With N=300000.
  - **Sample size n= 399.5 n~400**

Description of the design to the issues which shows clearly arguments which display step by step the real roadmap this Research project (data Flow diagram)





This diagram shows the whole process of data collection of secondary data, in which characterize by two indicators which are crop productions (Maize, rice and beans), others is about temperature and Rainfall. In the process of data collection, it was started with thinking about how data will be collected. After data collection, we had a period of checking the gaps in which are in a period of data collection and we have found some period where data haven't been collected. We tried to see how we can complete the possible period of data collection using Interpolation formula (**N=A+(A-B)/n)**, after completing some gaps we have continued with data analysis using MS Excel before using Origin software. I have tried to found the results in which is very important to interpret it.

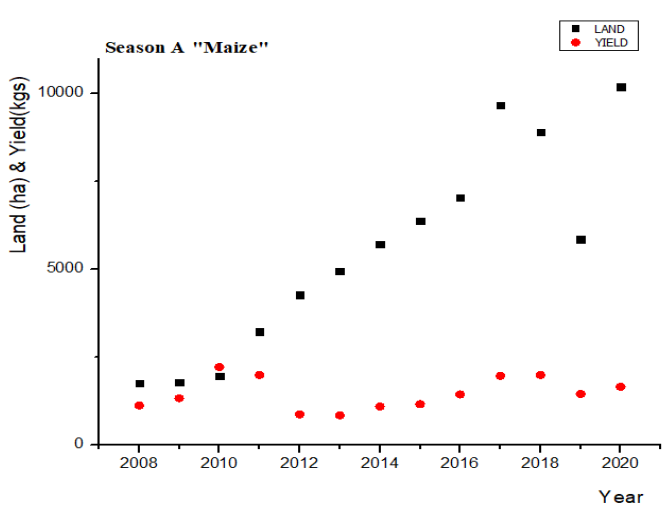


This diagram shows the whole process of data collection of primary data, in which characterize by two indicators which is to know how population survive refining of **Meal/day**. In the process of data collection, we constructed Google form for maintaining Social distance because of Covid19. After google form constructed. We have started interviewing, in that period all data have collected in MS Excel Automatically via my email account and then After dealing with data collection. I have tried to found the results in which is very important to interpret it.

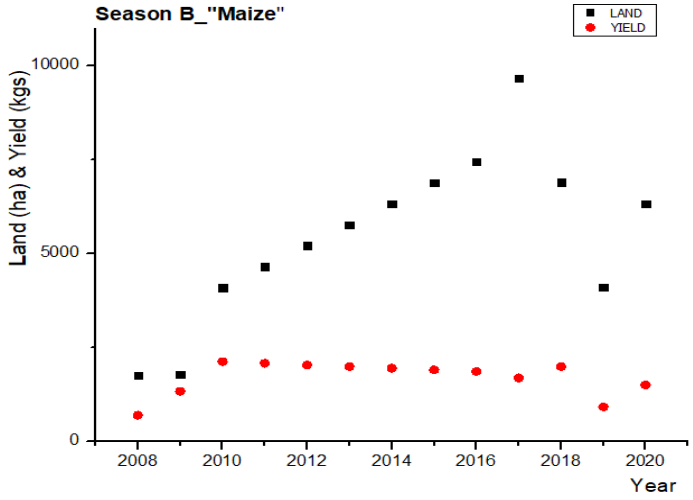
This paper project, was implemented referring on data collected in three sectors from Bugesera district in Rwanda. With the period of that given by Tongji University, School of Environmental Science and Engineering, I have decided to collect two kind of data which are the following: primary data and secondary data. From now I have finished to collect data and I am still in process of data analysis which is now on 68% before implementing the project.

I had some obstacles in data collection because of the issue of COVID19, it was a problem in collecting data during interview to local population. To deal with this problem I have decided to construct an online form for helping me to maintain social distancing during the process of data collection. This form will be displayed in the next slides of this presentation.

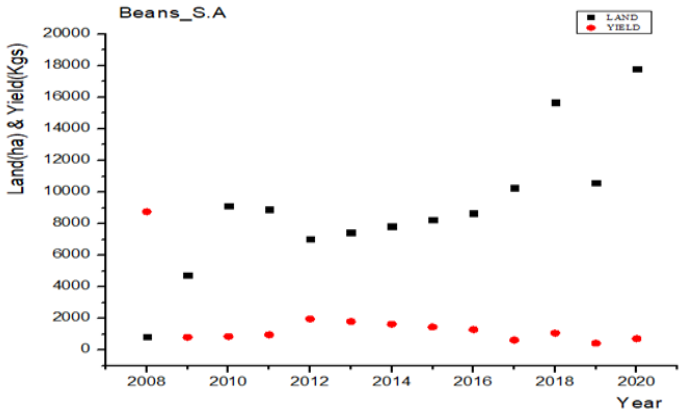
Before displaying the results of secondary data the objective was to know the level of air temperature, the situation of agriculture in Bugesera district referring on the **Land** and **Yield** between, Maize, Beans and Rice productivity and air temperature and rainfall for twenty years past in that area. Data have been collected but in the period given we had some obstacles of the gaps in the period of productivities but some gaps have been removed by Interpolation formula which is "**N=A+(A-B)/n**" These have measured with different instruments like Thermometer (Air temperature) and Rain gauge(Rain)



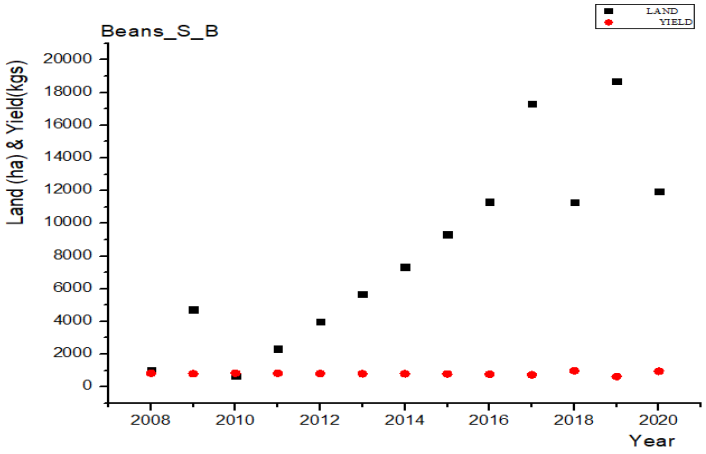
Bugesera District(Maize Production in Season A)



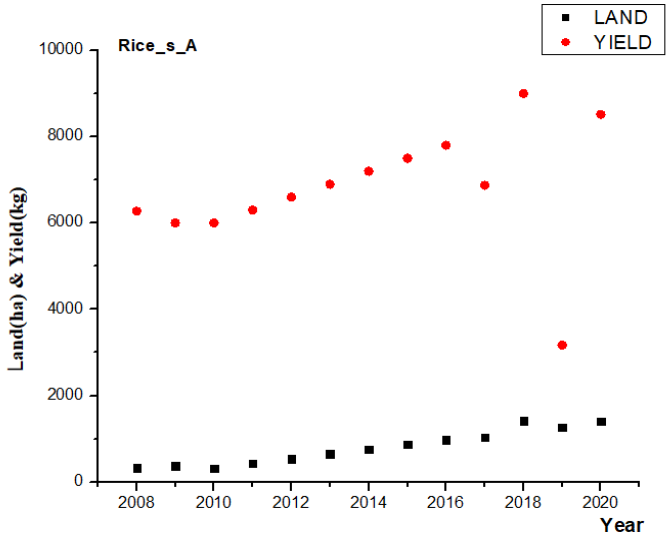
Bugesera District(Maize Production in Season B)



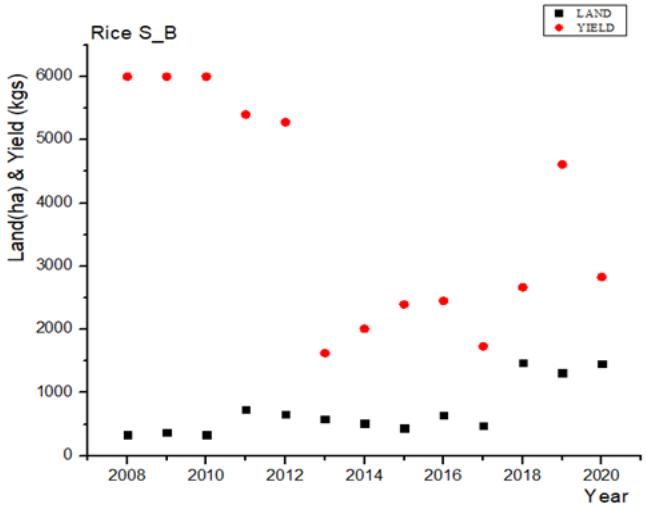
Bugesera District(Beans Production in Season A)



Bugesera District(Beans Production in Season B)

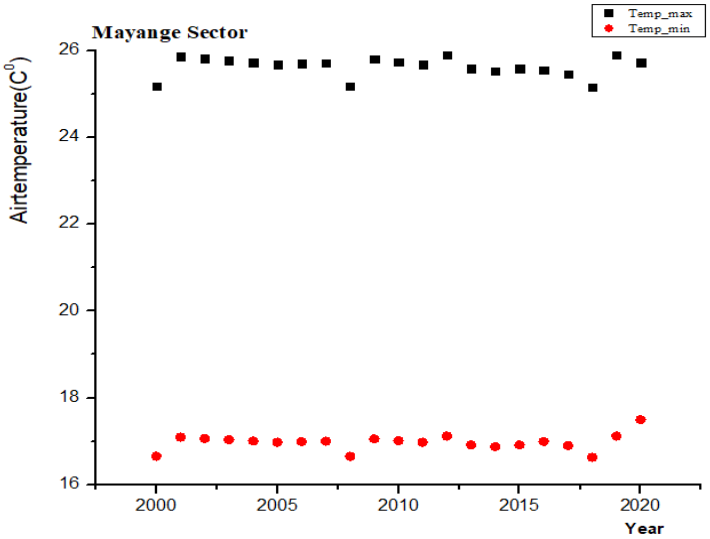


Bugesera District(Rice Production in Season A)

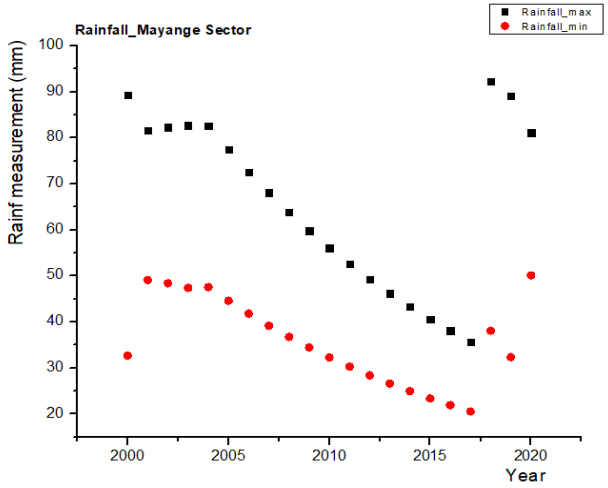


Bugesera District(Rice Production in Season B)

C

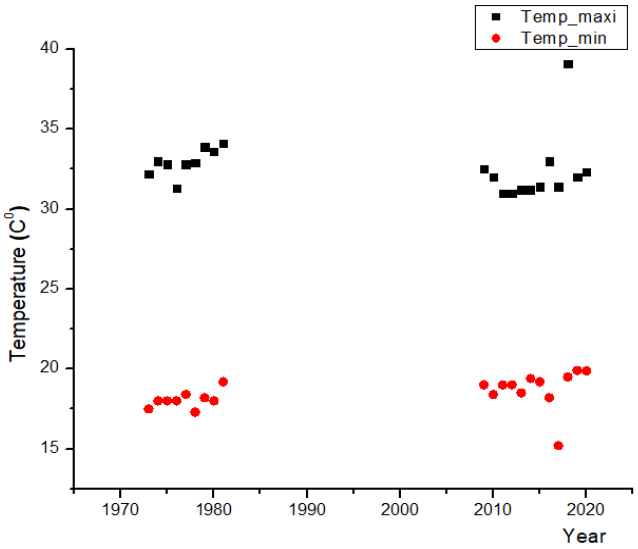


Mayange Sector *(Air temperature)*

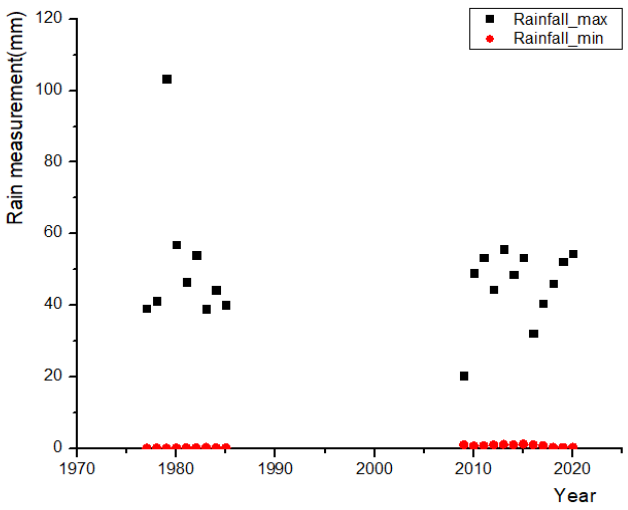


Mayange Sector *(Rainfall)*

D

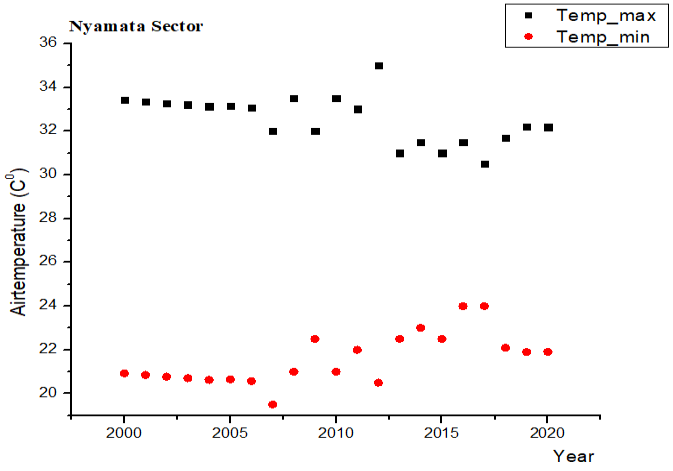


Gashora Sector (Air temperature)

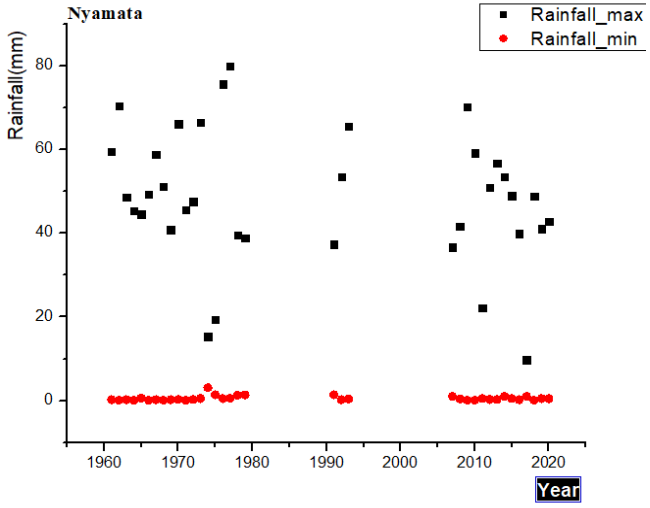


Gashora Sector(Rainfall)

E



Nyamata Sector (Air temperature)



Nyamata (Rainfall)

F

A: The graphics **A** here it shows the maize productivity in Bugesera district from 2008 to 2020, where the results referred to the Land and Yield. Because of the long period of dry season, we have the biggest Land but maize production was Low**.**

B: The graphics **B** here it shows the Beans productivity in Bugesera district from 2000 to 2020, where the results referred to the Land and Yield. Because of the long period of dry season, we have the biggest Land but Beans production was Low and this is the big effect of climate change in Rwanda especially to the population of Bugesera district**.**

C: The graphics **C** here it shows the Rice productivity in Bugesera district from 2008 to 2020, where the results referred to the Land and Yield. Even if there is a long period of dry season, we have the big productivity of Rice on the small Land this cannot cause the negative effect on life of the population in Bugesera district**.** The Good thig which cause the good productivity people cultivate in Marchland where the land is natural fertilized.

D: Graphic **D**, it shows the airtemperature and Rainfall variability where we have a maximum temperature of 26 celecius degree in **Mayange** sector with the and maximum Rainfall of 90mm but step by step the period of rainfall shows that the rainy has decreased from 2005 to 2018. This shows the high temperature in this area which can destroy the season of agriculture to the population in this Sector and this cause Migration of local population in this Sector.

E: Graphic **D**, it shows the temperature and Rainfall variability where we have a maximum temperature of 33 celecius degree in **Gashora** sector with maximum Rainfall of 107mm but step by step the period of rainfall shows that the rainy has decreased from 1970 to 2020. This shows the high temperature in this area which can destroy the season of agriculture to the population in this Sector and this cause Migration of local population in this Sector.

F: The graphics F shows the high air temperature of 35 celecius degrees with 82 mm of rainfall, this shows climate variability in Bugesera District especially in Nyamata Sector.

A1: The diagram A1 shows the percentage of Gender referring to N as a sample size planned during the proposal presentation of this project.

B1: The histogram B1 shows the Age group where we have interviewed the following categories: **18-29= 66(16.4%); 30-49=199(49.4%); >50=138(34.2%)**

C1: The histogram C1 shows the Education Level where we have interviewed the following categories: Primary=**294(73%)**; Secondary=**95(23.6%);** University=**13(3.2%)**; Other Specific university=**1(0.2%).**

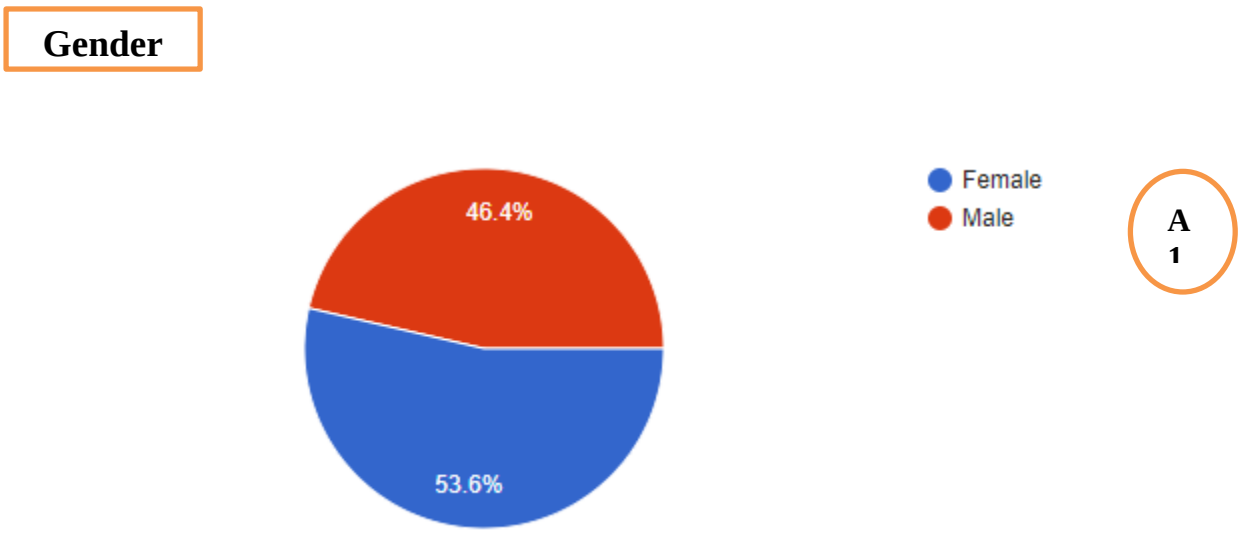
D1: Diagrams D1 shows if really the local population of Bugesera district have faced problem of Climate variability in their area a 100% on the diagram all people interviewed have faced climate variability.

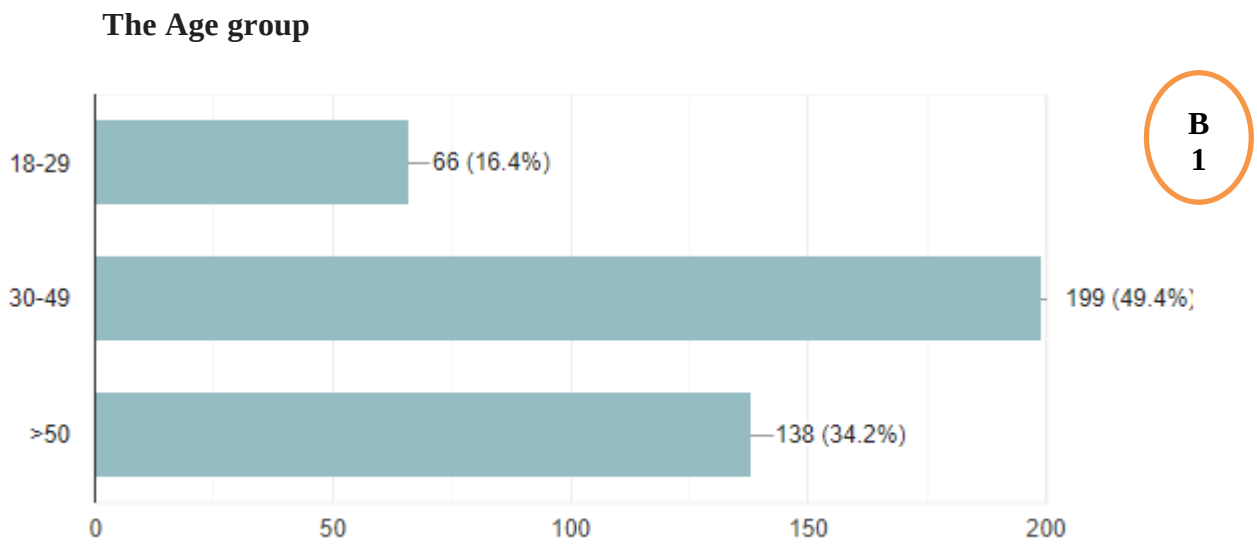
E1: The diagram E1 shows the results the dry season period of time takes in a year where the season are separated with different color displayed to the next pages.

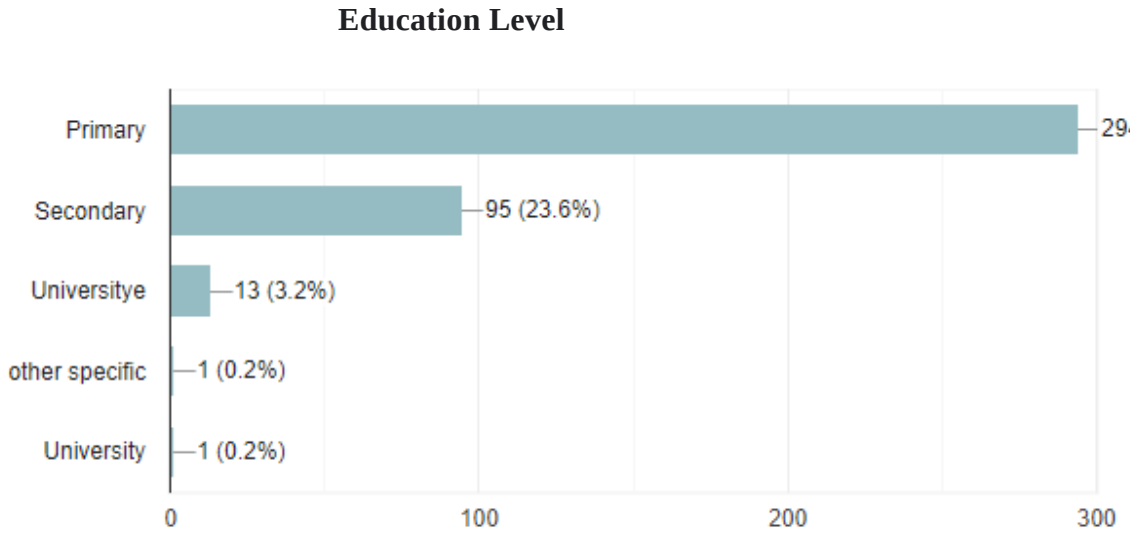
F1: The diagram F1 the crops have been cultivating from year 2000 up to 2020 in this area. This shows different crops production for seeing the kind of crops they cultivate (Maize and Beans one part is 55.6% and the second is 14.1%) and what the dry season destroy which are the important production in Bugesera district. If the dry season destroy this kind of crops people migrate to see how they can survive to other districts of Rwanda.

G1: The histogram here shows the percentage of incomes referring to their category of life these categories are Low level 281(69.7%); Medium level 120(29.8%), High level 3(0.7%). These categories of incomes present negatively the effect of Climate variability referring to the incomes comparing to the level of life of local population of Bugesera district.

Before displaying results of primary data, the first thing is that I have created google form which was for helping me to give interview to the local population from Bugesera district but the necessary important of this for was to avoid social distancing in the period of pandemic of Covid_19. The Objective of this Interview was to know living life style of these population and my Sample Size N was ≥400.The results show the relationship between the result from the secondary data and primary data, which is negative effect caused by climate change in that region of Bugesera where they have a bad long dry season which has effect on population agriculture of Bugesera district.

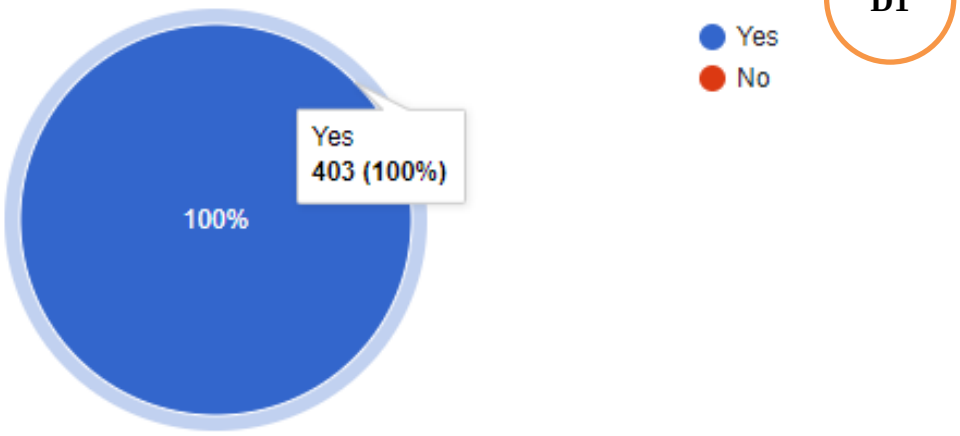






C 1

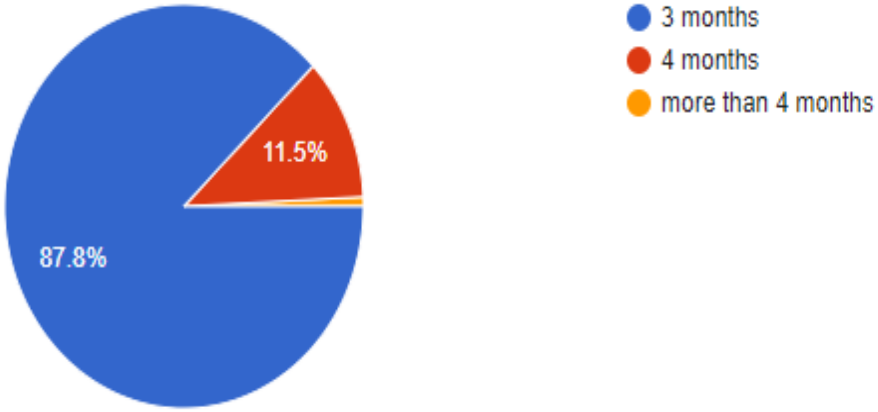
This shows that if there is a climate variability



D1

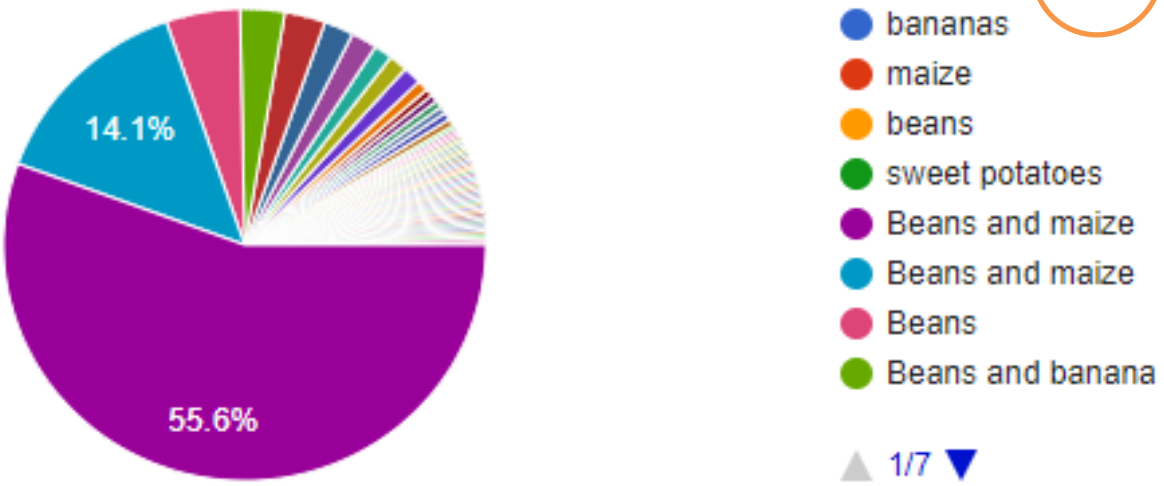
The dry season period of time takes in a year

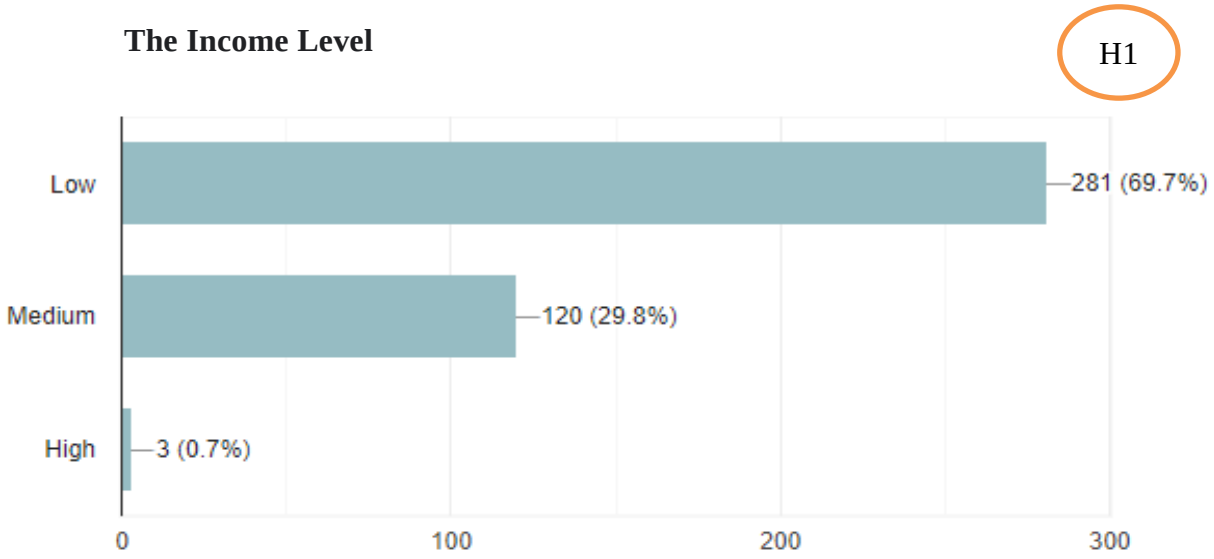
E1



The crops have you been cultivating from year 2000 up to 2020 in this area

F1





III. Conclusion and Suggestion

This paper project has been planned to work on negative effect of climate change in Rwanda but especially in Bugesera district. Different diagrams, graphics and histograms show the situation of Bugesera district where we have seen that Hunger crisis which cause migration of local population in that area this has caused by the longest dry season and highest air temperature which affect the agriculture production in Bugesera district especially in 3Sectors. To prove this problem, we have collected data in the regarding institution like Meteo Rwanda for air temperature and Rainfall, agriculture productivity and Interviewing local population in Bugesera district. After discovering the problem in that area we have suggest that Rwandan Government has to invest in this district to see how they can solve this problem. As a researcher my suggestion first is to plan a project which can go above 5 years, where government try to make a big project of agriculture in different areas of Bugesera district, just to create a big project where they can practice a special irrigation and planting trees this will help in this climate change here in Rwanda. Successful to this project government has to plan with ask some partnership with NGOs which can help in financial situation during Implementation of this project.

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