SOKOTO JOURNAL OF GEOGRAPHICAL STUDIES (SJGS) *PRINT ISSN: 3043-551X*

Volume 1, 2024 (Maiden Edition)

TEMPORAL ANALYSIS OF SELECTED STAPPLE CROPS YIELDS FROM 1997-2018 IN NIGER STATE, NIGERIA

I. J. Masha, Usman Adamu, Hassan Suleiman & Habiba, A. Muhammad

Department of Geography, Niger State College of Education, Minna

Corresponding Author's Email: jibrinisah3@gmail.com

Abstract

This study investigates the temporal trends of selected crop yields like (maize, soya beans, beans, yam, sweet potato, ground nut, cassava, rice and millet) in Niger State, Nigeria. Simple linear trend model and mean model were used to derive the time series and find the slope and intercept to determine the trend of crop yields, using data from Niger State Agricultural Development Programms. Results of the trend analysis showed significant spatial variability in crop yield, that cereal crops like maize, millet and rice yield were on constant increasing trend in 2008, 2016 and 2018 years respectively across the study area. Temporal trends also indicated declining yields for Soya beans and cassava which showed a positive trend of Y=0.047x-93.04 with the R^2 of 10% of weak positive linear model which implies a constant decrease in their yield in most of the years under study. The study recommends targeted interventions, such as climate-resilience agricultural practices and soil conservation measures, to enhance crop productivity.

Keywords: *Trend Analysis, Linear Model, Crop Production and Rain-Fed Agriculture*.

Introduction

Over 70 percent of rural inhabitants in Nigeria depend largely on rain fed agriculture (Ifabiyi and Ojoye, 2013; Usman and Abdulkadir, 2014). The rain fed agriculture in Nigeria renders rural inhabitants vulnerable to the adverse effects of climate variability. Extreme climatic events such as flooding, extreme heat, and drought resulted in low crop yields (Yawez, 2023). A decline in agricultural productivity discourages the farmers and affect their livelihood (Okoroh, 2014), especially in rural settings. Therefore, climate variability have severe consequences on farmers who rely on weather-dependent rain fed agriculture for their livelihoods (Khanal *et al.*, 2018). The observed impacts of climate variability in Nigeria include temperature increase, erratic rainfall, unpredictable seasons, and increased climate events. These impacts could adversely affect crop production, thereby increasing food and livelihood insecurity (Sani, 2014). The relationship between climate variability and food production depends mostly on when and which adaptation strategies are taken (IPCC 2014). Therefore, Khanal *et al*.(2018) posited that climate trends, rate of change, effective adaptation strategies, dissemination, and adoption at a broader level are crucial to deal with the current and future impacts. To ensure food security, we need to understand the climatic changes around us and how it affects agricultural productivity and rural livelihood. The climate in many parts of Nigeria is critical to rain-fed agriculture and staple grains production (Odjugo, 2010). For many rural farmers who form the bulk of the rural population in Nigeria, crop yield depreciation is a matter of survival as farming mainly depends on climate.

Niger State, is a significant producer of staple crops, including cereals (maize, rice, and millet), leguminous (beans, soya beans and ground nut), and tubers (yam, sweet potato and cassava) crops. The depreciation of crop yields in the State is increasingly seen as a manifestation of climate variability caused by global warming. Thus, climate variability remained one of the major challenges for the State with its multiple facets, including impact assessments and mitigation and adaptation measures (Abdullai *et al*, 2017). The temporal trends of selected crop yields in the State are not well understood, hindering evidence-based decision-making for Agricultural development and food security. Therefore, this research has studied lack of spatial patterns understanding, temporal trend uncertainty and socioeconomic implication of selected crop yields in Niger State.

Literature Review

There are many factors influencing crop production including soil, relief and climate, low capital base of farmers, pests and diseases, among others. Nevertheless, climate is the most important factor that influences agricultural production (Anyadike, *et al*, (2010)). According to Ayoade (2004), agriculture largely depends on climate to function, hence, precipitation, solar radiation, wind, temperature, relative humidity and other climatic parameters affect and solely determine the global distribution of crops and livestock as well as their productivity (yields). The concept of climate and agriculture has been extensively discussed. For example, Ayoade (2004), Cicek and Turkogu (2005), and Adamgbe (2012): have all confirmed that climatic parameters (i.e. rainfall, sunshine, temperature, evaporation, etc.) are closely interrelated in their influence on crops. In fact, in Nigeria variations and changes in climatic parameters can have significant impacts on agricultural production, forcing farmers to adopt new practices in response to altered conditions (Emmanuel and Fanna 2012). It is therefore submitted that climate is one of the major elements that influence agricultural productivity, however, the extent of these is not mostly shown. More so, several studies on crop-climate relations have been reported in different parts of Nigeria (see Anyadike, *et al*, (2010); Showemimo, 2002; Tyubee, 2006; and Adamgbe, 2012) and the results of these studies indicate that climatic effects vary among crops and regions in Nigeria. Consequently, in a large country like Nigeria with different climatic regions, studies of crop-climate relations are important towards government's programms on revitalizing the agricultural sector of the economy.

Theoretical Frame work

This study employed the daily version of century (DAYCENT) model used by Lee, De Gryze, and Six, in 2009 to predicted crop yields in California Central Valley, to stimulate changes in yield of alfalfa (*Medicago sativa*), cotton, corn, winter wheat, tomato, and rice under A2 (medium-high) and B1 (low) CO2 emission scenarios, using a total of 18 climate change predictions for the two scenarios. The results of the comparison, using five-year moving averages from 1953-2097, indicated that changes in yield were highly variable depending on the climate change scenarios across times. Furthermore, the variability in crop yield changes tended to increase toward the end of the century, showing that future climate had a broad range of impacts on crop yields. Overall, the results suggest that climate change will decrease crop yields in the long-term, particularly for cotton, unless greenhouse gas emissions and resulting climate change is curbed and/or adaptation of new management practices and improved cultivars occurs. However, the daily version of century (DAYCENT) model was used in this study as a theoretical framework because of its suitability as it indicated that changes in yield were highly variable depending on the climate change scenarios across time.

Materials and Methods

The Study Area

This study was conducted in Niger State, which lies between Longitude $3^{0E}$to 7^{0}E, and Latitude 8^{0N} and 9^{0}N.and cover a land area of about 86000km (or about 8.6 million hectares), representing approximately 9.3% of the total land area of Nigeria. It is located in the North geo-political zones where it shares borders with a republic (West), Zamfara (North), Kebbi, (North-west), Kogi (South), Kwara (South-west), Kaduna (North-East) and FCT (South-East).The state has 25 local Government Areas, with Minna as the State capital. The state is directly characterized by two seasons (rainy and dry seasons). The loamy, clay, and alluvium soil mainly occurs along the flood plain of river Niger and its tributaries. The soil is important for agriculture production such asrice, sugarcane, yam, sweet potato, maize, and etcetera. Vegetation wise, Niger State falls within the northern guinea savanna, which is influenced by its climate. The typical vegetation is open, wood land greatly modified by bush burning so that only a few woodland remains. The trees grow up to 40 to 50 meters high and have broad leaves. Tall grasses and tall trees characterize the vegetation during the rainy seasons. The average rainfall amount is 1203.18mm. The rainy season is between May to October each year with inter seasonal and annual variability. The pattern of rainfall support agricultural activities in the study areas.

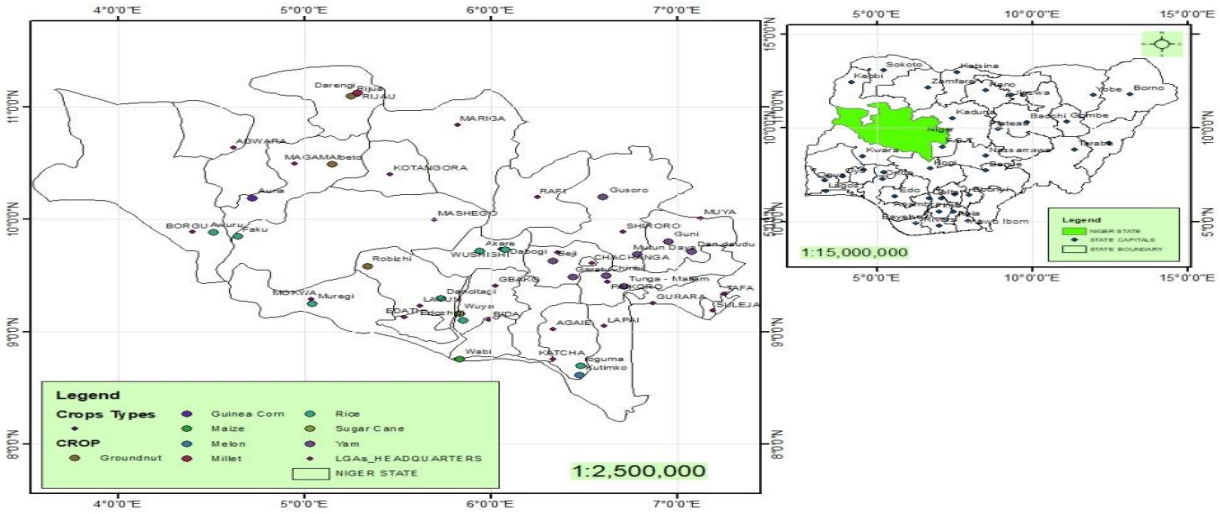

Figure 1: Map of Niger State
Source: Niger State Ministry of Land and Survey

Data Collection

Data on crop production (rice, yam, soya beans, cassava, sweet potato, beans, millet, maize and sorghum) were collected from the Niger State Agricultural Development Programme (NADP) for twenty one years (1997-2018). Only eight (8) crops (rice, yam, soya beans, cassava, sweet potato, beans, millet, maize and sorghum) were selected due to unavailability of complete data on other crops cultivated in the study area. The data collected were analyzed using simple linear trend model and mean model to derive the time series and find the slope and intercept to determine the trend of crop yields, i.e., a sloping line rather than horizontal line. The forecasting equation for the linear trend model is**:**

$$Y(t) = \propto + \beta t$$

Where t, is the time index, the parameters alpha and beta (the "intercept" and "slope" of the trend line) which are usually estimated via a simple regression in which Y is the dependent variable and the time index t is the independent variable.

Results and Discussions

Trend of Yield of Selected Crops in Niger State from 1997 to 2018

The trend of yield of selected crops was presented in Figure 2 to 10. The Figures 2 indicated the trend of years with the maximum number of yields while the other years indicate the minimum number of yields of maize in the state.

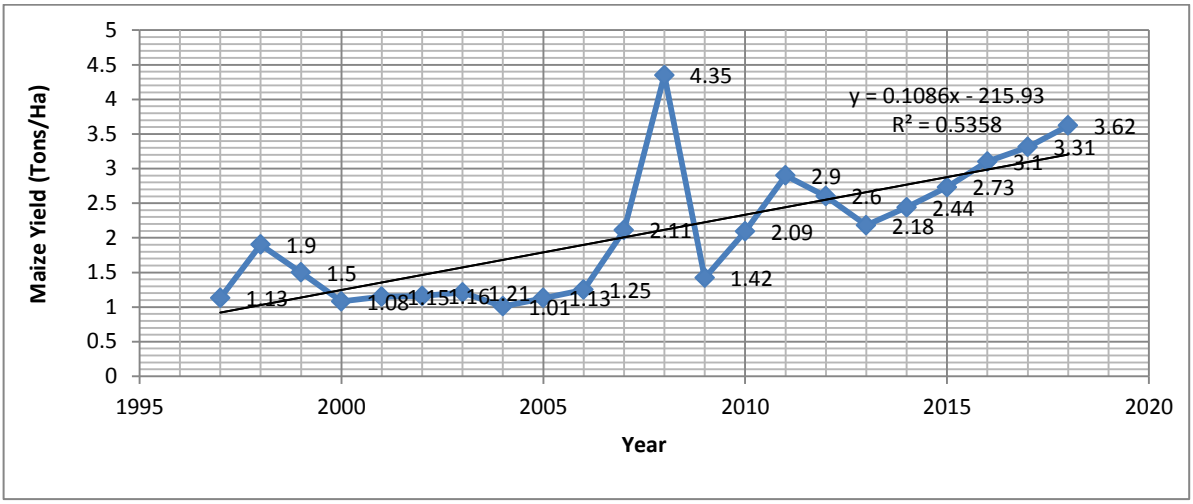

Figure 2: Trend of Maize Yield in Niger State from 1997-2018
Source: Data Analysis, (2024)

Figure 2, shows the trend of maize yield in Niger state in tons per hectare between 1997 and 2018. The result revealed that the highest maize yield of 4.30 tons/ha was observed in the year 2008 while the lowest maize yield of 1.01 tons/ha was observed in 2004, the trend line shows a positive trend of Y=0.108x-215.9 with the R^2 of 50% of the positive linear model which implies a constant increase of maize yield. It was also observed from the year 2016 and 2018 that shows a continuous increasing trend of maize yield within the state. The increase in maize production observed earlier in this study was as a result of intensification of maize production rather than through hectare expansion and a slight change in the system of agriculture from traditional farming methods to the use of chemicals. This finding is in contrary with the study of (Joshua, 2015) on the potential impact of climate variability on Nigerian agriculture. Whose results shows that accelerated growth in maize production (IGR 1.3%; CGR 1.3%) and productivity (IGR 2.6%; CGR 2.6%); and (ii) significant growth deceleration in maize hectare (IGR -1.4 percent; CGR -201%) over the period 1990-2011. Between 2000 to 2007 there was a decrease trend which signifies reduction in the yield of maize This could be explained as resulting from maize farmers gradually moving away from maize productions at that period in favor of sorghum and millet that require less fertilizer than maize because maize crop demands more fertilizer than other cereals and most farmers are resource poor, therefore cannot afford fertilizer.

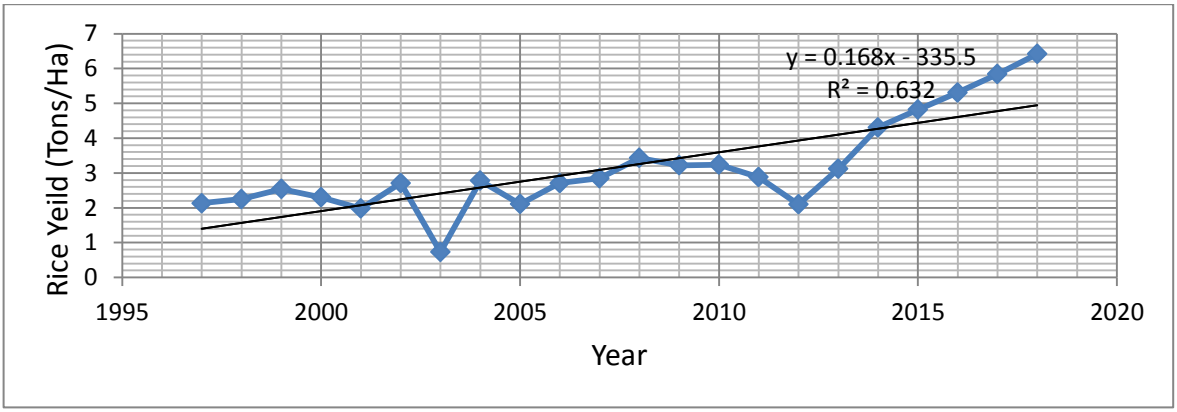

Figure 3: Trend of Rice Yield in Niger State from 1997-2018
Source: Data Analysis, (2024)

Figure 3, shows the trend of rice yield in Niger state in tons per hectare between 1997 and 2018. The figure showed that the highest rice yield of 6.42 tons/ha was observed in the year 2018 while the lowest rice yield of 0.7 tons/ha was observed in 2003.The drastic drop in the yield of rice in 2003 was as a result of adverse effect of climate variability (floods), and inadequate agricultural practices embarked upon by the rice farmers in the state. The trend line shows a positive trend of Y=0.168x-335.5 with the R^2 of 60% of the positive linear model which implies a constant increase of rice yield. The general increasing trend in rice production noticed in the study area was due to the introduction of improved variety of rice seeds and high demand of rice in the markets that motivated the rural farmers. The drastic increase noticed in 2014 and 2018 was as a result of government intervention of soft loan scheme; fertilizers were sold at subsidized rate and properly monitored to rural farmers in Niger state. Rice has also become a highly strategic and priority commodity for food security in Niger state and Nigeria in as a whole. Consumption is growing faster than that of any other major staple crops in the State because of high population growth, rapid urbanization and changes in eating habits although local rice production increased rapidly after the2007-2008 food crisis, a key problem facing the rice sector in Nigeria in general is that local production has never caught up with demand. This result was contrary to (Okoroh, 2014) findings that there was decrease on rice yield all over Nassarawa state in 1998-2016. However, between the years 2000 to 2006 the negative trend noticed in the state was due to floods.

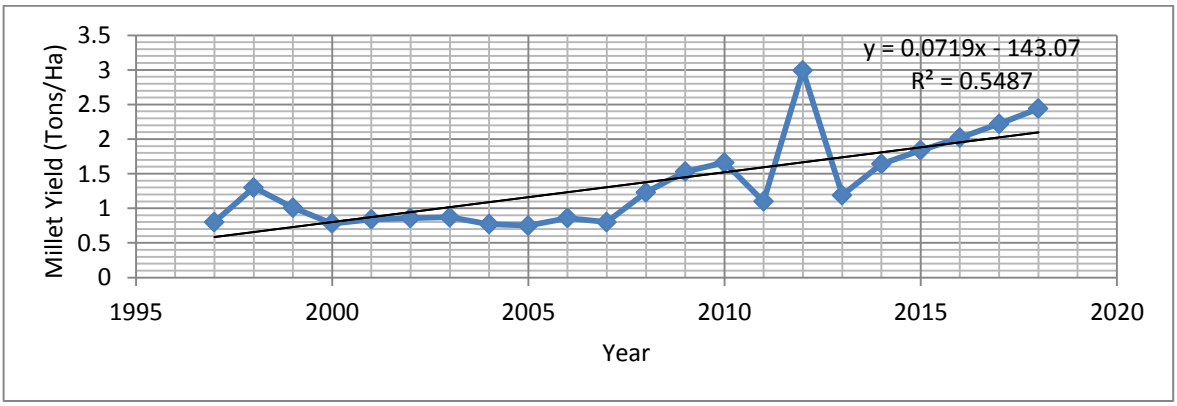

Figure 4: Trend of Millet Yield in Niger State from 1997-2018
Source: Data Analysis, (2024)

Figure 4, shows the trend of millet yield in Niger state in tons per hectare between 1997 and 2018. The figure showed that the highest millet yield of 2.99 tons/ha was observed in the year 2012 while the lowest millet yield of 0.75 tons/ha was observed in 2005. In 2011 and 2013 severe reduction and lower grain quality was observed in the State. This was as a result of the negative effect of pest and diseases (stem borers, armyworms, downy mildew, smut and ergot) that cause significant damage to millet plants, leaves, stems especially during the flowering and grain-filling stages. The trend line shows a positive trend of Y=0.071x-143.0 with the R^2 of 0.548 of positive linear model which implies a constant increase of millet yield. It was also observed from the year 2014 and 2018 that shows a continuous increasing trend of millet yield within the State. The increment in the yield these years was due to Government intervention of distribution of pesticides and insecticides to millet farmers in the State through ward councilors and sincerely monitored by State agricultural extension officers. This conformed to the findings of Obafemi, *et al* (2018) that there is an increase of millet yield in Nigeria in the year 1981 – 2018. It was also noticed that the State cultivates millet on a lower scale between the years 2000 to 2006 as rural farmers were discouraged due to serious outbreak of pests that feed on the millet fruits.

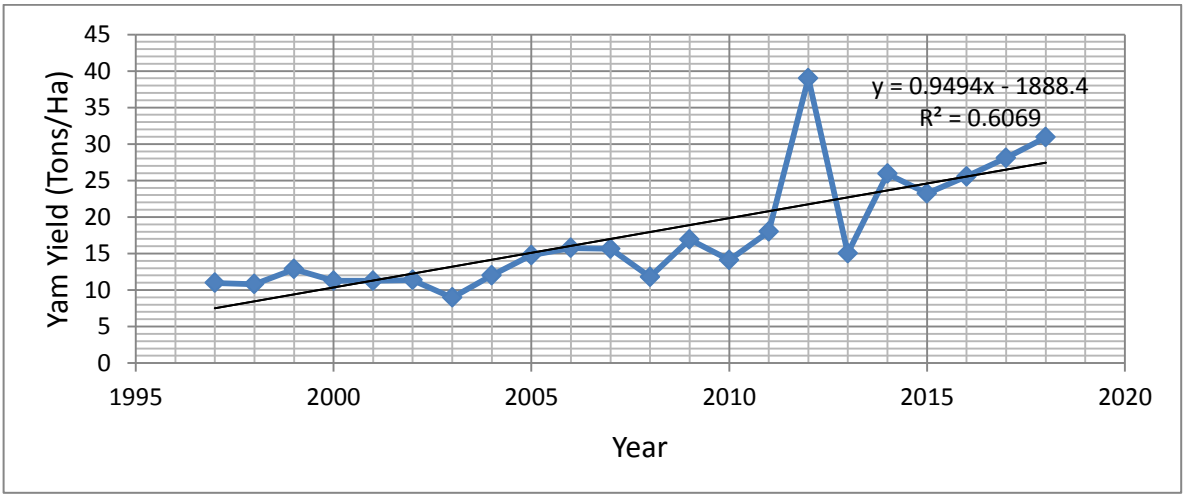

Figure 5: Trend of Yam Yield in Niger State from 1997-2018
Source: Data Analysis, (2024)

Figure 5 shows the trend of yam yield in Niger state in tons per hectare between 1997 and 2018. The figure indicates that there was an increase of 39.01 tons/ha in the yield of yam in the year 2012 The high yield of yam observed in this year was due to the arrival of new improved yam varieties in the State and high demand of yam observed in the market the previous years while the lowest yam yield of 8.95 tons/ha was observed in 2003 due to high effect of fungi diseases (yam anthracnose, yam tuber rot) and bacteria diseases(yam bacterial soft, yam mosaic virus and yam nematode) that have resulted in the soft and rotting of yam tubers in the year. The trend line shows a positive trend of Y=0.949x-1888.0 with the R^2 of 61% of the positive linear model which implies a constant increase of yam yield. The general increase in the yield of yam in the state over years was due to introduction of new improved varieties of yam seeds and intensification of yam production by the rural farmers due to high demand in the market. This conformed to Ojo and Oladimeji, (2022) who studied the evaluation of yam (Dioscorea spp.) varieties for yield and yield components in Niger state.

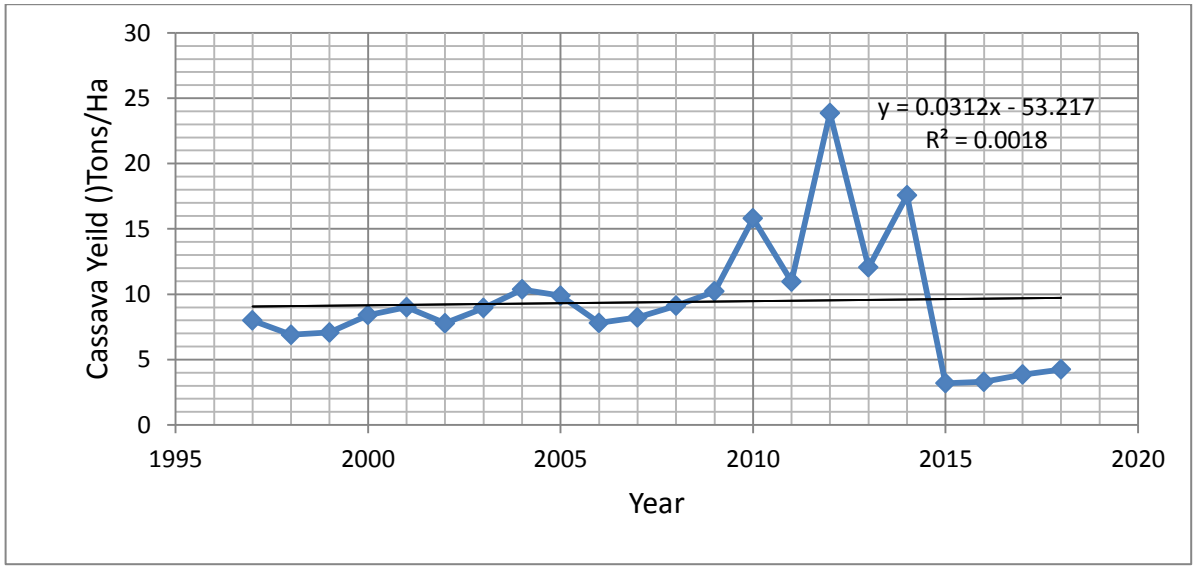

Figure 6: Trend of Cassava Yield in Niger State from 1997-2018
Source: Data Analysis, (2024)

Figure 6 shows the trend of cassava yield in Niger state in tons per hectare between 1997 and 2018. The figure indicates that the highest cassava yield of 23.86 tons/ha was observed in the year 2012 due to the high demand of cassava as it serve as source of raw materials for gari processing cottage industries spatially established in the state for the past two years. While the lowest cassava yield of 3.19 tons/ha was observed in 2016, the trend line shows a weak positive trend of Y=0.031x-53.21 with the R^2 of 0.001 of weak positive linear model which implies a constant increase and decrease of cassava yield. The year 2015 and 2018 shows a drastic reduction trend of cassava yield within the state. This was due to the farmers- herders' crises banditry and kidnapping that forced most farmers to leave their farms.

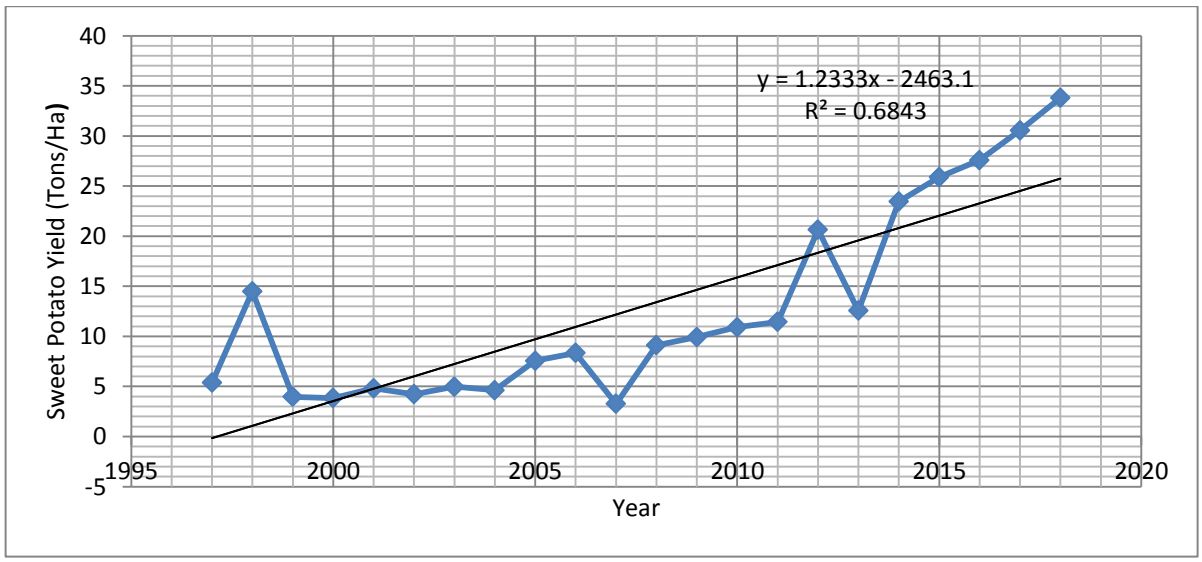

Figure 7: Trend of Sweet Potato Yield in Niger State from 1997-2018
Source: Data Analysis, (2024)

Figure 7 shows the trend of sweet potato yield in Niger state in tons per hectare between 1997 and 2018. The figure showed that the highest sweet potato yield of 33.8 tons/ha was observed in the year 2018 while the lowest sweet potato yield of 3.26 tons/ha was observed in 2007, the trend line shows a weak positive trend of Y=1.233x-2463 with the R^2 of 0.684 of strong positive linear model which implies a constant increase of sweet potato yield. The year 2014 and 2018 shows a drastic increase trend of sweet potato yield within the state due to high demand of sweet potato in the market. Sweet potato was seen in the state as easy and simple to cultivate by the farmers compared to other staple crops like yam.

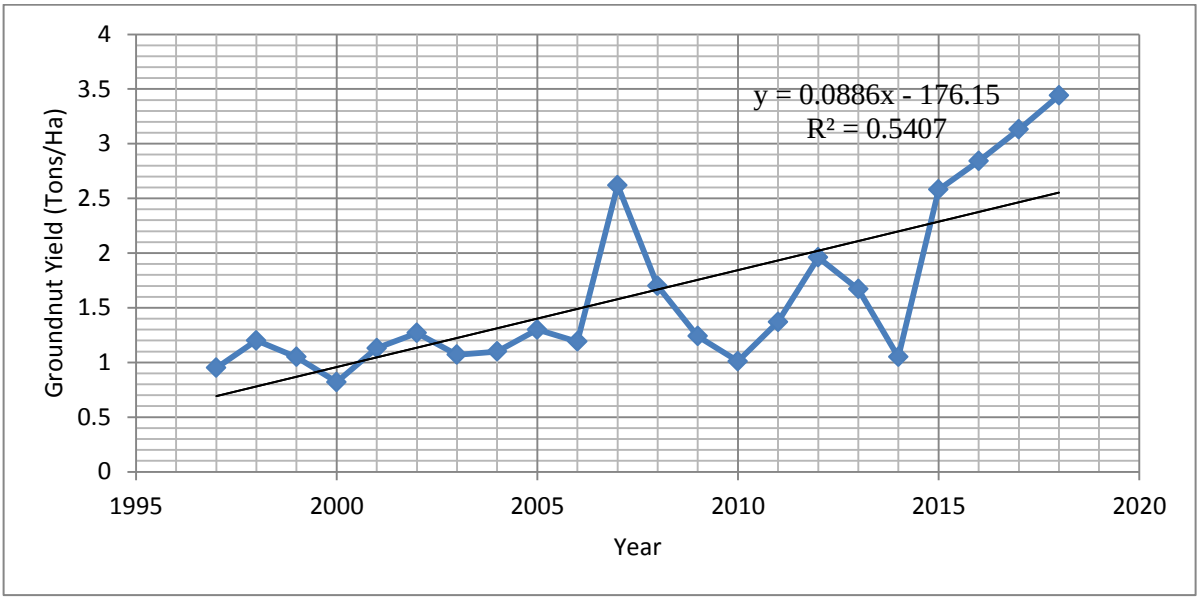

Figure 8: Trend of Groundnut Yield in Niger State from 1997-2018
Source: Data Analysis, (2024)

Figure 8 shows the trend of groundnut yield in Niger state in tons per hectare between 1997 and 2018. The figure showed that the highest groundnut yield of 3.44 tons/ha was observed in the year 2018. The trend line shows a positive trend of Y=0.88x-176.1 with the R^2 of 50% of positive linear model which implies a constant increase of groundnut yield. Since 2015 to 2018 there was steady increase in the yield of ground nut in the state due to improved farming practices embarked upon by the farmers, better government initiatives, research and development and increased investment. The lowest groundnut yields of 0.82 tons/ha was observed in 2000, 2010 and 2014 respectively. The drastic fall in the yields of groundnut within the State in the years 2000 and 2010 was that the growing season was characterized by several droughts, outbreak of pests and diseases (groundnut rosette virus) and poor farming activities that has affected the yield. In 2014 heavy rainfall, flooding soil degradation inadequate input supply (seeds, fertilizers and pesticides) and climate change negatively impact groundnuts yields. This conformed to Abdullahi and Mohammed (2020) on the Effect of organic and inorganic fertilizers on ground nut (Arachis hypogaea L.) yield in Niger state, Nigeria.

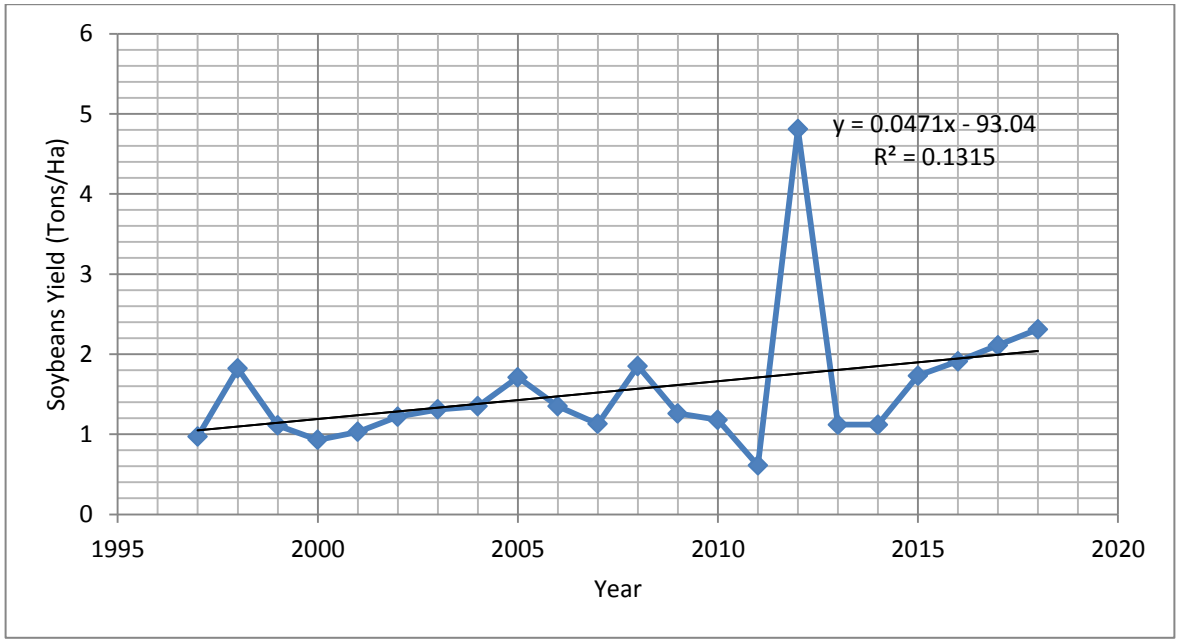

Figure 9: Trend of Soybeans Yield in Niger State from 1997-2018
Source: Data Analysis, (2024)

Figure 9: shows the trend of soybeans yield in Niger state in tons per hectare between 1997 and 2018. The figure showed that the highest soybeans yield of 4.81 tons/ha was observed in the year 2012. This was because the growing season was characterized by normal rainfall and improved farming practices. while the lowest soybeans yield of 0.61 tons/ha was observed in 2011, the trend line shows a positive trend of Y=0.047x-93.04 with the R^2 of 10% of weak positive linear model which implies a constant decrease of soybeans yield in most of the years under study. The severe reduction in 2011 as observed was due to insufficient supply of essential inputs, like seeds, fertilizers, negative effect of soil erosion and nutrient depletion. This finding is in contrary view with the result of Suleiman, and Aliyu, (2020) on the effect of phosphorus fertilizer on soya beans yield and nutrient uptake in the savannas of Nigeria.

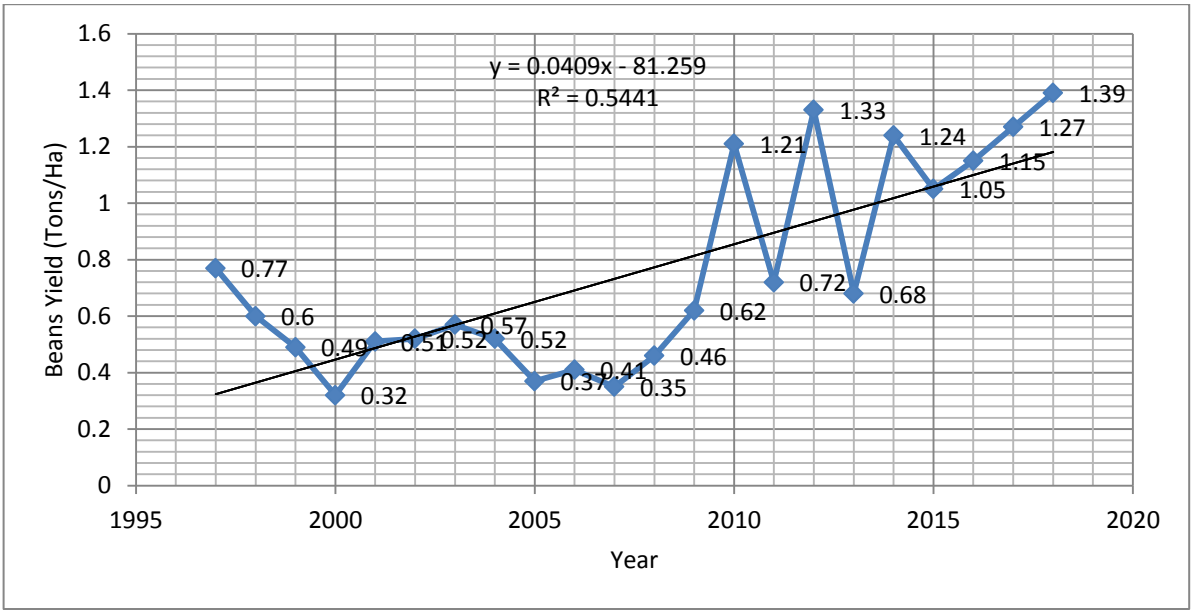

Figure 10: Trend of Beans Yield in Niger State from 1997-2018
Source: Data Analysis, (2024)

Figure 10 shows the trend of beans yield in Niger state in tons per hectare between 1997 and 2018. The figure indicated that the highest beans yield of 1.39 tons/ha was observed in the year 2018 while the lowest beans yield of 0.32 tons/ha was observed in 2000, the trend line shows a positive trend of Y=0.040x-81.25 with the R^2 of 50 percent of positive linear model which implies a constant increase of beans yield. The year 2015 and 2018 shows a drastic increase trend of Beans yield within the state. This was as a result of better government programs and initiatives that were aimed at supporting farmers, such as the provision of subsidies, training, and extension services in boosting beans production. This finding is in line with Agbola, *et al (*2016) that the beans yield in Western Ethiopia increase by 0.043 with the R^2 of 62 percent from 1996 to 2017.

Conclusion and Recommendations

Conclusively, the findings revealed significant temporal variability in crop yields, in the sampling points across Niger state. Crops like maize, millet, rice and yam yields were on constant increase over years across the study area while soya beans and cassava showed a weak positive trend. The results also, revealed that the state experienced a drastic decrease of cassava yield in the last four years (2015-2018), this is an indication that the trends of crop yields vary significantly across Niger state. The trends analysis is essential for evidence-based agricultural policy. The research therefore, recommends the use of high-yielding crop varieties that are resistant to pest and diseases and encourages farmers to use fertilizers to improve yields of crops.

References

Abdullahi, M. and Mohammed, I. (2020). Effect of Organic and Inorganic Fertilizers on Groundnut (Arachis hypogaea L.) Yield in Niger State, Nigeria. *International Journal of Agriculture and Rural Development, 23(1) 123-132.*

Abdullai, A.-R., Ziemah, M. K., & Akaabre, P. B. (2017). Climate Change and Rural Livelihoods in the Lawra District of Ghana. A Qualitative Based Study. *European Scientific Journal, ESJ*, *13*(11), 160. https://doi.org/10.19044/esj.2017.v13n11p160.

Adamgbe, E.M. (2012): Effect of Rainfall Variability on Maize Yield in Gboko L.G.A. of Benue State. *Unpublished M.Sc. Dissertation submitted in the Department of Geography, Benue State University, Makurdi.*

Agbola, A.O. Fayiga (2016). Effects of Climate Change on Agricultural Production and Rural Livelihood in Nigeria. *Journal of Agricultural Research and Development*.

Anyadike, R.N.C., Madu, I.A. and Ajaero, C.K., (2010): *Conference Proceedings on Climate Change and the Nigerian Environment*. Held at UNN.

Ayoade, J.O. (2004): Introduction to Climatology for the Tropics. Revised edition. Spectrum books limited, Ibadan.

Cicek, I. and Turkogu, N. (2005): Urban effects on precipitation in Ankara Turkey". *Atmosfere 18 (3):173-187.*

Emmanuel,A. and Fanna (2012) Variations in Climatic Parameters and Food Crop Yields: Implications on Food Security in Benue State, Nigeria. *Conference Journa of Environmental Studies (CJES), Kogi State University. 7(59-67).*

Ifabiyi, I. P. & Ojoye, S. (2013). Rainfall Trends in the Sudano-Sahelian Ecological Zone of Nigeria. *Earth Science Research*, *2*(2), 194–202. https://doi.org/10.5539/esr.v2n2p194

Intergovernmental Panel on Climate Change. (2014). *Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, United Kingdom and New York, NY, USA.

Joshua, A., Olusanya, A. & Adeniyi, G. (2015).*The Potential Impact of Climate Change on Nigerian Agriculture*. IFPRI Headquarter International Food Policy Research Institute 1201 Eye St, Washington, DC 20005-3915 USA.

Khanal, R. C. (2009). "Climate variability and Organic Agriculture" *The Journal of Agriculture.*

Khanal, U., Wilson, C., Lee, B. L., & Hoang, V. (2018). Climate Variability Adaptation Strategies and Food Productiviy in Nepal : A Counterfactual Analysis. *Climatic Change*, *110*, 454–469.

Lee, J., De Gryze, S. & Six, J. (2009). Effect of Climate Change on Field Crop Production in the Central Valley of California. *California Energy Commission, Sacramento, California.*

Obafemi, O. O. & Adebolu, E. A. (2018). Effect of Climate Variability on the Yield of Crops in Ondo State, Nigeria. *International Journal of Water Resources and Environmental Engineering*, *10*(5), 54–63. https://doi.org/10.5897/ijwree2018.0783.

Odjugo, P. & Ovuyorwiroye, A. (2010). *Adaptation to Climate Variability Agricultural Sector in the Semi-Arid Region of Nigeria*. A Paper Presented in 2000 International Conference: Climate Sustainability and Development in Semi-Arid Regions. August 16-20, 2020, Fortaleza – Ceara Brazil.

Odjugo, P. A. O. (2010). "General Overview of Climate Variability Impacts in Nigeria" *JournalHum. Ecol.*, 29(1), 47-55.

Ojo S. O. & Oladimeji, O. (2022). Evaluation of yam (Dioscorea spp.) Varieties for Yield and Yield Components in Niger State, Nigeria. *Jounal of Agricultural Science and Technology*. 22(3), 537-548.[i]

Okoroh J. P. (2014). Climate Change Mitigation and Adaptation Strategies Used by Farmers in Imo State, Nigeria. http://dx.doi.org/10.4314/jae.v20i2.10

Sani, S, (2014). C*limate Change Adaptation Strategies of Smallholder Farmers*: *The Case of Assosa District of BenishangulGumuz Regional State, Western Ethiopia*; Haramay University: Haramaya, Ethiopia, 2014.

Showemimo, F. A. (2002): Influence of Climatic Variations on Some Agro-nutritional Traits of Quality Protein Maize lines in Northern Guinea Savanna of Nigeria. *Journal Tropical Biosciences, 2 (1): 119-125.*

Suleiman, M. A. & Aliyu, H. (2020). Effect of Phosphorus Fertilizer on Soya Beans Yield and Nutrient Uptake in the Savannas of Nigeria. *International of Agriculture and Rural Development. 23(1),145-154.*

Tyubee, B. T. (2006): An Analysis of Food Crop Yields and Climate Relations in Benue State, Nigeria. *Journal of the Nigerian Meteorological Society. 6 (1).*

Usman, M. T. & Abdulkadir, A. (2014). An Experiment in Intra-Seasonal Agricultural Drought Monitoring and Early Warning in the Sudano-Sahelian Belt of Nigeria. *International Journal of Climatology*, *34*(7), 2129–2135. https://doi.org/10.1002/joc.3840.

Yawaz, H. (2023). Spatial Analysis of Monthly and Annual Precipitation Trends in Turkey. *Water Resources Management*, *26*, 609–621.