



Impact of Climate Change on Sugarcane Production and Adaptation Strategies in Kaduna State

Suleiman Musa Balarabe and Ikpe Elisha

Department of General Studies, Nuhu Bamalli Polytechnic, Zaria
Department of Geography, Ahmadu Bello University, Zaria

Corresponding author's e-mail: elishaikpe@yahoo.com

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Abstract

Sugarcane production has contributed greatly in creating employment and sources of income to the farmers and the government of Kaduna state. However, like other parts of the world, sugarcane production is greatly affected by climate change. This paper therefore examined the impact of climate change on sugarcane production and adaptation strategies by the sugarcane farmers in Lere Local Government Area of Kaduna State, Nigeria. To achieve this, a total of 200 farmers were randomly sampled and administered questionnaire through the help of Sugarcane Farmers and Marketers Association in the Local Government Area. The results were summarized and presented by means of frequencies and percentages in tabular forms and charts. The study revealed that majority of the farmers have observed a continuous increase in temperature which have positively increased sugarcane growth during the dry season; increase in temperature has resulted in increased need for irrigation, prevalence of weeds, diseases and insect pests of sugarcane. More so, an increase in rainfall amount in recent years has resulted to devastating floods which usually destroy most of the sugarcane farms and sometimes wash away the entire farmlands along the floodplains; Water stress due to excessive drought was also found to be another impact of climate change on sugarcane production in the area. The study highlighted several adaptation strategies which were used by the farmers to cope with the effects of climate change among which are the introduction of new hybrid-black sugarcane which is capable of withstanding the drought period and local boreholes which are dug with local implements. The study recommended the need for climate change awareness/education by both government and private organizations to farmers; creation of small earth dams; government, NGOs interventions to sugar cane farmers in form of loans, grants and subsidies to boost sugarcane production in the study area.

Keywords: *Adaptation strategies; Farmers; Impact; Lere local government; Sugarcane production.*

1.0 INTRODUCTION

Climate change refers to some observable variations in the climate system that are attributable to human (anthropogenic) activities, especially those that alter the atmospheric composition of the earth and ultimately lead to

global warming, Ozor (2009). The Intergovernmental Panel on Climate Change (IPCC, 2007) defined climate change as a “change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties, which persists for an extended period typically

decades or longer.” Climate change involves complex interaction between the climatic environment, economic, political institution, social and technological processes, IPCC (2001). Climate change, in the most general sense, encompasses all forms of climatic inconstancies (that is, any difference between the “long-term” statistics of the meteorological elements calculated for different periods but relating to the same area), regardless of their statistical nature or physical cause, (Maunder 1994). According to Ayoade (2003), climate change implies a new mean climatic state or climatic normal. The most crucial things about the concept of climate change is not only the time periods involved but also the degree of variability that the change is subjected to as well as the duration and impact of such variability on man and the ecosystem.

According to Odjugo (2010), climate change is caused by two basic factors, namely; natural processes (bio-geographical) and human activities (anthropogenic). The natural processes are the astronomical and extraterrestrial factors. The astronomical factors are the eccentricity of earth’s orbit, obliquity of ecliptic and orbital procession. The extraterrestrial factors include solar radiation quantity (sunspot) and quality (ultra violet radiation change). A high solar quality and quantity and period of perihelion (when the earth is nearest to the sun), result in heating up of the earth surface which lead to global warming. Volcanic eruptions also lead to both global warming and cooling. Through volcanic eruptions, lot of gases, vapour and particulate matter are emitted into the atmosphere.

In general, agricultural production is the most sensitive and vulnerable to climate change. Climate change is already affecting crop yields in Nigeria. As temperature increases and rainfall becoming more irregular, crop yield is adversely affected at almost all stages of development. Extreme weather events such as drought, thunderstorms, heavy winds and floods devastate farmlands and destroy crops. Climate change is likely to have negative impacts on agricultural production, food security and economic development. Sugarcane as a crop is

strongly affected by the impact of long-term climatic change as well as local weather and seasonal variations. Climate change and variations lead to the spread of pests and diseases which strongly affect the growth of crops. According to Mendelson, Dinar and Williams (2006), Nigeria and other West African countries are likely to have agricultural losses of up to 4% of GDP by the year 2100 due to climate change. Though there may be sufficient rain in many parts of the country, but its irregularity can adversely affect crop yield if there is failure in onset of rain during the crucial period of the growing season, Ifeanyi, Etuk and Jike (2012). Irrigation practices are also affected by extreme weather as a result of drying up of many streams and rivers which serve as a major source of water during the dry season, Rudolf and Herman (2009). Another effect of climate change in Nigeria is that it leads to low yield, stunted growth of crops, easy spread of crop’s pests and diseases and drying up of seedlings after germination. Livestock production is already affected and will continue to be vulnerable to climate change in Nigeria. The continuous decrease in rainfall in sudano-sahelian zone will consequently lead to reduction in the available pasture land which will greatly affect the growth and development of animals. This decrease in rainfall affects livestock directly through the decline in the availability of surface water resources, increase in salinity of water and evaporation which reduces the amount of surface water, Ozor (2009).

In Nigeria, sugarcane is an annual crop that depends on rainfall and irrigation. According to Gawander (2007), the amount and duration of precipitation, humidity, moisture content, temperature and soil condition has great impact on sugar cane production. These factors are to some extent interrelated and the change in one normally affects the others. In recent years, both natural phenomena, i.e. variations in the earth’s orbital characteristics, atmospheric carbon dioxide variations, volcanic eruptions, variations in solar output, human activities, particularly, the rapid industrialization which resulted in increased emission of CO₂, global warming,

greenhouse effect etc. has influenced the global climatic set-up, Gawander (2007).

Adaptation is the ecological, social, or economic systems in response to actual or expected climate stimuli and their impacts. Adaptation refers to changes in processes, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate, IPCC (2001). It involves adjustments to reduce the vulnerability of communities, regions or activities to climatic change and variability. Adaptation is important in the climate change issue in two ways: one, to assess the impacts and vulnerabilities, two, to develop and evaluate adaptation options, Smit and Skinner (2002).

Sugarcane production is an important agricultural activity in Northern Nigerian, particularly in Kaduna state, Aina *et al.* (2015). According to Kaduna State Agricultural Development Project (2013), sugarcane is produced and sold in many local government areas (LGAs) of the state, which includes Makarfi, Giwa, Lere, Kubau and Kudan. About twenty thousand (20,000) households in the state grew sugarcane in 2013. This indicated that many employment opportunities are available within the sugarcane industry. Given these contributions, any factor affecting the industry has an impact on its contribution to the total GDP of agriculture and hence to the overall economy. Just like other agricultural sectors,

2.0 STUDY AREA

The study Area (Lere Local Government) is located between latitudes 9° 30' N and 10° 10' N, longitude 7° 20' E and 8° 00' E (see figure 1). The local government is bounded by Kano State and Kubau LGA to the north; Bauchi and Plateau States to the east, Kauru LGA of Kaduna State to the west. It has a total landmass of 2567sq.Km² and population of 331,161 (NPC, 2006). The LGA experiences a tropical continental type of climate with distinct wet and dry seasons. The area has a mean annual rainfall

sugarcane farming is expected to be affected by climate change, Deressa, Hassan and Poonyth (2005). Several studies have been conducted to assess the impacts of climate change on agriculture, (e.g. Nzeadibe *et al.*, 2011; Ishaya and Abaje, 2008; Apata, Samuel and Adeola 2009; Nze and Eboh, 2011). Most of these studies paid more attention on farmers' perception and adaptation strategies to climate change on rain-fed crops unlike sugarcane production which depends on rainfall and irrigation. To the best of the researchers' knowing, there has not been any study to assess the impacts of climate change on sugarcane production and adaptation strategies in the study area. Thus, a paucity of the study – Impact of climate change on sugarcane production and adaptation strategies in Kaduna state was carried out.

The research answered the following questions:

- i. Are farmers in the study area aware of climate change?
- ii. What are their sources of information on climate change?
- iii. How do farmers perceive climate change?
- iv. What human activities cause climate change in the study area?
- v. What are the impacts of climate change in the study area?
- vi. What adaptation strategies are the farmers using in the study area?

of 1,500mm and mean monthly temperature rising from 22°C in January and attaining a maximum of 32°C in April. The relief of the area is generally undulating, varying in altitude from 600m to 850m above sea level. The area is surrounded by Kudu hills on western part rising up to 2,600m, Yage hills to the northeast which rises up to 2,800m above sea level which forms the boundary with Bauchi State. The soils of the study area are basically derived from the basement complex rocks. The soils are basically leached ferruginous tropical soils, Wikipedia (2014).

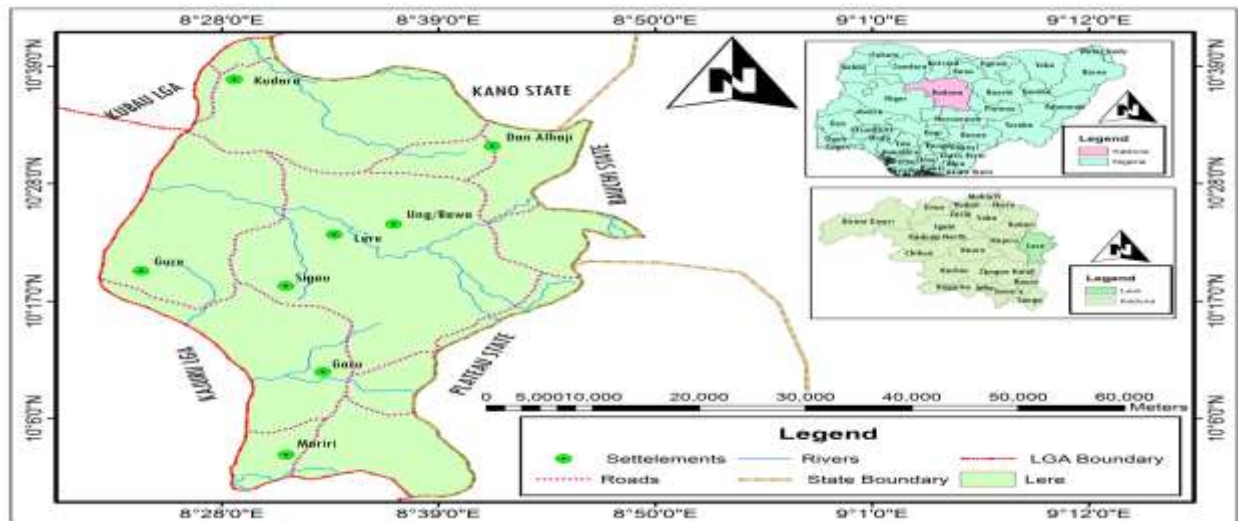


Figure 1: Map of the Study Area.

The Local Government is dissected by many rivers: rivers Rahama, Garu, Mariri, Karambana and river Gurza. These rivers and their tributaries are largely ephemeral in character and their flow regimes are highly irregular following rainfall events in the stream. Several other small streams which are the tributaries of the major rivers are found in the area. The rivers are characterized by extensive flood plains that favour the cultivation of rice, sugarcane and tomatoes in commercial quantity. The head waters of most of the rivers are experiencing gully erosion, Wikipedia (2014).

3.0 MATERIALS AND METHOD

Purposeful sampling technique was used to determine the respondents for the study. Households' Heads above twenty (20) years that were willing and concerned to make relevant contributions to the study regarding the incidence of climate change in the study area were purposively selected. Purposeful sampling, according to Bernard (2002) "is the deliberate choice of an informant due to the quality the informant possesses." Two hundred (200) respondents were selected and administered questionnaire from twenty (20) sugarcane farming villages in the study area (Mariri, Wauna, Gamagira, Lere, Sugau, Wauna, Lazuru, Juran Kari, Unguwan Zakari, Damau, Marji,

Lugura, Jamaan Iya, Garu, Babban Fadama, Dallahaji 1, Dallahaji 2, Waila and Tudai). Only villages that were easily accessible were randomly selected. The two hundred (200) questionnaire were shared proportional to the population of each village, but due to the non-availability of population figures for each village from the 1991 and 2006 census results, the questionnaire were distributed equally among the twenty (20) villages. Ten (10) questionnaires were administered in each of the sugar cane farming communities. Out of the 200 copies of the questionnaires administered in the field, a total of 191 copies were retrieved and analyzed. The data were analyzed and presented using tables, percentages and charts.

4.0 RESULTS AND DISCUSSIONS

Table 1: Personal Data of the Respondents

Parameters	Options	No. of Respondents	Percentages (%)
Age (years)	20 – 30	63	33
	31 and above	128	67
		191	100
Gender	Male	183	96
	Female	08	4
		191	100
Level of education	SSCE/GII	61	32
	Degree/HND	02	1
	NCE/Diploma	05	3
	No Formal Education	123	64
	191	100	

Source: Field Work 2015.

Table 1 showed that majority of the respondents (67%) falls between the ages of 30 years and above. This is an indication that the respondents were quite qualified to give information about the changes that is occurring in their environment. 96% of the sampled farmers were males while 4% were females. The results also

showed that majority of the respondents (64%) did not attend formal education; this is followed by those that obtained only SSCE certificate or Grade II (32%), while 1% of the respondents are first degree holders.

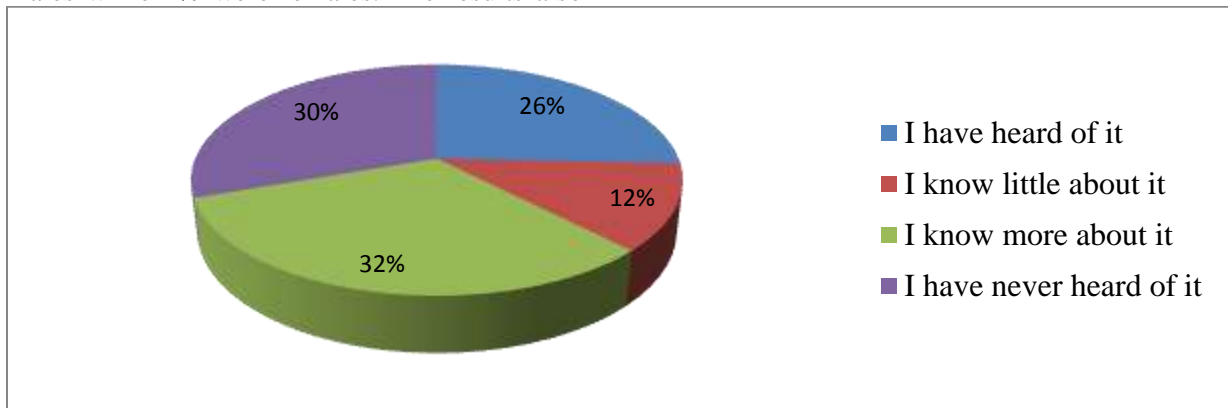


Figure 2: Climate Change Awareness among Sugarcane Farmers. **Source:** Field Work 2015.

Figure 2 showed that 32% of the respondents reported that they know much about climate change, 30% said they have never heard of it, while only 12% reported that they know little about climate change in the study area. The results indicated that the farmers are aware of climate change in the study area. Concerning

their sources of information about climate change issues, 64% reported that they obtained their information on climate change from radio, 16% from television, while 20% from the internet, newspaper and other printed materials like fliers and posters.

Table 2: Climate Change Perception among Sugarcane Farmers

Sugarcane Farmers' Perceived Climate Change Indicators	Yes	No	Neutral
1. The climate is changing negatively	105 (55%)	60 (31%)	26 (14%)
2. Climate change is a very serious problem	107 (56%)	63 (33%)	21 (11%)
3. Temperature is rising seriously	110 (58%)	49 (26%)	32 (17%)
4. Rainfall is becoming irregular & unpredictable every year	138 (72%)	32 (17%)	21(11%)
5. There has been incidences of flood after rain	160 (84%)	25 (13%)	5 (3%)

Source: Field Survey, 2015

As shown in Table 2, the results of the study showed that 55% of the respondents reported that climate change has negative effects on their environment; 31% reported that the climate is not changing negatively. 56% perceived climate change as a very serious problem in the environment; 33% reported that climate change is not a problem at all. Again, 58% of the respondents agreed that temperature in their environment is rising seriously, while 26% reported that there is no temperature increase;

73% of the respondents agreed that rainfall is becoming irregular and unpredictable each year and 84% observed that there has been an incidence of flood after rain of recent. The findings here are in agreement with scientific findings (Odjugo, 2009, 2010, 2011; Idowu, Ayoola and Ikenweiare 2011; Mishek, 2013), which reported the indicators of climate change as increasing temperature, irregular and unpredictable pattern of rainfall including prolong dry-spells, acute drought among others.

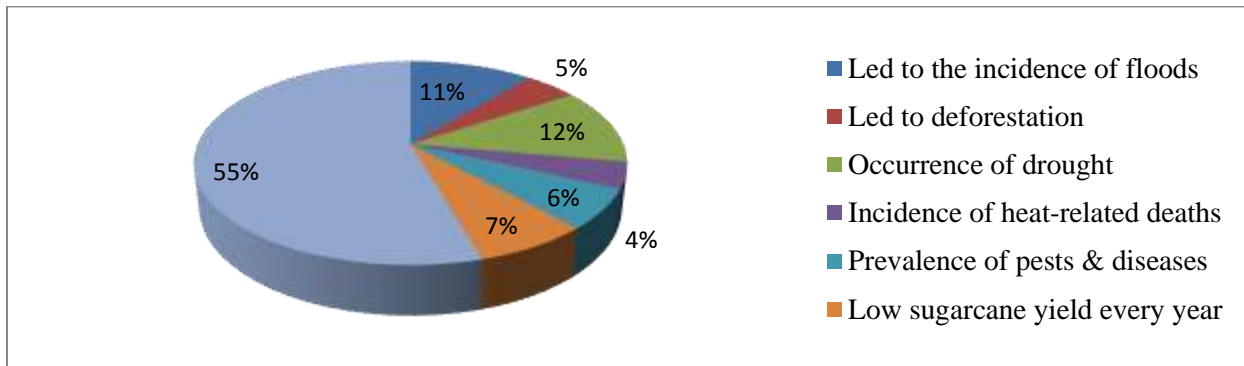


Figure 3: Impacts of Climate Change on Sugarcane Production in the Study Area, Source: Field Work 2015.

From figure 3, it is clear that majority of the respondents (55%) reported that climate change has negative impacts in their environment. The impacts of climate change are evident in the study area ranging from flooding which in recent years destroyed their sugarcane farmlands that are on the flood plains; acute shortage of water as a result of drying-up of almost all the streams which makes irrigation of farmlands very difficult in recent years and occurrence of

drought. Other climate change impacts which were discovered from the respondents included low sugarcane yield, prevalence of pests and diseases among others. The finding here is consistent with the results of Mishek, (2013) and Deressa, Hassan and Poonyth, (2005) who had discovered several climate change impacts on sugarcane in Zimbabwe and South Africa.

Table 3: Adaptation Strategies by Sugarcane Farmers.

Adaptation Option	Yes
1. Introduction of new hybrid black sugarcane breed	90%
2. Small earth dams using used-cement bags to block streams	54%
3. Use of local implements to dig the dry river valley for water	65%
4. Digging of local bore-holes	83%
5. Use of Pumping machines to replace local method of pumping water	92%
6. Planting of trees along river valleys to prevent landslide	41%
7. Shifting away from land that is prone to landslide	55%
8. Use of chemical fertilizer to boost sugarcane yield	95%
9. Mulching to protect sugarcane from water loss	61%

Source: Field Survey, 2015

Sugarcane farmers in Kaduna state adopt several adaptation strategies as a way of coping with the impacts of climate change on sugarcane production in the study area. Table 3 illustrated the several adaptation strategies by sugarcane farmers to cope with the impacts of climate change. 90% of the respondents reported that they have replaced the traditional breed of sugarcane with a more improved variety which is capable of enduring the harsh climatic condition of the environment; 54% reported that in order to cope with extreme water shortage during the dry season, they usually create local earth dams by blocking the streams with used bags of cement filled with sand and then utilize the water in the dam during water stress. In line with this also, majority of the respondents use local implements, like hoes (small and big), shovels etc. to dig the dry river valley for boreholes during water stress in search of water

5.0 CONCLUSION

The study has achieved to a reasonable extent the aim of carrying out this study on the impact of climate change on sugar cane production and adaptation strategies in Kaduna state. The study revealed that 55% of the sugar cane farmers are aware of climate change issues. The farmers' perceptions of climate variability are in line with climatic data records reviewed in the literature. Radio stations was the major source of information on climate change related issues. Indicators of climate change issues in the study area were itemized as: increase in temperature, irregular and unpredictable rainfall pattern, increasing evapotranspiration, increasing

for irrigation. 92% reported that they use modernized pumping machines which presently replace the use of buckets for watering the sugarcane farms during the dry season.

To prevent the river banks from excessive landslides, 41% reported that they plant trees and cover crops along it while 55% reported that they shifts away from any area that is prone to flood and landslide each year. 94% of the respondents affirmed that they use chemical fertilizers. The chemical fertilizers were found to be very effective in making the sugarcane stick to grow bigger and taller ahead of the water level during the excessive flood. Also, 61% of the respondents were discovered to practice mulching which helps to prevent sugarcane roots from excessive water loss during the dry season period.

disruption in climate patterns and increasing frequency and intensity of unusual or extreme weather related events such as thunderstorms, lightning, landslides, floods and droughts. The study further revealed that climate change has several impacts in the study area like drought, floods, prevalence of pests and diseases of sugarcane and other crops. These consequently affect sugarcane yield. To cope with the impact of climate change, the farmers adopt the use of improved sugarcane varieties, creation of local earth dams, use of chemical fertilizers, mulching among others as adaptation strategies. The study concludes that the impact of climate change on sugar cane production would be more

devastating if no conscious effort is made in creating awareness on the impacts of climate change on sugarcane production and bringing up viable adaptation strategies in the study area.

The farmers should be educated on the importance of tree-planting and dangers of felling tree without replanting.

6.0 RECOMMENDATIONS:

Based on the findings made in the study, the following recommendations are made:

- i. There is need to raise more awareness on climate change in the area. Government agencies and NGOs can help to educate the Nigerian farmers and the general public on the reality and impacts of climate change on the environment, agriculture, human and animal health.
- ii. There is need for government's intervention in providing funds to the farmers to boost their sugarcane production. The funds can be in the form of loans, grants or subsidies.
- iii. Construction of standard dams with well-connected drainage channels across the farmlands is imperative in the area as this will enable the farmers to make use of the available water in the dams during water deficit in the area.
- iv. There is need to build artificial levees alongside most of the streams in the area to prevent the destructive annual flood. This can be done by the Government, NGOs or the collaboration of both.
- v. There is need for government, NGOs and the farmers to provide new farming technologies in the area. Tractors, giant pumping machines, standardized boreholes and fertilizers should be provided to farmers at subsidized rate.
- vi. Government policies should therefore ensure that farmers have access to improved seed varieties, chemical fertilizer, water for irrigation and affordable credit as these increases the resilience of farmers to climate variability.
- vii. Farmers' education development on new mitigation and adaptation to climate change should be ensured through extension agents in the area.

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