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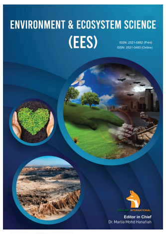

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RESEARCH ARTICLE

EVALUATION AND IMPACT OF CLIMATIC VARIABILITY ON GUINEA CORN (SORGHUM BICOLOR) IN SELECTED STATE IN NIGERIA

Ibrahim Sufiyan[a*], J.I. Magaji[a]. A.T. Ogah[a], K. Karagama[b]

[a]Department of Geography, Nasarawa State University Keffi, Nasarawa State Nigeria
[b]Mai Idris Alooma Polytechnic, Geidam Yobe State, Nigeria
**Corresponding Author Email: ibrahimsufiyan0@gmail.com*

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ABSTRACT

Climate variability is one of the serious environmental challenges that have received a lot of public outcry in most parts of the world due to its consequence on agricultural production and other sectors of the national economy and general wellbeing. This study, therefore, sought to examine the effects of climate variability on crops production in the Bakori Local Government Area of Kastina State, Nigeria. Rainfall, temperature and selected crops (Sorghum) data from the farmers living in Bkori and cultivate Guinea corn every year. The data were analyzed using correlation and regression analysis in SPSS and the trend the function of Microsoft Excel.). The study identified positive crop yield while comparing temperature trend sorghum temperature characteristics, the most important climatic variable that influences the yields of Sorghum in Bakori is temperature and rainfall. This has beeachieved by monitoring 100 farmers at different locations in the study area and the use of farm inputs and monitoring of crop-climate relationships to achieve improved crop yield.

KEYWORDS

agricultural production, Rainfall, regression analysis, crop-climate.

1. INTRODUCTION

Guinea corn (Sorghum bicolor), is known all over the world as the fifth most important food crop grown in the world. It is known also as Durra, Jowari, Dawa or milo. The people of Nigeria especially the northern and middle belts, make use of the guinea corn grain as a source of food, portage, Jollop and local brewed wine (Burkutu). The modern usage in the industries nowadays produces biscuits and other edible product from the sorghum (Sani, et al., 2011). A studied the behaviour of the Guinea corn (Sorghum Vulgare) from germination and listed all the stages of its development (Aisien and Ghosh, 1978). The state engaged in the farming actively includes Sokoto, Katsina, Nasarawa, Kebbi, Bauchi, Adamawa, Niger, Taraba and Zamfaran. Another study conducted, compared the inter-correlation of nutrient amino acid quality in the germinating seed of guinea corn (Sorghum bicolor), (Jar Dawa) (Adeyeye, 2008). The presence of an effective water supply was compared to the growth of sorghum in relation to its yields (Choudhary et al., 2019). The different substance can be obtained in guinea cornhusk such as the production of bioethanol (Oyeleke and Jibrin, 2009).

Agriculture has always been a dominant sector in developing economies. The sector contributes a major share in Gross Domestic Product (GDP), the balance of trade, employment and even to the sustainable daily livelihood of the people of the developing countries. Without development in the agricultural" sector, it is difficult to achieve the desired development and poverty reduction. As oppose to this, existence of traditional farming system, dependence of the agriculture on climatic condition, involvement of semi-skilled and unskilled farmer in the agriculture along with other bottlenecks like lack of efficient agricultural market, timely availability of improved seed and chemical fertilizer and less incentives of government for commercial farming retards to achieve the desired level of agricultural development. Hence, one of the emerging phenomenon and the most important and serious issue to deal with is the consequences of climate change on agricultural output (Bernstein et al., 2008).

Sorghum is a cereal grain that grows taller and is very useful in the United States for making a different product such as livestock feed, and ethanol. The crop is resistant to drought and needs more moisture to reach cultivation especially in parts of Africa and Asia (Ofor, et al., 2009). Climate change refers to 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, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use.

The Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." The UNFCCC thus makes a distinction between climate change attributable to human activities

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altering the atmospheric composition, and climate variability attributable to natural causes (Field and Van Aalst, 2014).

According to the World Meteorological Organization, variation in the mean state and other statistics of the prevailing climate variables on temporal and spatial states beyond normal weather is climate variability (WMO, 2015). It is used to denote changes in climatic variables over a given period of time as compared to long-term statistics of respective climatic variables. Climate variability is measured by calculated deviations, which are termed as anomalies (Dong, et al., 2016). Agricultural productivity is subsequently affected due to changes in land and water regimes as a result of changes in temperature and precipitation. Different researches such as have shown that in tropical regions, with many of the poorest countries, impacts on agricultural productivity are expected to be particularly harmful (Sivakumar, et al., 2005; Lobell, et al., 2011; Dinar, et al., 2012). Technological, resource and institutional constraints prevailing in these countries have an additional negative impact. Although estimates suggest that global food production is likely to be robust, experts predict tropical regions will see both a reduction in agricultural yields and a rise in poverty levels as livelihood opportunities for many engaged in the agricultural sector become increasingly susceptible to expected climate pressures (Kurukulasuriya and Rosenthal, 2013). Agriculture is extremely vulnerable to climate variation. Higher temperatures eventually reduce yields of desirable crops while encouraging weed and pest proliferation, changes in precipitation patterns increase the likelihood of short-run crop failure and long-run product declines. The overall impact of climate variation on agriculture are expected to be negative although there will be-gains in some crop in some region of the world, threatening global food security (Nelson et al., 2009).

Nigeria produces about 65 to 70% of sorghum in West Africa. The producing includes; Katsina, Kano, Bauchi, Borno, Zamfara, Yobe, Gombe, Adamawa, Kaduna, Jigawa, Niger, Kebbi, Taraba, Plateau, Sokoto and Nasarawa. Other places in the world include; Australia, Asia, Mesoamerica and India (Umar, 2016). Guinea corn has different species; it is naturally grown in pastureland and particularly useful as fodder plants. Essentially, sorghum as a grain contained valuable nutrient and it withstands heat and drought. The nutrient contains different minerals such as potassium, phosphorus, iron, magnesium, thiamine, copper, riboflavin niacin and calcium (Sambusiti, et al., 2013).

Sorghum has a lot of health benefits to both human and farm animals. The improvement of health condition has motivated farmers to embark on the vast cultivation. The crop helps in the control of diabetes and regulates the insulin and the level of glucose in the body, the presence of magnesium and calcium helps in bones and cure arthritis. The Niacin chemical compound also helps in boosting energy. The part of body digestion, aids and improves the issue of bloating and constipation. Guinea corn is strong antioxidants (Raju, et al., 1990).

The guinea corn also uses in various ways and apply to different situations. This includes the production of food, animal fodder, alcohol and beverage, making of fuel as ethanol fuel (biofuel), it is also used for making bread, the local broom is made from the comb, it serves like snacks, popcorns. It also mixes with rice and cooked together in some parts of Africa. In Nigeria, it can be ground and serve as a drink (Kunu), sorghum flour and many different usages (Rai, et al., 2008).

Table 1: The marketplaces of Guinea corn (Sorghum bicolor and Vulgare)

MARKETPLACES	LOCATION	STATE OF PRODUCTION
Illela	Illela	Sokoto
Giwa	Giwa	Kaduna
Kaura Namoda	Kauran Namoda	Zamfara
Dawanau	Dawakin Tofa	Kano
Maiaduwa	Daura	Katsina
Dandume	Dandume	Katsina
Lafiya	Lafiya	Nasawara
Mai Gatari	Mai Gatari	Jigawa
Bodija	Ibadan	Oyo
Mile 12	Epe	Lagos
Saminaka	Lere	Kaduna
Minna	Minna	Niger

Some researchers pointed out that climatological temperatures substantially affect cloud cover and precipitation. Climate variability refers to the Spatio-temporal variation of climatic conditions beyond individual weather events (Oguntunde, et al., 2012; Feranec, et al., 2007). Similarly, also define climate variability as the variations in the mean state and other statistical descriptions of extreme climatic conditions on all temporal and spatial scales beyond that of individual weather events (Walthall, et al., 2013). With regards to the definition, climate variability is seen as the climatic parameter of a region varying from its long-term mean (Lawrence and Vandecar, 2015). Again, the emphasis is also placed on the significance of Spatio-temporal scales of weather events. The definition of climate variability is in consonance with emphasis placed on the dimensions of the variability (Abaje, et al., 2014; Solomon, 2007). Other researchers observed that the highest mean annual rainfall was recorded in 1999 with a sum of 984.06mm followed by 1998 with a sum of 958.98mm (Adakayi and Ishaya, 2016). The year 2003 had a sum of 956.98mm of rainfall.

2. Material and Methods

The study was conducted in the major area of Guinea corn production that is one of the Katsina state local Government areas called Bakori. Bakori is situated in the North-West of Katsina South Senatorial District headed by the elected chairman the following are the districts and wards under Bakori, and the study covers about 10 of these districts. These include; Bakori, Kandarawa, kakumi, Tsiga, Yankwani, Magaji, Kwantakwarwm, Kabomo, Jargaba, Guga, Dawan Musa, Gazara and Barde. Bakori local government area is situated in the North-West Geopolitical Zone and under Katsina South Senatorial Districts; the LGA is headed by the incumbent Chairman and his elects. Districts & Wards Under Bakori Local Government Area (Pittin, 2002).

Figure 1: Study Area Map of Bakori, Katsina State, Nigeria

Bakori Local Government Area is on Latitude 11.639836, and longitude 7.428764. It covers a total land area of 679km². The antipodes are -11.639836 and - 172.571236.

2.1 Data Analysis and Presentation

The data used for this study were extracted directly from the yearly documentation of climatic variables (rainfall and temperature in particular) obtained from NiMET and that of yearly crop yields obtained from the State Ministry of Agriculture. The data for this study were processed and analyzed quantitatively. The quantitative data were analyzed using both descriptive and inferential statistics with the help of Correlation analysis and SPSS Statistics Software version 17. The inferential statistics employed in this study are multiple correlations and regression analysis. The findings of the study were presented in forms of tables, charts and graphs. About 100 samples of questionnaires were administered in the field to cover almost all the farmers at different locations. 50 additional farmers and the farm sies were surveyed to see the length and the total area of the farmland which can be used to calculate the output of crop yields

2.2 Trend Analysis

The Microsoft Excel function of the linear trend, as well as line chart, was used to analyze the trend of climate variability in the district. The line chart" trend line, trend equation and the degree of variation within the excel function were used to determine the nature and direction of the trend of the variables under investigation i.e. temperature (maximum and minimum) and annual rainfall.

3. Results and Discussion

3.1 Temperature and the crop yields (Sorghum)

Table 2 present the data on the temperature input that is compared with the crop yields in Bakori.

Table 2: Temperature input and the Crop Yields

S/no	Maximum Temperature	Crop Yields (Sorghum)
1	25	100
2	30	120
3	28	150
4	29	125
5	32	80
6	31	75
7	33	70
8	34	65
9	30	72
10	27	150

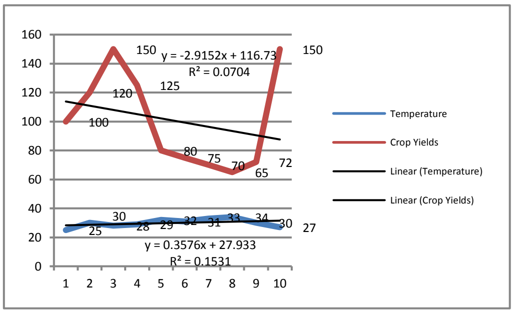

Figure 2: The Graphical presentation of the Temperature Trend and the Crop Yield

The double trend in figure 2 is showing and comparing the significance temperature in an increase of the Guinea corn yields. The average temperature of 30% is equating with 150 bags of Sorghum at both sides of the equations. That means at the temperature level of 30⁰C, Sorghum is favourability increase with high yields by the farmers. This is clearly indicated in figure 3.

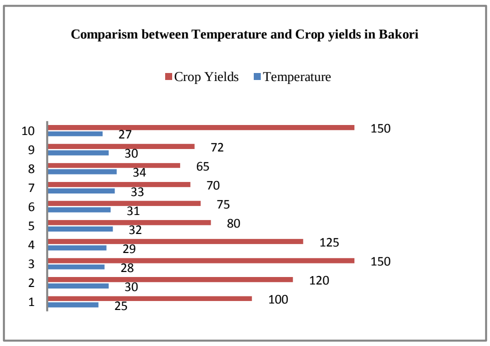

Figure 3: Combined Bar graph showing high Sorghum yields in Bakori, Katsina State Nigeria

The highest response to the temperature that determines the Sorghum yield in Bakori is 270c and 28oc. These have shown positive crop yields at different levels. The implication of the rise in temperature in the district is the fact that this will increase the rate of evaporation and cause a reduction in soil moisture. When evaporation increases, the result is that the amount of soil moisture lost through vaporization will also increase thereby leaving little or no moisture to support plant growth. In effect, crops that need some considerable amount of water to grow will be affected. This supports the part of the conceptual framework of the study which looks at the linkage between high temperature and crop yield.

3.2 Quantities of Guinea corn (Sorghum Bicolor) Produced in Bakori

Table 3: Quantities and income from the Harvest of Sorghum

S/no	Quantities in 50kg per bags	Frequency	Total output in 50kg bags
1	20	6	120
2	40	10	400
3	60	15	900
4	60	9	540
5	100	25	2500
6	120	11	1320
7	140	10	1400
8	160	3	480
9	180	7	1260
10	200	4	400
Total	1080	100	9320

A total of 9320 Table 3, shows as the output or quantities of Sorghum by different farmers can be multiplied by the amount sold by the farmer that is (9320*N2000 per bag) the result has shown that 100 farmers can sale Sorghum worth 9320 kg and for each 50 kg at the rate of N2000. The total cost is N 18,640,000. Figure 4. 8, is the graph showing the distribution with the pout of intersection showing a very high correlation.

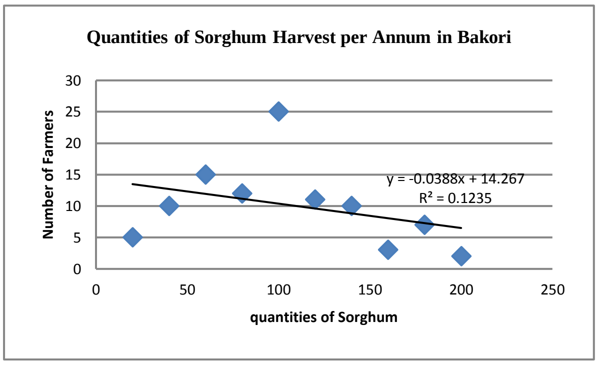

Figure 4: Scattered graph shows the distribution and relationship of quantities of Sorghum harvested at different farmlands in Bakori.

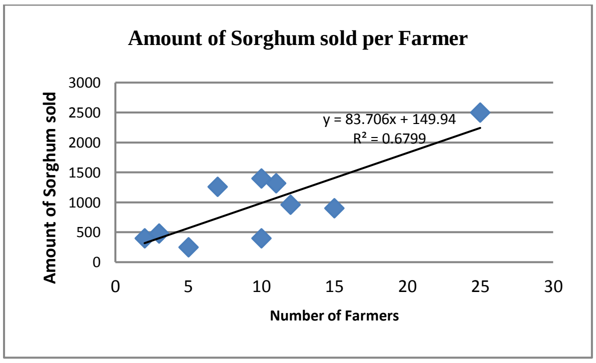

Figure 5: Positive relationship between Harvest and the farmers' income in Bakori

There is a positive correlation between the amount of Sorghum sold and the number of farmers engaged in harvesting the crop output with 0.67 as shown in figure 5.

3.3 Impact of Climatic elements on Growth of Sorghum

Table 4: Impact of Climatic Parameters on Sorghum Yields

S/no	Impact of Climate	Frequency	Respondents
1	Temperature & Rainfall	30	50
2	Humidity & Moisture	8	30
3	Wind and Pressure	9	11
4	All of the above	3	9
	Total	50	100

Almost all the climatic elements in Table 4 have a greater impact on the growth and development of Guinea corn production not only in Bakori but areas located at the same latitude in Nigeria such as Kano, Jigawa, Sokoto, Yobe and Borno State. These zones are having unique temperature trend during the raining season. According to Table 4, temperature and rainfall have more impact than the rest of the climatic elements with 50% dominant followed by humidity and moisture.

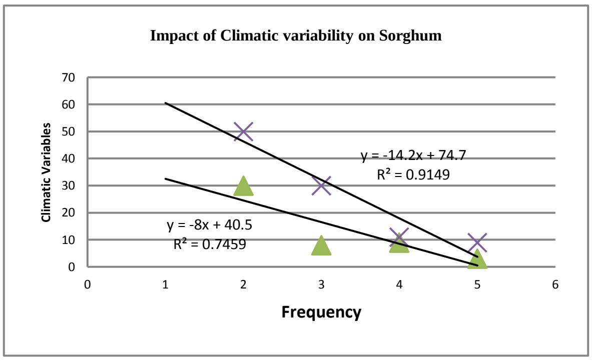

Figure 6: Impact of Climate on Sorghum Yield in Bakori

There is a positive Impact and correlations with 0.914 refer to figure 6. The model described the impact of temperature and rainfall as the high factor influencing the increase in the Guinea corn production in Bakori, Katsina State, Nigeria.

4. Conclusion

There is a positive correlation with 0.895904. the model described the impact of temperature and rainfall as the high factor influencing the increase in the Guinea corn production in Bakori. This is consistent with the study of (Hansen, Sato, & Ruedy, 2012) who assert that more warming conditions would be experienced in the 21st century than the preceding decades. The reason for the rise or increase in maximum temperature in the district may be partly due to the extent of bad farming practices (e.g. slash and burn) coupled with deforestation that characterizes farming activities and other anthropogenic activities in the area. The implication of an increase in the minimum temperature to crops, in general, is that it will affect photosynthetic activities of crops which may, in the long run, affect the yield of crops such as groundnut, millet and sorghum which according to (Chinoy, 1947) needs a minimum amount of temperature of about 25^{0}C to 35^{0}C, 20^{0}C to 30^{0}C and 15^{0}C to 25^{0}C respectively for survival.

The relationship between, temperature and the sampled crops were examined using correlation analysis shown in tables 4.5. The result of the analysis revealed that rainfall has a strong positive relationship with sorghum yield (0.895904.) The implication of this is that the higher the rainfall the higher the yield of groundnut, while millet and sorghum require minimal rainfall. This finding collaborates with the findings of (Bature, Sanni, & Adebayo, 2013) who found a week positive relationship (0.37) between rainfall and groundnut yield, fairly strong negative (0.47) and strong negative (0.67) relationships for millet and sorghum in his study on the effect of climate change on agricultural productivity in the Federal Capital Territory. However, the finding contradicts that of (Ibrahim & Mohammed, 2015) which found that groundnut yield (-0.467) has a fairly strong negative relationship with rainfall while millet and sorghum have weak positive relationships with correlation coefficients of 0.220 and 0.152 respectively.

To assess the effect of some of the climate variables (rainfall and temperature) on agricultural production based on the selected crop yield in Bakori LGA, multiple regression analysis was performed to investigate the ability of the two climate variables (rainfall and temperature) to predict the yield of sorghum. Guinea corn or Sorghum is known to be the fifth crop in the world, eating at different varieties in the different geographical regions. Base on this study the first objective has been achieved by assessing the climatic variability on the production of Sorghum bicolor in Bakori.

The study has established that there is high variability in temperature characteristics which translates into high variability and sorghum yields in Bakori Local Government Area. The data were analyzed using correlation and regression analysis of the SPSS and the trend function of Microsoft Excel. The result of the study shows that there is a significant relationship between the temperature and the crop yields in Guinea corn Sorghum (Bicolor). Most farmers in Bakori have addressed the issue of problems of Sorghum production. Temperature is having a significant impact.

References

Abaje, I.B., Sawa, B.A., Ati, O.F., 2014. Climate variability and change impacts and adaptation strategies in Dustin-Ma Local Government Area of Katsina State, Nigeria. Journal of Geography and Geology, 6 (2), 103.

Adakayi, P.E., Ishaya, S., 2016. Assessment of annual minimum temperature in some parts of northern Nigeria. Ethiopian Journal of Environmental Studies and Management, 9 (2), 220–227.

Adeyeye, E.I. 2008. The intercorrelation of the amino acid quality between raw, steeped and germinated guinea corn (Sorghum bicolor) grains. Bulletin of the Chemical Society of Ethiopia, 22 (1).

Aisien, A.O., Ghosh, B.P., 1978. Preliminary studies of the germination behaviour of guinea corn (Sorghum Vulgare). Journal of the Science of Food and Agriculture, 29 (10), 850–852.

Bature, Y.M., Sanni, A.A., Adebayo, F.O., 2013. Analysis of the impact of national fadama development projects on beneficiary's income and wealth in FCT, Nigeria. Journal of Agricultural Economics and Sustainable Development, 4 (17), 11–24.

Bernstein, L., Bosch, P., Canziani, O., Chen, Z., Christ, R., Davidson, O., Kattsov, V., 2008. Climate change 2007: Synthesis report: An assessment of the intergovernmental panel on climate change. IPCC.

Chinoy, J.J. 1947. Correlation between the yield of wheat and temperature during the ripening of the grain. Nature, 159 (4039), 442.

Choudhary, M., Wani, S. H., Kumar, P., Bagaria, P. K., Rakshit, S., Roorkiwal, M., Varshney, R.K., 2019. QTLian breeding for climate resilience in cereals: progress and prospects. Functional & Integrative Genomics, 1–17.

Dinar, A., Hassan, R., Mendelsohn, R., Benhin, J., 2012. Climate change and agriculture in Africa: impact assessment and adaptation strategies. Routledge.

Dong, B., Sutton, R., Shaffrey, L., Wilcox, L., 2016. The 2015 European heatwave. Bulletin of the American Meteorological Society, 97 (12), S57–S62.

Feranec, J., Hazeu, G., Christensen, S., Jaffrain, G., 2007. Corine land cover change detection in Europe (case studies of the Netherlands and Slovakia). Land Use Policy, 24 (1), 234–247.

Field, C.B., Van Aalst, M., 2014. Climate Change 2014: Impacts. Adaptation, and Vulnerability.

Hansen, J., Sato, M., Ruedy, R., 2012. Perception of climate change.

Proceedings of the National Academy of Sciences, 109 (37), E2415–E2423.

Ibrahim, K., Mohammed, B.M., 2015. Rising Temperature: Evidence of Global Warming in Northern Nigeria. J. Environ. Earth Sci., 5 (22), 50–55.

Kurukulasuriya, P., Rosenthal, S., 2013. Climate change and agriculture: A review of impacts and adaptations.

Lawrence, D., Vandecar, K., 2015. Effects of tropical deforestation on climate and agriculture. Nature Climate Change, 5 (1), 27.

Lobell, D.B., Bänziger, M., Magorokosho, C., Vivek, B., 2011. Nonlinear heat effects on African maize as evidenced by historical yield trials. Nature Climate Change, 1 (1), 42.

Nelson, E., Mendoza, G., Regetz, J., Polasky, S., Tallis, H., Cameron, Dr. Kareiva, P.M., 2009. Modeling multiple ecosystem services, biodiversity conservation, commodity production, and tradeoffs at landscape scales. Frontiers in Ecology and the Environment, 7 (1), 4–11.

Ofor, M.O., Ibeawuchi, I.I., Oparaeke, A.M., 2009. Crop protection problems in the production of maize and Guinea corn in Northern Guinea Savanna of Nigeria and control measures. Nature and Science, 7 (12), 8–14.

Oguntunde, P.G., Abiodun, B.J., Lischeid, G., 2012. Spatial and temporal temperature trends in Nigeria, 1901–2000. Meteorology and Atmospheric Physics, 118 (1–2), 95–105.

Oyeleke, S.B., Jibrin, N.M., 2009. Production of bioethanol from guinea cornhusk and millet husk. African Journal of Microbiology Research, 3 (4), 147–152.

Pittin, R.I., 2002. Economy, History and Structure of Katsina. In Women and Work in Northern Nigeria (pp. 20–53). Springer.

Rai, K.N., Gowda, C.L.L., Reddy, B.V.S., Sehgal, S., 2008. Adaptation and potential uses of sorghum and pearl millet in alternative and health foods. Comprehensive Reviews in Food Science and Food Safety, 7 (4), 320–396.

Raju, P.S., Clark, R.B., Ellis, J.R., Duncan, R.R., Maranville, J.W., 1990. Benefit and cost analysis and phosphorus efficiency of VA mycorrhizal fungi colonization with sorghum (Sorghum bicolor) genotype grown at varied phosphorus levels. In-Plant Nutrition—Physiology and Applications (pp. 165–170). Springer.

Sambusiti, C., Ficara, E., Malpei, F., Steyer, J.P., Carrère, H., 2013. The benefit of sodium hydroxide pretreatment of ensiled sorghum forage on the anaerobic reactor stability and methane production. Bioresource Technology, 144, 149–155.

Sani, B.M., Danmowa, N.M., Sani, Y.A., Jaliya, M.M., 2011. Growth yield and water use efficiency of maize-sorghum intercrop at Samaru, Northern Guinea Savannah, Nigeria. Nigerian Journal of Basic and Applied Sciences, 19 (2).

Sivakumar, M.V.K., Das, H.P., Brunini, O., 2005. Impacts of present and future climate variability and change on agriculture and forestry in the arid and semi-arid tropics. In increasing climate variability and change (pp. 31–72). Springer.

Solomon, S., 2007. IPCC (2007): Climate changes the physical science basis. In AGU Fall Meeting Abstracts.

Umar, S., 2016. Awareness, manifestation and information sources on climate change among irrigation farmers in Katsina State, Nigeria. Scholars Journal of Agriculture and Veterinary Sciences, 3 (1), 37–41.

Walthall, C.L., Anderson, C.J., Baumgard, L.H., Takle, E., Wright-Morton, L., 2013. Climate change and agriculture in the United States: Effects and adaptation.