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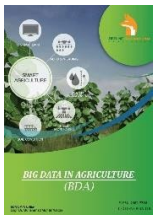

RESEARCH ARTICLE

MODELING AND SIMULATION OF YAM CROP YIELD FOR TEN YEARS IN KEFFI, NASARAWA STATE, NIGERIA

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ABSTRACT

Yam crop tuber is the stable crop grown widely in all part of Nasarawa State, and this is attributed by the climate and soil factor. In this study, the water required (rainfall) has been simulated. The total area of land mass has been calculated for obtaining and determining the Yam crop simulation. The software minitab was used to calculate the Rainfall Trend Analysis (RTA). The mean monthly rainfall was estimated by dividing the accumulated rainfall for a month by the total number of days it rains in that month using the mean equation and transposed to make a sum of 120 months (10 years). The highest rainfall recorded was in 2020 with 2650mm of rain and less recorded rainfall trend was in 2011 with 1800mm of rainfall. This analysis has shown the rainfall trend in 10 years period with 0.77 Pearson correlations. The Pearson Matrix correlation has indicated the high correlation of 0.92. This was illustrated in the rainfall simulation and sequentially arranged in linear direction following the rainfall trend pattern. The average hectares of land cultivated has increased from 1.5 hectares geometrically in linear trend simulation. The Pearson correlation has indicated high Yam yield in Keffi with 0.93 in 2018.

KEYWORDS

Yam crop, simulation, Climate, soil, correlation Analysis

1. INTRODUCTION

Rainfall is one of the vital climatic elements that control the growth of crops for human consumption. Large African, as well as Nigeria population, depends on rain-fed Agriculture. This study is paramount in determining the rainfall trend using time series analysis to ascertain the intensity of rainfall in the study area (Cornet et al., 2023). The amount of rainfall particularly in the different locations can be determined through a simulation study. The simulation prosper solutions of where certain crops to be grown. The crop yield may be calculated based on the rainfall received. This study is important to farmers especially in determining crop yield as well as checking the rainfall trend and the value for each station at different locations (Bandil et al., 2024). The study is also paramount to planners as well as the Academician. Both of them will find this study useful and vital in terms of research and development. The socio-economic development in the Agricultural sector is the lead-way to economic prosperity determined by climatic variability in the Keffi Local Government Area of Nasarawa State.

Climate change and global warming have increased at an alarming rate as a result of anthropogenic factors such as urbanization. Therefore, the study is relevant because it will assist researchers to understand the future consequences of rainfall variation due to climate change (Okongor et al., 2021). This is because climate change has been linked to the climate, which in turn would affect where and how people make a living, how the flora and fauna species would thrive, how food would be produced which would be influenced by the availability of water (Pushpalatha et al., 2021). Studies have shown that both plants and animals require a specific amount of water for their existence, excess or inadequate supply of water could lead to their demise. Carbon dioxide is emitted into the atmosphere at an accelerated rate and also the depletion of the ozone layer has caused the earth's surface to be heated up (Adesokun et al., 2024).

Precipitation is a fundamental part of the environment, and progress in their example can impact the neighborhood climate, widely varied vegetation, water accessibility in lakes, agrarian creation, irrigational practices and harvest (Raymundo et al., 2014). Different investigations have been embraced to assess the impact of climatic changes on water assets and crop cultivation (Adifon et al., 2020). Africa has been perceived as one of the landmasses that are both most noticeably awful impacted by, and generally powerless against, environmental inconstancy and change (Mignoma et al., 2020). Changes in the dissemination and size of outrageous precipitation occasions seen in many pieces of the African landmass are related to both environmental change and environment changeability which can fluctuate starting with one district then onto the next Outrageous hydrological system, for example, dry seasons and floods are relied upon to increment in force under environmental change situations, causing both ecological and financial issue (Angba, 2020).

Desertification, desert infringement and a modification of hydrological systems have as of now been seen in a few African environments and areas (Emason et al., 2024). A lack of water can damagingly affect vegetation condition, horticultural creation and livelihoods, as numerous African nations depend on low usefulness downpour took care of farming. Semi-bone-dry and parched regions amassed in sub-Saharan Africa are especially inclined to outrageous precipitation fluctuation and water deficiencies. Most individuals in sub-Saharan nations (85%) live in provincial regions and are occupied with agrarian exercises; along these lines cultivating is a chief wellspring of their livelihoods. Most of group researcher gave proof that drawn-out patterns in precipitation have impacted monetary development rates in sub-Saharan Africa (Galy-Lacaux et al., 2009; Dwanmena et al., 2022).

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2. Material and Methods

2.1 Study Area

The study was restricted to the keffi main towns. And the simulation has help in determining the issue of rainfall duration and its intensity as well. Figure 1 depicts the area study.

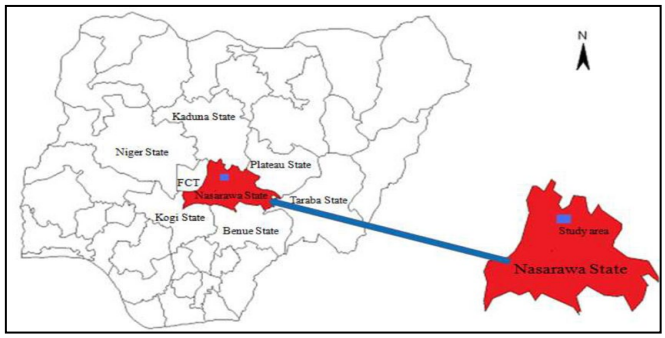

Figure 1: Study Area map of Keffi, Nasarawa State Nigeria

2.1.1 Location of the Study Area

The demarcations of the area surveyed were conducted by using GIS software with the plotting of the coordinates using GPS. The Ground Control Points was digitized and analysed using Google Earth Pro. The following are points where the survey was conducted:

GCP 1 Lat 8°51'36.50"N, Long 7°50'2.01"E

GCP 2 Lat 8°48'43.57"N, Long 7°51'42.03"E

GSP 3 Lat 8°49'19.17"N, Long 7°55'36.48"E

GSP 4 Lat 7°55'36.48"E, Long 7°54'59.90"

The study area has georeferenced with four control points. The survey has depicted the perimeter where the crops are being cultivated in Keffi.

2.1.2 Climate and Vegetation

The climate of the study area is the same as that found in most parts of Northern Nigeria. Areas located in Sudan and Sahel Savannah zones are characterized by the wet and dry seasons. The vegetation falls within the derived savannah with both characteristics of forest and savannah (Onyeneke, 2024). The wet season is between late May to early September, the mean annual temperature usually is between 29oc to 32oc. Mean annual rainfall is between 1500mm to 2000mm and the amount of the humidity is only higher during the rainy or wet season 15%-20% in the dry period and 50%-60% during the wet periods.

2.2 Sources of Data

The data from this study was driven from Nigerian Meteorological Agency (NiMET) and other relevant agencies and field investigations. Both primary and secondary data has been inculcated in this study.

2.3 Time Series Analysis (TSA)

The mean monthly rainfall was estimated by dividing the accumulated rainfall for a month by the total number of days it rains in that month using the mean equation and transposed to make a sum of 120 months (10 years). The analysis was carried out using Minitab software (Asfaw et al., 2024).

2.4 Rainfall Anomaly Index (Simulation)

Precipitation Anomaly Index (PAI) and Annual Rainfall Anomaly Index (ARAI) was utilized to investigate the recurrence and force of the dry and stormy years. The month-to-month RAI was likewise determined for explicit long periods of the authentic series meaning to examine the circulation of precipitation in the long stretches of the best inconsistency (Srivastava and Amir, 2010)

2.5 Rainfall Trend Analysis

The software minitab was used to calculate the Rainfall Trend Analysis (RTA). This has been conducted using time period of the years and the amount of rainfall obtained during or at different period of the years.

3. Result and Discussion

3.1 Assessment of Rainfall Trend Analysis in the Study Area

The data obtained from 2011 to 2020 was analyzed as shown in Table 4.1. These include the total annual rainfall distribution, the number of Hectares of crop cultivated, the crop yield and the individual crop yield per hectare in the study area.

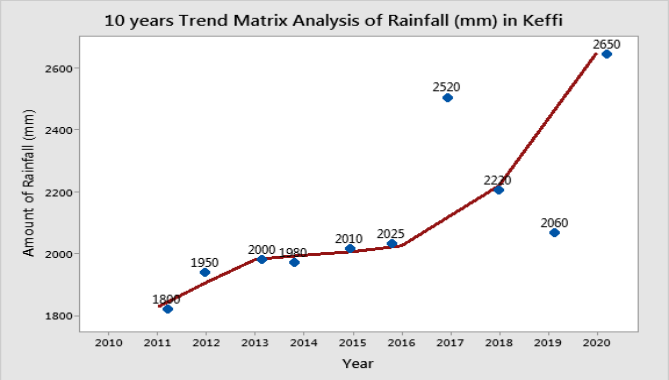

Figure 2: Rainfall Trend correlation Matrix from the Study Area

The results were obtained in three different categories to cover the wide area of the study. The first analysis is the 10 years rainfall trend matrix as in figure 2 showing the Pearson rank correction with linear measurement. The highest rainfall recorded was in 2020 with 2650mm of rain and less recorded rainfall trend was in 2011 with 1800mm of rainfall. This analysis has shown the rainfall trend in 10 years period with 0.77 Pearson correlation matrix.

3.2 Evaluation of Rainfall Trend in Keffi

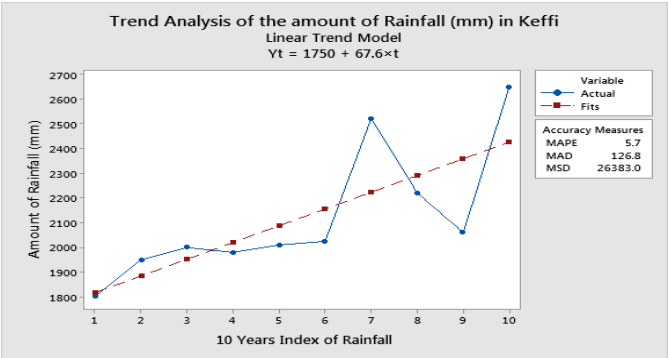

Figure 3: Rainfall Index Trend Analysis in the Study Area.

The rainfall simulation has shown two important years of high rainfall events. These are found in the year 2017 and 2020 as shown in figure 3. The correlation matrix of the 10 years rainfall simulation has 0.76 Pearson correlation matrix.

3.3 Determine the Mean Annual Rainfall Distributions in Keffi

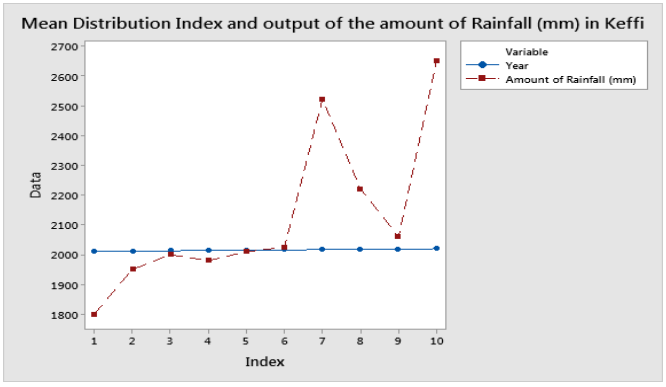

Figure 4: Mean Distribution of Rainfall in Keffi, Nasarawa State

Figure 4 was the second result showing the mean annual distribution of the rainfall in Keffi. Within the 10 years period of the rainfall distribution,

there was 2100mm of rainfall as an annual mean. This denotes that the amount of the rainfall distribution were determined and fitted and different crops to be cultivated from the land obtainable

3.4 Determine the 10 Years Rainfall Simulation Matrix in Keffi

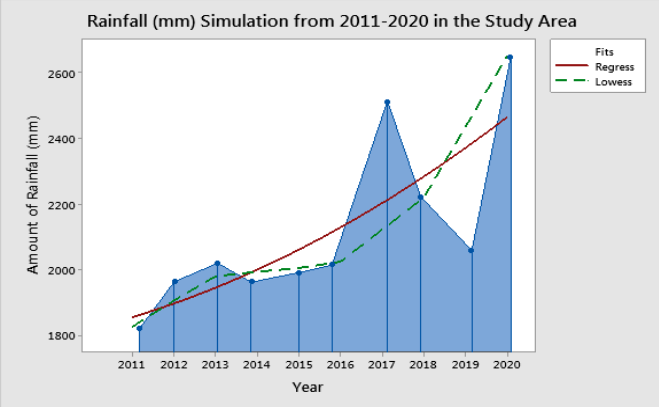

Figure 5: Rainfall Simulation Analysis in the Study Area.

The area of field cultivated determined how high or low the crop yield might be found. Increase in the farm input and the land carrying capacity indicates more participation in Agriculture. The land area simulation has shown three stages of incensement through simulation. These are 2016, 2019 and 2020. These were been illustrated in figure 5.

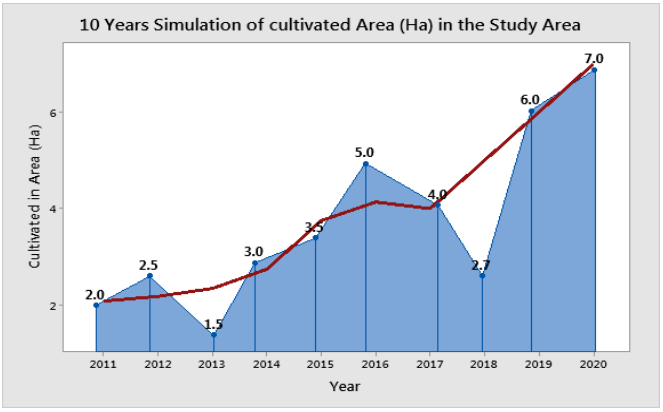

Figure 5: Analysis of land mass Area simulation for yam Crop in the Study Area

In the 10 years period of rainfall, there were changes between the amount of rainfall and the crop yield. For this reason Yam has been selected to determine the growth and yield. If there is less amount of rainfall, the Yam yield will be less. Based on the simulation trend of the amount of rainfall and the Yam crop yield, it was considered that yield has correlation of 0.69 because the amount of rainfall has fallen to the mean distribution of 2100mm of rainfall. While two variables has the highest Yam yield which are 55000 kg and 58000kg. Also the less Yam yield was found where rainfall amount falls to 1800mm as shown in figure 5.

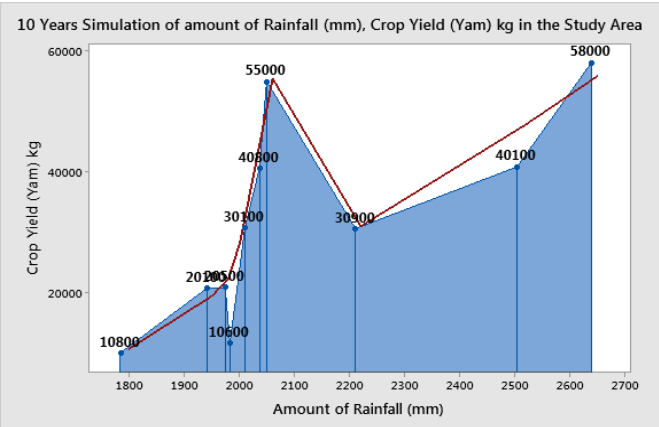

Figure 6: Simulation Analysis of Rainfall amount for Yam crop Yield in Keffi

The Pearson Matrix correlation has indicated the high correlation of 0.92. This was illustrated in the rainfall simulation and sequentially arranged in linear direction following the rainfall trend pattern. Figure 6 has shown the Yam yield simulation of 10 years period.

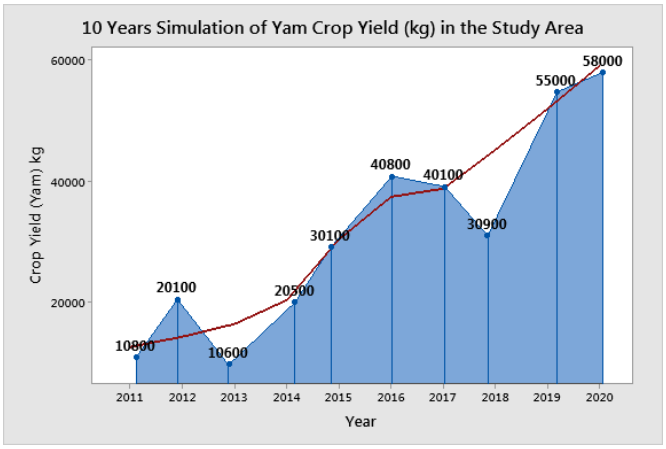

Figure 7: Simulation of 10 years crop Yield in Keffi

The Yam crop yield simulations per hectare were also analysed. Using the same simulation matrix, the yield was calculated based on the division of total Yam crop of the particular to obtain the individual or per single hectares of land. The result indicated that between the 10 years period of the simulation, 2018 appeared to be the year of the highest Yam crop yield in the study area as indicated in figure 7.

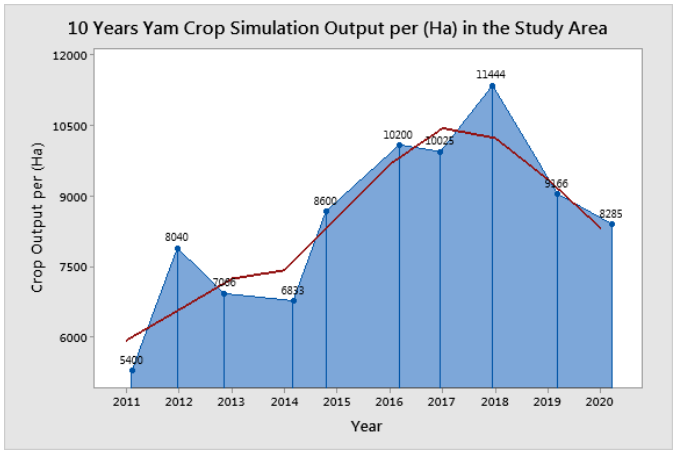

Figure 8: High Yam Crop Yield Simulation in Keffi

Yam crop yield has increased based on the analysed model in figure 8. The average hectares of land cultivated has increased from 1.5 hectares geometrically in linear trend simulation. The Pearson correlation has indicated high Yam yield in Keffi with 0.93 in 2018.

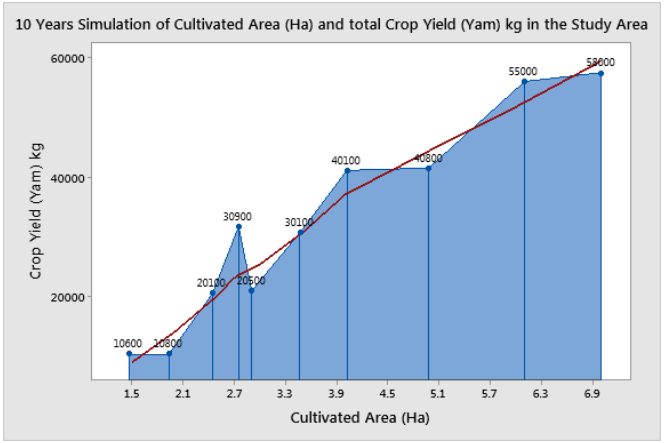

Figure 9: Land Cultivated and Yam crop Yield in Keffi

Figure 9 is the amount of land area cultivated in hectares and the actual crop yield of Yam. The highest yam yield were obtained from the 6.3 to 6.5 hectares of land

4. Conclusion

The simulations of rainfall were successfully done showing the year 2017 and the year 2020 having the highest rainfall input. The recorded year of high intensity of rainfall is 2020 with maximum of 2650mm within the 10 years trend. Using the simulation analysis, the mean annual distribution of rainfall in Keffi is 2100mm. Farmers in the study area have opportunities to cultivate annual crops with high yield due favourable climate and soil factor in Keffi Nasarawa state. Based on the model in Figure 4.8, the highest period of Yam crop yield was illustrated in linear trend simulation. The rainfall pattern remains almost the same mean distribution. This determines to the large extend the growth in Yam production geometrically. The analysis of Pearson matrix correction appears to be high with 0.93. While the increments in population both farming and non farming sector has increases over the years. The model has simply shows the linear growth in Yam production in keffi. However it was concluded that with the 2100mm of rainfall as an annual mean distribution, varieties of crops such as the tubers, corn and cereals can be growth abundantly.

Recommendations

1. The government at both Federal and State level should understand the issue of rainfall variability is very important especially to farmer and other stakeholders.
2. Farmers will benefits more through the study rainfall simulation; the crop production can be determined by the simulated rain for certain periods of time. The duration and the prediction of period of growth can also be ascertained.
3. Stakeholders and private partnership would acquire the knowledge of rainfall trend provided with essential information on increase or decrease amount of rainfall at different period of time in the study area.
4. If we know the mean annual rainfall distribution in a particular area or region, farmers will have choice to determine which crop should be grown.
5. The study of water requirement of a certain crop provides other opportunities of practicing similar crop of the same or different species of economic values.
6. Farmers should have the knowledge of seasonality coupled with the determination of farm size. The ability to have more rainfall has been considered to provide more crop yield especially that of yam.

References

Adesokan, M., Alamu, E.O., Fawole, S., Asfaw, A., and Maziya-Dixon, B., 2024. Elite Genotypes of Water Yam (Dioscorea alata) Yield Food Product Quality Comparable to White Yam (Dioscorea rotundata). Applied Sciences, 14 (9), Pp. 3704.

Adifon, F.H., Atindogbé, G., Bello, D.O., Balogoun, I., Yabi, I., Dossou, J., Saïdou, A., 2020. Effect of climate variability on yams (Dioscorea spp.) production in Central and Northern Benin. American Journal of Climate Change, 9 (4), Pp. 423-440.

Angba, C.W., Baines, R.N., and Butler, A.J., 2020. Examining yam production in response to climate change in Nigeria: A co-integration model approach. Social Sciences, 9 (4), Pp. 42.

Asfaw, A., Agre, P.A., Dieng, I., Adebola, P., Obidiegwu, J.E., Chamba, E., Dibi, K.E.B., 2024. Trends in genetic gain for yam in the IITA breeding program. Crop Science.

Bandil, D.K., and Kumar, S., 2024. Crop Yield Prediction in Diverse Agricultural Landscapes Transforming Agricultural Management for a Sustainable Future: Climate Change and Machine Learning Perspectives, pp. 255-267: Springer.

Cornet, D., Sierra, J., Tournebize, R., Dossa, K., and Gabrielle, B., 2023. Expected yield and economic improvements of a yam seed system in West Africa using agro-physiological modelling. Plants, People, Planet.

de Barros, E.C., Silva do, S., Jose, A.A., Taube, P.S., Gasparin, E., Cotta, D., Rômulo, A., da Silva, S.E., and da Paixão, G.P., 2024. Risk of climate change to sweet potato cultivation in the American continent. Journal of Crop Improvement, Pp. 1-17.

Dwamena, H.A., Tawiah, K., and Akuoko, K., Amanda, S., 2022. The effect of rainfall, temperature, and relative humidity on the yield of cassava, yam, and maize in the Ashanti region of Ghana. International Journal of Agronomy, 2022 (1), Pp. 9077383.

Mignouna, D.B., Aighewi, B.A., Maroya, Norbert, A., Bolanle, B., Morufat, A., Oluyemi, T., Abdoulaye, T., 2023. Evaluation of training on good agronomic practices for seed yam production in Nigeria. Seeds, 2 (1), Pp. 116-126.

Mignouna, D.B., Akinola, A.A., Abdoulaye, T., Alene, A.D., Manyong, V., Maroya, N.G., Lopez-Montes, A., 2020. Potential returns to yam research investment in sub-Saharan Africa and beyond. Outlook on Agriculture, 49 (3), Pp. 215-224.

Okongor, G., Njoku, C., Essoka, P., and Efiong, J., 2021. Climate Variability and Yam Production: Nexus and Projections. Sarhad Journal of Agriculture, Pp. 37.

Onyeneke, R.U., Ejike, R.D., Osuji, E.E., and Chidiebere-Mark, N.M., 2024. Does climate change affect crops differently? New evidence from Nigeria. Environment, Development and Sustainability, 26 (1), Pp. 393-419.

Pushpalatha, R., Santhosh, M.V.S., Sunitha, S., Goerge, J., Nedunchezhiyan, M., Mamatha, K., Tarafdar, J., 2021. Impact of climate change on the yield of tropical root and tuber crops vs. rice and potato in India. Food Security, Pp. 1-14.

Raymundo, R., Asseng, S., Cammarano, D., and Quiroz, R., 2014. Potato, sweet potato, and yam models for climate change: A review. Field Crops Research, 166, Pp. 173-185.

Srivastava, A.K., 2010. Management effects on yam production in Benin Republic: Experimental Analysis and Modeling. Bonn, Univ., Diss.