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Impact of Climate Change on Cassava Farming a Case study of Wabinyonyi Sub county Nakasongola District

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Abstract

Cassava is a potential crop to improve the livelihood of people but findings from this research through conducting interviews from respondents show that 97.8% responded that climate change contributed to the decline in yield. There is increased incidences of pest and diseases that cause rotting of the tubers that are the economic part used by the people. The study recommends that the Government of Uganda should strengthen climate change issues through line ministries such as Ministry of Agriculture, Animal Industries and Fisheries, Ministry of Lands, Housing and Urban development; Ministry of Water and Environment in terms of policies to support the development of smallholder farmers during this era of climate change. Nakasongola District Local Government and its development partners should strengthen agricultural service delivery in all areas particularly climate change smart agriculture and much attention should be put on cassava value chain from production, value addition and marketing as a high value crop for both food security and income generation.

Introduction

Cassava is widely grown and has the potential to alleviate poverty in Uganda. Cassava (*Manihotesculenta Crantz*) is an important food and cash crop for small holder farmers in Nakasongola District. Besides, it's a source of industrial raw material. Products obtained from cassava include chips//pellets for human consumption, high quality cassava flour for confectionery-(bread/cake making as a substitute to wheat flour), animal feed and starch for industries. However, recent studies show that the production of the crop is grossly constrained by poor agronomic practices, pests and diseases notably cassava mealy bug and African cassava mosaic disease (ACMD), cassava brown streak disease(CBSD) inadequate post-harvest technology; and poor marketing structure . Since 1987, cassava has been the major food crop in Nakasongola District.

Climate change is a term used to describe a gradual shift in the current state of climate over at least several decades; example the Sahara used to have a rainy climate and now has a dry one. Climate changeis directly or indirectly attributed to human activity which alters the composition of global atmosphere and additionally the natural climate variability observed over comparable time periods (Luziraa *et al.* 2007). The changes include erratic rainfall on-set which comes early or late, poor rainfall distribution, and little rainfall. The temperatures vary between too hot, moderate and extremes of too hot or too cold.

Around the world, the climate is changing. Average global temperatures are rising - the 20th century was the warmest the world has seen in 1,000 years, and the 1980s and 1990s were the warmest decades on record (Stern, 2006, ODI, 2007). Climate change affects food security system and all components of food security through multiple paths. A warmer world with a more intense water cycle and rising sea

levels will influence many key determinants of wealth and wellbeing, including water supply, food production, human health, availability of land, and the environment. The poor will be hit earliest and most severely (Stern, 2006).

With climate change, people's ability to access food may be affected due to reduced income from loss of livelihood or slow macro economy due to low export market, poor or no transport to market, high price of food in the market, poor human health due to susceptibility to malaria and other climate change-induced diseases which undermine livelihood capability. As climate changes, the types of seed cultivars and varieties that can be grown also change.

According to the IPCC (2001, 2007 and ,) reports, global warming has accelerated in recent decades and that there is new and stronger evidence that most of the warming over the past 50 years is attributable to the increase in greenhouse gas emissions such as carbon dioxide, methane and nitrous oxide which are associated with human activities. During the past century, global surface temperatures have increased at a rate near 0.06°C/decade (0.11°F/decade) but this trend has increased to a rate approximately 0.18°C/decade (0.32°F/decade) during the past 25 to 30 years.

(Stephen *et. al.* 2007) asserts that climate change is more than a warming trend. Increasing temperatures is as a result in changes in many aspects of weather, such as wind patterns, the amount and type of precipitation and the types and frequency of severe weather events that may be expected to occur in an area. Climate change and the threat of related extreme conditions such as floods and droughts is a concern to all States. Climate change has serious implications on development, particularly for poor countries like Uganda and communities like in Nakasongola who have fewer resources to cope with the additional shocks and stress a changing climate will bring. The changes in climate, the impacts on physical and biological systems, the vulnerability of ecological and human systems, and the harmful and beneficial consequences for human well-being and sustainable development will be conditioned by exposures to other stresses and the capacity to cope, recover and adapt, all of which will vary across space and time. Global warming has far reaching implications on social and economic development and the entire global ecosystems. Indeed it threatens to undo many years of development efforts and frustrate poverty reduction programmes in developing countries and overall global development targets.

Climate change will therefore not only delay the achievement of the Sustainable Development Goals (SDGs) in many countries but escalate hunger and human suffering. Our actions now and over the coming years could create risks of major disruption to economic and social activity, on a scale similar to those associated with the great wars and the economic depression of the first half of the 20th century and it will be difficult or impossible to reverse these changes (Stern, 2006).

Vincent et al. (2010) pointed out that projected climate change such as increase in temperature and reduction in precipitation will change the availability of natural resources such as forests and potentially affect the growth of staple crops due to increased drought and water shortages. Cassava being one of the staple crops is equally affected by climate change in terms of drying of cassava plants, increased incidences of pests such as mealy bugs and white flies which results in increased incidences of diseases such as CBSD. This leads to reduced yield as root tubers are rotten. There is scarcity of cassava planting materials as they are affected by CBSD and eventually leads to low cassava production which can result in food insecurity. Increased extreme weather events such as hailstorms, drought and floods can also damage cassava plants and eventually affect the livelihood of the people.

Cassava yields per unit area of production in Uganda like in other Sub Saharan African (SSA) countries is declining. The main contributing biophysical factors are nutrient or soil fertility depletion, low soil fertility particularly N and P deficiencies, cultivation of marginal land and continuous cropping; unreliable rainfall, increased incidences of pests, diseases, and increased temperatures due to climate change. These pose a threat to food security in the area.

Objective

The major objective of the study was to assess the effects of climate change on farmers' livelihoods in cassava agro ecological farming system in Wabinyonyi Sub County Nakasongola District.

Methodology

The researcher adopted a descriptive cross- sectional survey design. Both quantitative and qualitative design was used in data collection. This design facilitated the collection of both qualitative and quantitative information. This approach was used to get data from respondents. Data derived from quantitative by use of questionnaires, qualitative interview guide and focus group discussions (FGD_S) was edited, coded and analyzed using cross tabulation and chi-square in SPSS computer programme. Cross tabulation was frequently employed to examine the relationship between two variables usually nominal or ordinal. Chi-square determined whether or not there is a statistically significant association between two variables. If the variables are not associated, they are said to be statistically independent. As an inferential statistics it allowed to draw conclusions about the population on the basis of the sample results. Here half or close to half of the respondents were affected by climate change and the other half or close to half of the respondents were not affected by climate change. Photographs were taken during data collection to show actual physical features associated with the impact of climate change on cassava farming. Quantitative data obtained was analyzed using Statistical Package for Social Sciences (SPSS) computer program. Cross tabulation tables, chi-square and bar graphs were drawn to different variables to draw conclusions.

Area of study

Nakasongola is located in the central part of Uganda and boarders with the districts of Masindi and Kiryandongo in the west and north west, Luwero in the south, Mukono and Kayunga in the east, Lira and Amolatar in the north east, and Apac in the north.

According to National population and housing census results, UBOS (2014); there are 36,620 households in Nakasongola with a population of 181,800 of which 50% are pure crop farmers. 97% of the crop farmers do farming at subsistence level and do depend on family labour and rudimentary tools. Women and children provide most of the family labour, there is limited participation by men and youth. Approximated area of the District is 3424.4km^2; representing 1.412% of the country's total surface area. 321.6 sq. km is occupied by swamps (wetlands) and the lake. Approximate arable land is 912.6km2 and area under cultivation is 228.2km^2(Nakasongola district council, 2011/12- 2015/16).

Nakasongola district was created by the act of parliament and started operating on the 1/07/1997. Buruuli County that formed Nakasongola District was formerly part of Luwero District. The District has 8 sub counties and 3 town councils: Kakooge, Kalungi, Kalongo, Wabinyonyi, Lwampanga, Lwabiyata, Nabiswera and Nakitoma sub counties; Nakasongola, Migeera and Kakooge Town Councils (Nakasongola district council, 2011/12- 2015/16).

My scope of work for research study was in Wabinyonyi Sub County in Nakasongola District targeting 180 farmers and 20 other extension workers/leaders totaling to 200 respondents out of 380 stakeholders along cassava value chain. Wabinyonyi Sub County has a population of 13,816; 7,098 male and 6718 female; 2,408 households and eight parishes: Kageri, Ssasira, Kamunina, Kyamuyingo, Kiwongoire, Sikye, Wabigalo and Wampiti, (Nakasongola district council, 2011/12- 2015/16).

Wabinyonyi Sub County is one of cassava growing Sub Counties in the District. It is located in the centre of the District. Nakasongola Town Council was curved off from Wabinyonyi Sub County.

Farmers in this sub county grow cassava for both food security and income generation. It is one of the sub counties that is affected by climate change that consequently affect cassava production.

Sample size and sampling techniques

Stratified random sampling method was used in Sample selection. Stratified random sampling is a probability sampling technique where the subjects were grouped into different classification or strata such as age, gender and educational attainment. I selected 184 cassava farmers in Wabinyonyi Sub County of Nakasongola and other stake holders to represent the population of 380 cassava farmers in Wabinyonyi Sub County. This was determined with guidance of sample size determination tables designed by Amin (2005). The studies suggested that for every 320 potential subjects, 172 subjects should be considered for study. This means that an adequate representative sample should be more than 50% of a given population sample.

However, Sakaran (2003) asserts that, it would be practically impossible to collect data from all and every element of the study population. Therefore, in this study the researcher based on the above recommendations to come up with the selection of categories along the cassava value chain.

Data collection methods and instruments

The researcher used secondary data and primary data which were collected through: questionnaires, interviews, observations and group focus discussions.

Self-administered questionnaires

The questionnaires comprised of structured and semi structured questions based on the research hypothesis. The use of self-administered questionnaires on the selected respondents was being important as regards the sample in the study population. The various respondents were: farmers, traders, processors, extension workers and local leaders. It was be important to have a diversity of respondents in order to give in-depth information about the situation in the study area.

Semi qualitative interview guide

Studies carried out by Best and Kahn (1986) pointed out that nervous respondents are more willing to talk than write. This means if a good enabling environment with such respondents, where a friendly rapport was established, makes them avail sensitive information than telling them to write it. These two authors pointed out that by interviewing such respondents/farmers, the research could access useful research information better than any other ways. The researcher applied semi qualitative interviews on the farmers as they were the principal informants in this study. The use of interviews on farmers disclosed several issues that were important in this study to understand the impact of climate change on cassava farming in Wabinyonyi Sub County.

This method was administered to key respondents like farmers who could not write to get in depth sensitive information for the researcher. Face to face interviews immediately generated answers to the researcher and it reduced fears among respondents, hence confirming Best and Kahn (1986) study that pointed out that respondents are more willing to talk than write.

Observations and focus group discussions

This was guided by the themes arranged according to research objective. The researcher and respondents shared views about the effects of climate change on farmers' livelihoods in cassava agro ecological farming system in Wabinyonyi Sub County. During the discussions, the researcher took notes of the views from the respondents as well as observing their reactions and the area.

Data analysis

The researcher analyzed data by use of both descriptive and quantitative method of analysis with help of SPSS computer programme. The researcher generated categorical and numerical data from different categories of respondents. In descriptive (exploratory) statistics the presentation of the body of data was made in form of tables and graphs. At multivariate level (cross-tabulation) data was analyzed in frequency tables and data at univariate and bivariate level data was computed and presented in the form of figures. At inferential (confirmatory) statistics the sample was examined to reach the generalization about a population. This was done by hypothesis testing which involved the computation of population parameters for a hypothesized relationship between the variables for inference. Chi-Square test was also used to assess the significance of the difference between the proportions.

Methods of data presentations depended on nature of data obtained. In table, respondents view points were captured, grouped and analyzed both by statistically, frequencies and percentages.

184 respondents were served with questionnaires and interviewed for data collection in the study area. In this survey, focus group discussion was done and data was collected. After that data was coded, processed, analyzed and presented by use of SPSS with cross tabulation tables and chi-square. However, excel spread sheet was also used to come up with bar graphs.

Result presentation

Members of household in their cassava garden that appears to be clean but with rotten roots in figure 1

Figure 1. **Household members in their cassava garden. And without cassava, the household of this size with children is at the risk of food shortage and poverty**
Photo taken by Magado Ronald

i. 97.8% responded that they were affected by climate change as far as cassava farming was concerned at their households in terms of acreage labeled in figure 1 and table 1.
ii. 82.1% responded that cassava yield was affected by climate change.
iii. Cassava yield was declining due to pests and diseases such as CBSD and cassava tuber rotting as labeled in figure 2.
iv. Mitigation mechanism used by farmers was tree planting such as trees for fire wood, pine, oranges and mangoes. The households interviewed integrated cassava with other enterprises for sustainable development.
v. All households carry out mixed cropping system as a coping mechanism against climate change.

Table 1. **Respondents perception on the effect of climate change in cassava farming**

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
How many acres of cassava per year do you grow * Based on information provided have you been affected by climate change as far as cassava farming is concerned?	180	97.8%	4	2.2%	184	100.0%
What is the yield per acre * Based on information provided have you been affected by climate change as far as cassava farming is concerned?	151	82.1%	33	17.9%	184	100.0%

Source: Author's field results

Cassava roots affected by CBSD

Figure 2. **Cassava root tubers which are the economic part are affected by CBSD. Household members with such root tubers are at a risk of food insecurity.**
Photo taken by Magado Ronald

In figure 3, 39.4% observed that climate change was the major cause of pests and diseases in cassava.

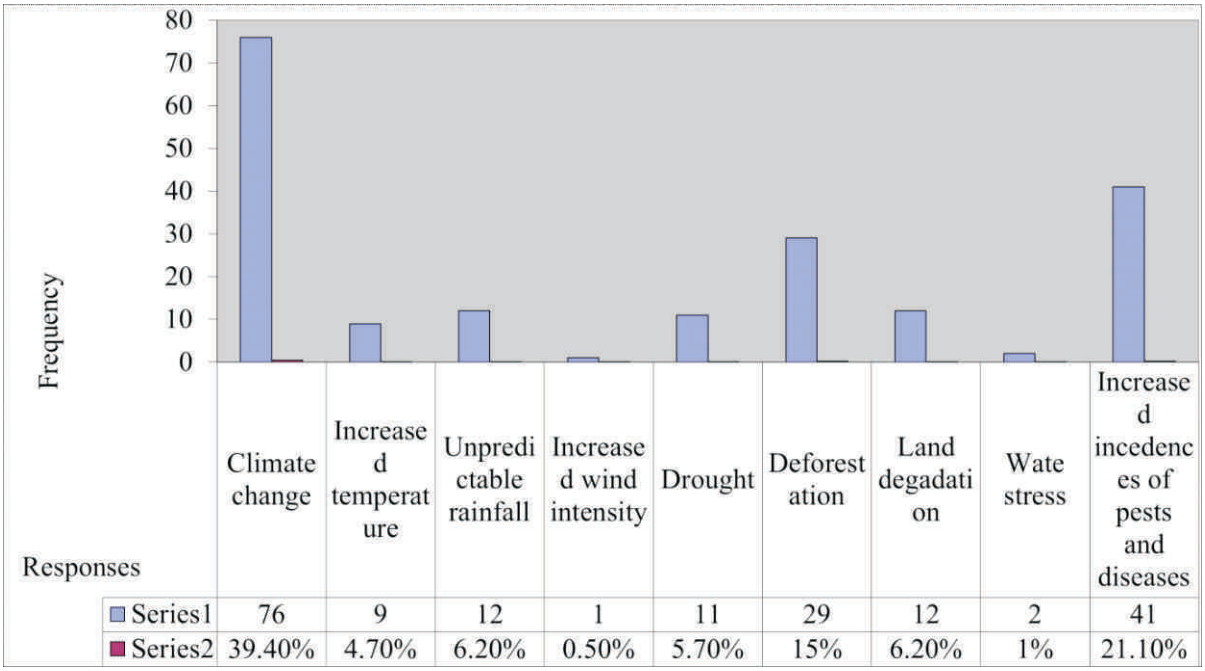

Figure 3: **Causes of pests and diseases in cassava**

The results further show that 60.9% were small holder farmers growing between 1-5 acres of cassava for their household livelihood. These farmers are affected by climate change due to increased incidences of pests and diseases as shown in Fig. 3 and insufficient soil moisture to support the growth and development of cassava plants. This was in agreement with Nakasongola district council, (2011/12 – 2015/16) integrated development plan.

As shown in Table 2, the value of the chi-squared statistics was 8.168. The chi-squared statistics has 2 degrees of freedom (from the df column). The last column gave the two-tailed p value that was associated with the chi-squared value. In this case, the p value equals .017. Therefore, the p value was larger than (0.05) so HI was true and could not be rejected. That is, there is sufficient evidence to conclude there is impact of climate change on cassava agro ecological farming system.

Table 2. **Chi-Square Tests**

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.168(a)	2	.017
Likelihood Ratio	10.223	2	.006
Linear-by-Linear Association	2.207	1	.137
No of Valid Cases	180		

Source: author's field results

This confirmed the hypothesis that there is impact of climate change on cassava agro ecological farming system in Wabinyonyi Sub County affecting farmers' livelihoods.

The researcher together with the farmer were in the field observing cassava field affected by the impact of climate change in figure 4.

Figure 4. **Magado Ronald with cassava farmer observing effect of climate change on cassava farming in Nakasongola District**

In figure 5, shows that planting resilient cassava varieties result into good yield.

Figure 5. **Improved cassava cultivars are quick maturing varieties. Farmers harvest cassava root tubers early as a coping strategy against climate change for both home consumption and income generation**
Photo taken by Magado Ronald

Discussion

The effects of climate change on farmers' livelihoods in cassava agro ecological farming system in Wabinyonyi Sub County

According to Luziraa *et al.* (2007) climate change affects agricultural production in a diverse and complex manner such as increase in temperature escalates soil chemical reactions leading to increase in decomposition of organic matter and therefore release of greenhouse gases like carbon dioxide, nitrous oxide and methane into atmosphere. This process also results in loss of fertility thus affecting yield negatively. On the other side increased temperatures can increase or decrease the yield of certain crops. Temperature increase can lead to extension of growing period for crops in high latitudes and an increase in yield at higher than normal. According to the same author continues to say that the effects of climate change are difficult to predict. Figure 3, shows that cassava farmers (39.40%) were affected by climate change in cassava farming and this qualifies the hypothesis that climate change affects cassava farming. Furthermore results disclosed that cassava farmers (60.9%) grow cassava between 1-5 acres on small scale and their cassava yield was declining due to pests and diseases such as CBSD and cassava tuber rotting that eventually lead to food insecurity at households in the long run. Table 1 shows that 81.2% of the respondents disclosed that their cassava types/varieties grown were affected by climate change leading to low yield. This is because most of cassava varieties released from NARO are just tolerant and not resistant to weather events, pests and diseases. And the other reason could be that most of the farmers have the habit of using the same seed year after year and even they may lack knowledge and skills of seed selection that is resilient to climate change leading to breakdown due to diseases, pests, extreme drought and increased temperatures.

According to Nakasongola district council, (2011/12-2015/16) integrated development plan, there is limited chance for established plants to absorb soil moisture for their physiological processes. Plants are miserable and retarded. And what happens is low yield, Pest and disease infestation (ACMVD/CBSD) has played the major setback of retarding cassava yields in the district. Leaves are malformed and turn yellowish leaving a small surface area for photosynthesis to take place due to *Mealy bug* infestation. The effect of this pest multiplies very fast during the dry season. Stems dry out, leaves shade off and the available tubers are rotten. This problem has been prevalent for the last four years, and it is still a big problem. Massive soil rich in humus is washed away during heavy down pours. This finds its way in valleys. There is no conservation measures put in place at holdings *(bibanja)*. It is common to find bare land without vegetation growth, a sign of land degradation. There is indeed high loss of bio-diversity and soil fertility, partly due to bush burning, charcoaling and poor cultivation methods. There is lack of water harvesting techniques in the field, such as retention ditches, terraces-*(fanyajuu and fanyachini)*. And low yield is expected on such a poor soil. Poor farmers just plant cassava-planting materials on the land, which is not well prepared. This limits the number of plants per unit area. And on top of this there is inadequate weeding, giving chance to the aggressive weeds to compete with the crops. Cassava plants elongate become weak and poor resulting into low yield. Farmers in Nakasongola have low literacy levels. The literacy rate among women stands as 54.7% while that of men is 63.7%. Farmers have inadequate agricultural knowledge and skills. They have limited exposure in agricultural education and training to follow the recommended practices in the cultivation of cassava crop. Many farmers have continued to plant local and diseased planting materials, season after season or year after year. There is insufficient improved cassava varieties owned by few individuals. And the only alternative to the majority of farmers is to plant diseased materials, which give poor yields. Over 90% of the population is subsistence farmers. Much of the

food produced is consumed at home. And the levels of savings are very low, hence low income. Very few families have income generating activities. And very few farmers can afford to buy cassava cuttings, usually sold at Ushs. 20, 000 per bag or Ushs. 200 per stem. But still some farmers have negative attitude that cassava cuttings cannot be bought, even if they have money. This is because in the past the Government/Department of Agriculture and other NGO`s used to give farmers farm inputs free of charge (Nakasongola district council 2011/12-2015/16). The labour force used at household level is usually family labour. This involves husband, wife/wives, children and relatives in cassava production. They use rudimentary tools- mainly hand hoe. Women and children provide most of the labour. There is shortage of labour in production as women are involved in many other activities like fetching water, preparing food, looking for firewood and attending to children. In general men do less work as compared to women. Therefore, there is an unequal shared responsibility at household level, a factor that contributes to food insecurity. Inaccessible Extension services which is 0.6% only is a contributing factor to low cassava yields as compared to 90.2% farmers, revealed by the study. Many farmers at sub-county levels have little or no access to Extension Advisors. And where the Extension Advisor is available at the sub- county level, he is not well facilitated with transport and other logistics to enable him cover all the farmers. It is estimated that one Extension Advisor in a sub-county should visit 3000 farmers. This is quite impossible. This means there is communication break down between farmers Extension Advisors as far as new technology transfer is concerned. Farmers end up using their experience a thing that has contributed to low crop yield .The vagaries of weather in terms of the amounts, reliability and distribution of rainfall, constrains production of crops grown in the region. Many farmers in the fertile areas of the region fear to expand production due uncertainty of rainfall. And the findings in Wabinyonyi Sub County were in line with Koutsouris (2009) theory; where agricultural production depended on the hand-hoe resulting into poor tilling capacity, low soil and water conservation and low labour productivity. Inadequate input support: where only a few progressive farmers had access to improved seeds. The majority of the rural population lacked credit facilities and consequently could not afford to purchase agricultural inputs required to boost agricultural production.

Conclusion and recommendations

The study concludes that climate change increased incidences of pests, deforestation, unpredictable rainfall and land degradation as major impacts contributing to declining yield in cassava farming.
The study continues to conclude that cassava farmers' plant improved cassava cultivars such as Nase 1, TME 14, and Nase 14 labeled in figure 5 as a coping mechanism to adapt to climate change.

Furthermore farmers preserve cassava by chipping it, drying by solar energy and then milled to get cassava flour which can be stored for about 6 months given the right moisture content.

The study recommends that the Government of Uganda should strengthen climate change issues through line ministries such as Ministry of Agriculture, Animal Industries and Fisheries, Ministry of Lands, Housing and Urban development; Ministry of Water and Environment in terms of policies to support the development of smallholder farmers during this era of climate change.

More important crop insurance scheme should be high on agenda given the losses farmers experience as a compensation mechanism due to the impact of climate change in cassava farming.

The study also recommends National Agricultural Research Organization through the Root crop programme to strengthen their routine surveillance of re-emerging pests and diseases in a participatory and representation manner along the entire cassava value chain.

Furthermore this study recommends Nakasongola District Local Government and its development

partners to strengthen agricultural service delivery in all areas particularly climate change smart agriculture particularly much attention should be put on cassava production, value addition and marketing as a high value crop for both food security and income generation.

Currently Operation Wealth Creation the Government programme under NAADS should continue with distribution of tolerant cassava varieties to Cassava Brown Streak Disease (CBSD) and Cassava Mosaic Disease (CMD) such as NARO CASS 1, NASE 14 in cassava growing areas for food and income security.

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