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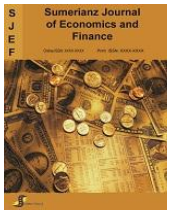

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Determinants of Climatic Variability and Adaptation Strategies of Farming in Benue State Nigeria

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Abstract
The study examined ex-post evaluation of flooding impact in Benue State, Nigeria. The study used purposive, multi-stage random, and convenient sampling techniques to select 315 farmers whose farms have been affected by flooding. Cross-sectional and time-series data for the study were collected from both primary and secondary sources using structured questionnaires, interviews, journals, data from NIMET and publications from other relevant agencies like BNARDA. The data collected were analysed using descriptive statistics, Ordinary Least Square (OLS) Estimate, Maximum Likelihood Estimate (MLE).The mean age of the farmers in the study area is 47 years. The analysis of the gender indicates that farming activities are dominated by males. It was revealed that 79.0% of the household heads were married. Also, 45.7% of the farmers have primary school education, while only 28.5% (Secondary School holders) constitute lower mean averages in terms of educational qualifications. The household size in the study area showed 20.6% of the household size in the study area constituting (1-5) number of persons per household, 52.1% of the household size constituting (6-9) number of persons per household. This is lower than the average of 9 persons per household whose provision in the agricultural sector is significant, as reported by Irohibe and Agwu (2014), but could place greater burden on non-farming households. The trends of the climatic variables (especially rainfall) were significant on the yields of crops: Maize, Rice, Sorghum and Yam. These crops were selected for based on crops farmers grow predominantly in the area and by extension they were planted during excessive rainfall (flooding).This excessive rainfall led to SPIKES (a sharp rise in rainfall followed by a sharp decline),it was observed that the crop yields responded to the spikes which brought about lower yields in such years whose impact were felt in one or two more years after. The unit root and diagnostic tests were conducted on the time-series variables. Also, ARDL co-integration estimations were used to determine the effect of the long run on each of the variables. More so, the adaptation strategies that farmers used were examined and the Mean, Variation and Standard Deviation of these strategies and constraints encountered by farmers were analysed. In conclusion policy recommendations were made in order to proffer solution to some of these challenges.
Keywords: Climatic variability; Benue State Nigeria; Adaptation strategies.

1. Introduction
1.1. Background to the Study
Economic losses caused by floods are rising in Africa (Hoeppe and Gurenko, 2013). Both researchers predicted that if nothing is done by way of mitigation, crop yields would drop by 50% in 2017. This scenario is already manifesting in Asia and other tropical countries where the rural farming households depend on agriculture for their livelihood. The impact of flooding reported in the last two decades have been significant and are estimated to be tens of billions of US dollars (Guha-Sapir *et al.*, 2013).Over 3700 flood disasters are recorded in the EM – DAT (Emergency Database), covering the period 1985 to 2014 (Emergency Event Database, 2014). These events were responsible for hundreds of thousands of deaths mostly in Asia notably (China, Thailand and Bangladesh).The floods have adversely affected billions of people mostly through loss of farms and farmlands, rendering people homeless. There were mortality, injuries, fecal-oral and rodent borne diseases, vector-borne diseases (mainly in 1tropical areas) and psychological conditions through depression, anxiety and posttraumatic stress (Ahem, 2015; Few, 2004; Huntar, 2003; Keith, 2013; Tapsell and Tunstall, 2008).

A flood is an overflow of water that submerges land, low-lying villages or towns or an unusual condition affected by inflow of the tide (Guha-Sapir *et al.*, 2013). Flooding may occur as an overflow of water from water bodies, such as a river or lake, or sea or large natural water basins, or it may occur due to an accumulation of rainwater on saturated ground in an aerial flood. Flooding resulting from extreme hydro and meteorological events and that takes place in unexpected magnitudes and frequencies can cause loss of lives, farmlands, livelihoods and infrastructure (Ahem, 2015). Annual floods are fast becoming part of people's lives in various regions of the world, recurring with varying magnitudes and frequencies to which people have adapted for centuries (Huntar, 2003).

Economic losses due to the effects of damaging floods have increased significantly around the world (Integrated Flood Risk Management in Asia, 2015) .The frequency of natural disasters has been increasing over the years, resulting in loss of life, damage to property and destruction of the environment. Flood losses reduce the assets of households, communities and societies through the destruction of standing crops, dwellings, infrastructure, machinery and buildings, apart from the tragic loss of life. In some cases, the effect of extreme flooding is dramatic, not only at the individual household level, but also in the country as a whole (WMO, 2009). Pachauri and Reisinger (2007) of the Intergovernmental Panel on Climate Change (IPPC) predicts "heavy precipitation events, which are very likely to increase in frequency, will augment flood risk". These floods will affect life and livelihoods in human settlements in all areas such as flood plains, coastal zones, river deltas and mountains. Flooding is also increasing in urban areas, causing severe problems for poor and vulnerable people.

In Nigeria, flooding and solution to its impacts are critical issues (Obeta, 2014). With history of devastating floods which affected millions of human populations and caused fiscal losses amounting to millions of Naira, the importance of exploring more realistic flood risk mitigation measures for Nigeria should be paramount. Flooding in Nigeria are Pluvial (resulting from rivers over topping their natural and manmade defenses), coastal (affecting mainly the coastal areas) and flash, arriving unannounced, following a heavy storm in nature and have been a major cause of concern for rural areas and cities within the country (Andjelkovic, 2001; Bashir *et al.*, 2012; Houston, 2011). Whilst stake holders' efforts towards tackling the hazard have not yielded satisfactory results, being ad-hoc, poorly coordinated, non-generalizable and not well established, it is, in the light of 'best practices' in flood risk reduction and 'lessons learned' from other countries experiences of flooding, that it can be argued that such stake holders' efforts are limited by lack of quality data, which are needed to systematically tackle flooding, poor perception of flooding among the general population, lack of funds and improved technology as well as poor political will power (Obeta, 2014). More so, the growing numbers of flood victims and the constrained sustainable development caused by flooding within the country suggest that much of what is known regarding flooding within the county is deficient on remedies. More critical is the subject matter of Nigeria being one of the most populous countries of the world with population size estimated at over 170 million people (World Bank, 2013). Considering the theory that future population growth will decide future flood risk, the population size along with future estimate spurs for good planning to check the menace of flooding and the resultant effect on food production in any nation that must feed her population (Guha-Sapir *et al.*, 2013).

Benue State is proudly referred to as the 'food basket of the nation' since the rich nutrients deposits of alluvial soils that support bumper harvest have helped farmers in producing crops on large scale. However, with the climate change and River Benue overflowing its bank, flooding has become a critical issue in recent years. Therefore, climate change and its attendant climate events (especially floods) have become what farmers will have to cope with, since it is fast becoming unpredictable to give accurate account of crop yields on farms. Farmers therefore need adequate knowledge on the nature and causes of climate change with the attendant climatic events and the various mitigation, adaptation and coping strategies to use. This of course, depends on their access to credible information sources and their capacity to apply the information. A major problem for crop production in Nigeria (at large), and Benue State (in particular), as it concerns climate change is the reduction of arable lands which arises from the incursion of sea to arable land for farming.

1.2. Statement of the Problem

Most farmers in Nigeria depend on rain-fed agriculture and hence fundamentally are dependent on the vagaries of weather. Climatic events (especially flooding) is impacting negatively on ecosystems, farming systems and other livelihood processes. The problem of flooding impact has been significant in the reduction of crop production in Benue State with the change in cropping patterns. The change in cropping patterns has made Benue state gradually losing the acronym 'food basket of the nation' due to the lowering of agricultural output by this scourge. In recent years, there has been a decline in Benue's agricultural produce. In previous years, groundnut was produced in commercial quantity in Benue State but the situation is no longer the same in recent time. As crops decline so are food prices rising. Cultivation of the crop has gradually dropped (Ripples, 2018).

The problem has resulted in the situation where the present crops(Yam ,Rice, Maize, Sorghum and other cereal crops) produced in large quantity to replace this commercial quantity of groundnut are expressing great flooding impact due to climate change. The scourge has affected crops both in quality and quantity. In October 2017, Nigeria's tubers of yam exported to the United States were rejected due to low quality. There is some evidence that climate change is already having a measurable effect on the quality and quantity of food produced globally. Farmers are no longer able to farm due to challenges posed by climate change. Two hectares of rice farmlands were washed away by heavy rainfall in Benue State as a result of climate change in August 2017. Over 3,000 other farmlands were also submerged, affecting about two million farmers in the state. The overflow of water from the River Benue coupled with the excess water from River Niger have increased the incessant occurrence of flooding in Benue State (Ripples, 2018). The severity of flooding was also noted in the months of September and October, 2012, when it ravaged some parts of Nigeria especially Benue State and the quantification of such economic loses on crop production was quite immense. Cereal crops were the worst hit with over 75% of crops like rice, maize, sorghum suffering economic loses and 50% of yams cultivated had specific quality challenges. These challenges are products of unprecedented flooding which destroyed hundreds hectares of farmlands and damaged crops as a result of different heavy downpour, river over flows(especially River Benue) among others (Adeloye and Rustum, 2014).

1.3. Objectives of the Study

The main objective of this study is to evaluate the determinants of climatic variability and adaptation strategies of farming in Benue State, Nigeria.

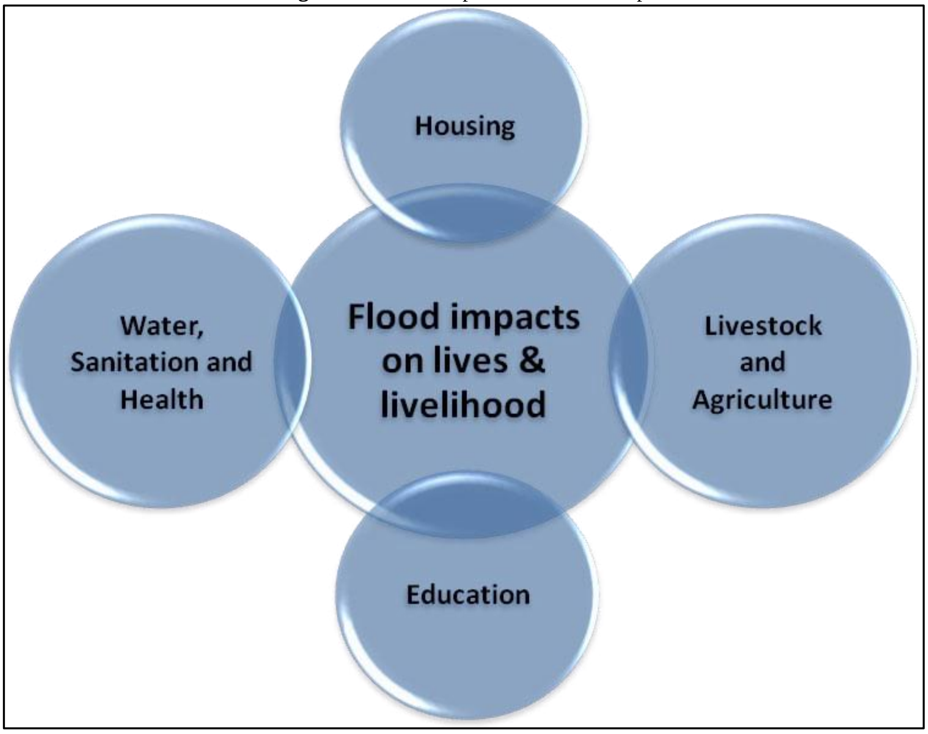
The specific objectives include to:

i. determine the trends of climatic variables on yields of crops in the study area
ii. investigate the flooding adaptation strategies employed by farmers in the study area.
iii. identify the constraints to choice of adaptation strategies in the study area

2. Literature Review and Theoretical Framework

Food production and non-agriculture income contribute to household income which in turn influences the means of livelihood for the families. When the means of livelihood in the community grinds to halt, it triggers exodus of community members into urban centers in search of new and better income opportunities; which leads to congestion and wrong planning and eventually when there is large rainfall, the lack of management of excess water leads flooding. The impacts of flood on lives and livelihoods depend on the combination of different types of impact on individual sector. Being essentially agricultural producers, the main consequence of flooding has been the destruction of food crops on farms as well as seeds stores; eventually culminating in a decline in food production and Food security. Starvation together with a decline in environmental quality resulting from flood related damage, fuel the desire for migrating out of these rural areas (see in the Figure 2.1). The reduction in food production resulting from floods also means loss of income for many in these communities which further reduce their ability to purchase food and thereby contributes to increasing the problems of food shortages and starvation within household. In these communities, non-agricultural income opportunities are few. However, social networks can enable residents' to be informed of the existence of opportunities both within and without the communities. Nonagricultural income can contribute to increase household income and thereby reduce starvation that may result from flooding. Such destruction and physical loss is usually accompanied by generalized destitution and sense of grief among people who have lost loved ones. These together increase the desire of people to move out of these communities in search of safer and more stable means of livelihood. Sometimes, the risks prevailing in the destination of prospective migrants are higher yet, individuals migrate. Some potential migrants are aware of the risks associated with migration while others are not aware. In the *agricultural impacts*, increase in agricultural labor results in a corresponding increase in agricultural activities (productivity) which in turn amplifies food production. When food production increases, the risk of starvation is minimized. Less starvation suggests that individuals become less susceptible to diseases. More agriculture activities lead to a rise in food production which in turn enhances the likelihood of seed storage which leads to

Figure-2.1. Flood Impact and Relationship



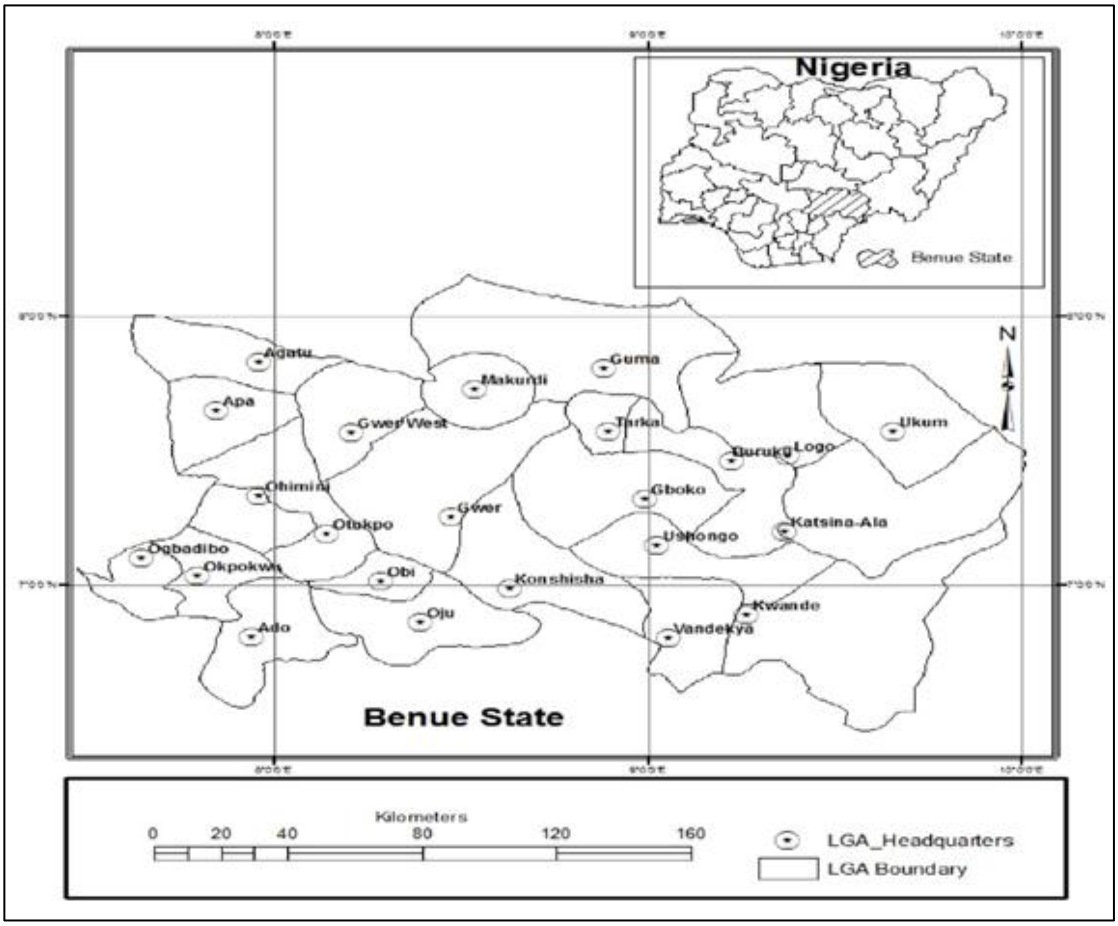
A situation that reduces the strength to reduce vulnerability of the flood as well as health and social impact. The onset of these floods could lead to incidents of disease which potentially could lower the ability of the influence agricultural production.

Flood has negative impacts on the sector of health and education also. During flood the flood water increases the chances to get different types of water born disease. Especially child and elderly people are more vulnerable to these hazards. These may impact the economic factor for treatment cost.

The destruction of crops by the floods makes it imperative for the community members to shift dependence on agriculture income to non-agriculture income or diversify their agricultural livelihoods. In the *non-agricultural income*, flood events simultaneously trigger reduction in income level production. Also, fish, livestock farms are destroyed and agriculture lands become inundated and unsuitable for cultivation for most of the staple foods within the study area leading to reduction in household income. It must be emphasized that existing bad sanitation practices within the communities also feed into the outbreak of the disease. Infected individuals in most cases lack the capacity to contribute to non-agriculture labor. The total process of this cycle is depending on one another. Within this circular process if any part is affected the other part automatically get affected. Flooding along with its severe impacts on human lives, properties and economic activities is globally acknowledged (Keith, 2013). Conceptually, flooding is the result of water overtopping its natural and manmade defenses and overflowing places not typically submerged (Smith and Ward, 1998). It is a result of sudden arrival of heavy storms, which overwhelms soil infiltration capacity and urban drainage systems. In the literature, it is claimed that flooding is the most widespread hazard phenomenon on natural environments, accounting for more than 40% (both in frequency of occurrence and potential for loses) of the total disasters globally. From wave dynamics, flooding is described as a down-slope propagation of attenuated longitudinal wave motion with inundation extent, depth and duration, as well as water flow velocity. Various forms of flooding can be identified by Pluvial, coastal and those reading from Pluvial events which in recent times have threatened many urban areas (Hassan, 2013; Lauber, 1996; Ward and Robinson, 2000). Arguably, these urban flood are becoming more widespread nowadays and causing significant loss of lives and property, due to the large number of population exposed within the cities (Chen *et al.*, 2009; EA, 2007; Gupta, 2007; Jeffers, 2013; Jha, 2012). In the US, 32.9% of the total natural disasters in 2012 were hydrological with urban floods accounting for the most part, affecting more than 9 million people and causing about US $ 0.58 billion worth of damage recorded for Europe and about US $ 0.83 billion and US $ 19.3 billion damage for Africa and Asia respectively resulting from urban flooding. Hence, four different floods that hit United Kingdom cities in 2012 caused a total loss of $ 2.9 billion with many human populations affected (CRED, 2013). Increased frequency and intensity of rainfall drives pluvial floods and is a major cause of concern for urban areas (IPCC, 2017). Urban areas are significant in the economic and political development of regions and states (Cohen, 2004). However, urbanization is an important anthropogenic influence on climate change especially in forcing increased rainfall intensity and frequency. Also, impervious surfaces, which are extensive in urban areas, influence local and regional hydrology by increasing surface water runoff and causing peak discharge and reduced time of peak. These are pertinent issues to environmental management, urban planning and flood risk reduction. However, urbanization along with rapid population growth in most places especially the developing countries (DCs) have been unaccompanied by adequate urban planning (Adeloye and Rustum, 2011). This brings about flood risk which is linked to exposure of social systems, to flood hazards (in the form of flood water depth, extent, duration and velocity of flow) and their vulnerabilities (the propensity to be adversely affected by flooding caused mainly by lack of coping capacity) (Balbi, 2012; Birkmann, 2006; Crichton, 1999). It is also the product of likelihood of occurrence of flood hazard and its consequences identified as possible losses resulting from flooding (Brooks, 2003; Jeffers, 2013; Smith and Ward, 1998). Moreover, the likelihood of occurrence of flooding can be defined as the percentage probability of flood return period. Within research spheres, which makes the likelihood of flood occurrence to be generally delineated by the 100-year flood (EA, 2007).Globally, these are key issues which are driving activities towards reducing the risk of flooding across various regions and states (Agbola *et al.*, 2012; EA, 2007; Houston, 2011; Merz, 2010) driven by the predictions of worsened flood risking the future coupled with the notion that floods are inevitable phenomenon which can never be fully constrained within the natural environment. Therefore efforts towards tackling flooding are based on reducing its impacts on human population, development infrastructure and economic. These efforts have been fundamental to the “living with floods and not fighting them idea”, which dominates key environmental risk research themes (for examples: Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) (Balbi, 2012; Di Baldassarre and Uhlenbrook, 2012), and improving the awareness of flooding in local communities, provision of data and technical know-how as well as provision of funds towards building a community of human populations who are able to live with floods well as securing critical infrastructure against flood losses, which has driven approaches towards addressing the challenges of flooding in places like China, the Netherlands, United Kingdom and the United States. Flood risk reduction is a multi-disciplinary approach which integrates structural and non-structural measures to achieve the key elements of risk management which are: prevention/migration, protection, preparedness, emergency response, recovery and lessons learned. The realization of these key elements appeared to have undetermined structural measures which basically include engineering works aimed at containing water disruptions in rivers, thereby reducing exposure to flooding and susceptibility to flood damage (WMO, 2009). On the contrary, non-structural measures do not involve physical constructions; instead focus is on knowledge, practice or agreement to reduce risks and impacts, in particular through policies and laws, public awareness raising, training, education and research and include; flood insurance, assessment of vulnerability to flooding which provides information that will enable the classification of a given population with regards to their lack of capacity to cope with the hazard, flood risk/hazard mapping, creating public awareness, relocation of exposed human populations, land-use, zoning, flood proofing, flood forecasting and flood early warning systems. The success of flood risk reduction can be said to depend to a large extent on knowledge-based decision, robust institutional framework and flood risk reduction. The creation of awareness in stakeholders and local communities regarding flooding and its impacts is driven by flood risk communication.

3. Methodology and Data

3.1. The Study Area



Source: GIS Lab. Fed. University Dutsin-Ma

3.2. Data Collection

Cross-sectional and time series data for this study were collected from primary and secondary sources respectively. Primary data were collected through questionnaires with the help of Agricultural Development Programs enumerators of the selected state, at the extension block level. Primary data were also collected using structured interview schedules. The data collection instrument focused on capital resources used, agrochemicals used and other relevant information. .The secondary data were collected from Ministries, Agricultural and other relevant agencies, like NIMET (Nigeria Meteorological Agency), Benue State Meteorological Agency and Benue Agricultural and Rural Development Agency (BNARDA). Annual time series data were collected from Nigerian Meteorological Agency and such include the following: temperature, relative humidity and rainfall data. Annual time series data of yields (Sorghum, Maize, Rice, Yam) between 1980 and 2018 from Benue Agricultural and Rural Development Agency (BNARDA) were also collected.

3.3. Data Analysis

The following analytical tools were used to achieve the stated objectives (i-v) in the study:

i. Descriptive Statistics and Ordinary Least Square (OLS) Method of Estimation are used to achieve objective (i)
ii. Ordinary Least Square (OLS) is used to achieve objective (ii)
iii. Descriptive Statistics is used to achieve objective (iii)

The hypotheses were tested using t-test, z-test, and Chow test was applied to determine the structural breaks in climatic variables.

3.4. Model Specification

3.4.1. Trend Model

The trend model as given by Onyenweaku and Okoye (2005), Okoye and Continental (2008) and Bassey *et al.* (2014) is specified as follows

$Y_{it} = b_0 e^{b_1 T}$ ………………………………………….3.1

Where

Y_{it} = Variable whose trend is being described
b_0 = Intercept
b_1 = Slope coefficient

T = time trend variable (years)

When linearized in logarithms, equation 3.1 becomes

$lnY_{it} = \beta_0 + \beta_i T + \mu i$ ……………………………………….3.2

Where,

ln = natural log

Yit = variable of interest

β_0 and β_i = parameters

μi = random error

LnY_{it} = natural log of Y $\{Y_i = Y_1(YAM_t), Y_2(RICE_t), Y_3(MAIZ_t), Y_4(SORG_t), Y_5(TOY_t)\}$

b_0 = intercept

b_1 = slope coefficient

T = Time trend variable (1980-2018)

$InYAM_t = b_0 + b_1T + \mu_i$ ……………………………………….3.3

$InRICE_t = a_0 + a_1T + e_i$ ……………………………………….3.4

$lnMAIZ_t = d_0 + d_1T + v_i$ ……………………………………………3.5

$lnSORG_t = L_0 + L_1T + w_i$ ……………………………………………3.6

$lnTOY_t = c_0 + c_1T + z_i$ ……………………………………………3.7

3.4.2. Estimation of Impact of Flooding on Crop yields

The implicit Form of the model is stated as:

$Y = F(X_1, X_2, X_3)$--3.8

The explicit Ordinary Least Square Model;

$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + e_{1t}$ ---3.9

Where Y = Crop Yield in Metric Tonnes (mt), (in years)

β_0 = Constant

β_1-β_3= Coefficients

X_1 = Annual mean rainfall

X_2 = Annual Mean temperature

X_3 = Annual Mean relative humidity

e_1 = Error term or unexplained variable.

3.5. Diagnostic Test

3.5.1. Unit Root Test

The test for stationary was performed using the standard Augmented Dickey-Fuller (ADF) test. The ADF test is given by:

$Yt = \beta_1 + \beta_2 Y_{t-1} + \mu_t$ t =1,2…… ……………………3.9

Where

Y_t = variable y at time t

Y_{t-1} = variable Y at lagged 1

For convenient unit root testing, the equation is subtracted by Yt-1 and gives the:

$\Delta Y_t = \alpha_1 + \alpha_2 \Delta Y_{t-1}$ + et and $\alpha_2 = \rho-1$ …………………………………3.10

The hypothesis for unit root test is as follows

H0: $\alpha_2 = 0$ (Y_t is non-stationary)

H1: $\alpha_2 < 0$ (Y_t is stationary)

4. Results and Discussions

4.1. Socio-Economic Characteristics of the Respondents (Farmers)

The Socio-economic characteristics of respondents (farmers) affected by flooding is presented in Table 1. The result shows that 71.4% of the farmers were males, while 28.6% were females. This implies that farming in the study area is dominated by male and it is also of significance that more female will have to be encouraged to participate in farming in the study area. Also, it is shown that 73.8% of the farmers fall within the age bracket of 42-51, while 26.2% fall into 52-61 years. This agrees with Pendo-Edna (2011) who posited that age structure is critical to providing understanding about labor potential of a particular population. The mean age of farmers in the study areas is 47 years. This means that majority of the farmers are within the working age group. The study also revealed that 79.0% of the household heads were married and this agrees with Zierogel (2006) who agreed that men who were married have easier access to farmland through paternal inheritance.

Education plays a significant role in decision making skill acquisition and enhancement of one's ability to understand to plan and to plan and take risks. In the table below 45.7% of the farmers have primary school education. This has implication especially as it concerns adaptation strategies in the study area as adoption of adaptation strategies will come with slow pace due to this percentage. Only 28.5% (Secondary School holders) and 25.7% (Tertiary School holders) constitute the lower mean averages in terms of educational qualification. The household size in the study area shows, 20.6% of the household size in the study area constitutes (1-5) number of persons per household, while 52.1% of the household size constitutes (6-9) number of persons per household. This result is lower than the average of 9 persons per household as reported by Jeffers (2013) in Kano State, Nigeria that large household size could play a great role in family labor provision in the agricultural sector, but could place greater burden on non-farming households.16.5% constitutes (10-13) number of persons per households, 4.76% constitutes (14-17) number of persons per household, 2.54% constitutes(18-21) number of persons per household, while 1.90% and 0.63% constitutes (19-25, and 26-29) number of persons per household respectively. The result also shows 79.1% of the farmers take farming as their main occupation or means of livelihood while 18.3% civil servants take farming as a part-time means of livelihood. More so, 2.6% students use farming to support themselves. On accessibility to credit, only 9.52% of the farmers, that is 30 farmers, have access to credit, while, 90.48% (285) of them have no access to credit facilities. Estimated monthly income showed a greater proportion (65.08%) of the household heads realized between ₦40,000 and ₦ 60,000 per month, which means most of household heads still operate on a low income per farm basis.

Table-1. Socio-Economic Characteristics of the Farmers

Variables	**Frequency**	**Percentage**
Gender		
Male	225	71.4
Female	90	28.6
Age		
22-31	2	5.3
32-41	52	15.5
42-51	141	43.8
52-61	88	26.2
62-71	32	9.2
Marital Status		
Married	249	79.0
Single	28	8.9
Widows	28	8.9
Divorced	10	3.2
Educational Qualifications		
Primary School(1-6)	144	45.7
Secondary School(7-12)	90	28.5
Tertiary School(13 and above)	81	25.7
Household Size		
1-5	65	20.6
6-9	164	52.1
10-13	52	16.5
14-17	15	4.76
18-21	08	2.54
19-25	06	1.90
26-29	02	0.63
30 and above	03	0.95
Means of Livelihood		
Farmers (main occupation)	249	79.04
Civil Servant (Part-time occupation)	58	18.41
Students (support occupation)	8	2.54
Access to credit		
Yes	30	9.52
No	285	90.48
Estimated Monthly Income(Naira) Income ≤ 20,000	17	5.40
20,001 ≤ 40,000	33	10.48
40,001 ≤ 60,000	205	65.08
60,001 ≤ 80,000	47	14.92
80,001 ≤ 100,000	07	2.22
100,001 and above	06	1.90
Total	315	100

Source: Data Computed 2019

4.2. Result of Preliminary Tests

4.2.1. Diagnostic Test

4.2.1.1. Unit Root Test

This study used the unit root test in order to test for the stationary of the time series data collected for the research to avoid spurious regression.

Using the Augmented Dickey Fuller test, the result showed that some of the variables(Rainfall, Temperature, Relative humidity) are stationary at levels I(0). Meanwhile, the variables of (total crop yields, Rice, Sorghum, Maize and Yam) are not stationary at their levels that is, at first difference. This is shown in table 2:

Table-2. Unit root test

Logged Variables	ADF- Statistic			Order of integration
	Level	First Difference	Second difference	
Log of total crop yield (LNTY)	-0.9918	-5.7071	-	I(1)
Log of Rice (LNR)	-1.4438	-6.6549	-	I(1)
Log of Maize (LNM)	-2.8470	-7.1014	-	I(1)
Log of Sorghum (LNS)	-1.0554	-6.1045	-	I(1)
Log of Yam (LNY)	-1.7957	-5.9291	-	I(1)
Log of Rainfall (LNRF)	-5.0544	-	-	I(0)
Log of Max.Temp (LNMT)	-4.7665	-	-	I(0)
Log of Min. Temperature (LNMIT)	-4.1735	-	-	I(0)
Log of Rel. Humidity (LNRH)	-5.0726	-	-	I(0)

Unlogged Variables	ADF-Statistic			Order of Integration
	Level	First difference	Second difference	
Log of Linear Rainfall (RAF)	-5.4056	-	-	I(0)
Log of Max. Temperature (MAT)	-3.7965	-	-	I(0)
Log of Min. Temperature (MIT)	-3.4492	-	-	I(0)
Log of relative humidity (REH)	-5.0726	-	-	I(0)
Log of Rice (RICE)	-1.5905	-7.0344	-	I(1)
Log of Maize (MAIZ)	-2.8733	-7.2930	-	I(1)
Log of Sorghum (SORG)	-0.6321	-3.1479	-	I(1)
Log of Yam (YAM)	-1.4419	-6.8310	-	I(1)
Log of crop yield (TOY)	-1.1646	-6.089631	-	I(1)

Source: Data Computed 2019.

4.2.2. Results of the Objective

4.2.2.1. Determining the Trends of Climatic Variables and Yields of Crops in the Study Area

The estimated trend in time variables of Yam, Rice,Maize Sorghum and Total yield is presented in the table 3

Table-3. Estimated trend equations for YAM_t, $RICE_t$, $MAIZ_t$, $SORG_t$, and TOY_t

Dependent variable	B_0	B_1	r^2	Adj R^2	F-ratio
InY_t	7.9874 (31.099)	-0.000126 (-0.968)	0.0247	-0.001638	0.9378
$lnRICE_t$	-4.847 (0.108)	0.000048 (5.510)	0.000313	-0.0267	0.0116
$lnMAIZ_t$	0.0000863 (-0.6283)	4.9173 (18.1420)	0.01056	-0.01619	0.3948
$lnSORG_t$	-0.000378 (-0.73622)	5.4185 (5.3462)	0.01444	0.0122	0.5420
$lnTOY_t$	6.1396 (0.000)	-0.0000845 (0.7593)	0.002568	0.02439	0.953

Source: Generated data from Crop Variables: BNARDA (1980 -2018)

The result in Table 3 shows that the coefficients of the time variables for yam (-0.000126) and total yields (-0.0000845) were negative and statistically insignificant even at 10%, thus indicating a decrease in trend of climatic variables on yields under study. This also implies that time trend variable was not a major factor in determining the values of yield of yam (i.e. values of yam responded to changes in time by decreasing in values overtime). The coefficients of the time variables for rice (0.000048), maize (4.9173), sorghum (5.4185) were positive and statistically insignificant even at 10%. This further implies that time (climatic variations over time) was a factor in determining the values of $Rice_t$, Maize, sorghum in Benue (i.e. values of $Rice_t$, Maize and $Sorghum_t$ responded to changes in time (most especially flooding).

4.2.3. The Trends of Climatic Variables and Yields of Crops

4.2.3.1. Trend Analysis of Yield

The yield data from 1980 to 2018 recorded more often a decreasing trend and less increasing trend on the various crops analyzed in the study area. This is due to the amount of rainfall (mm) that Benue state accessed and whether such rainfall is in adequate supply or excess (which leads to flooding). Also, the yields are based on crop production fluctuation especially during the flooding period.

The result showed for specific years of intense flooding, that is, SPIKE in rainfall (as shown in the graphs below) which are: 1981,1986,1991,1995,2004,2007,2010,2011,2016,2017 and 2018 respectively, for the four crops that were studied : Maize, Rice, Sorghum and Yam. The SPIKES IN RAINFALL revealed lower yields in the years of occurrence with impacts felt in some cases one or two years before there are higher yields when rainfall is adequate for crops.

The yields of maize followed the following trends 100mt, in 1981, 110mt in 1986, to as low as 80mt in 1991, picked up in 1995 to 160 mt, thereafter to 132mt, 150mt, 170mt, and came as low as 98mt, 90mt and 85mt in years; 2016, 2017 and 2018 respectively (as shown in Table 4 and graphs below). The implication of this is reduction and instability in crop yields amounting to low crop production and threat to the food security of the state. This will also affect rural farming households by lowering the production capacity of the farmers.

Rice followed both increasing and decreasing trends depending on whether they are upland rice or lowland rice.

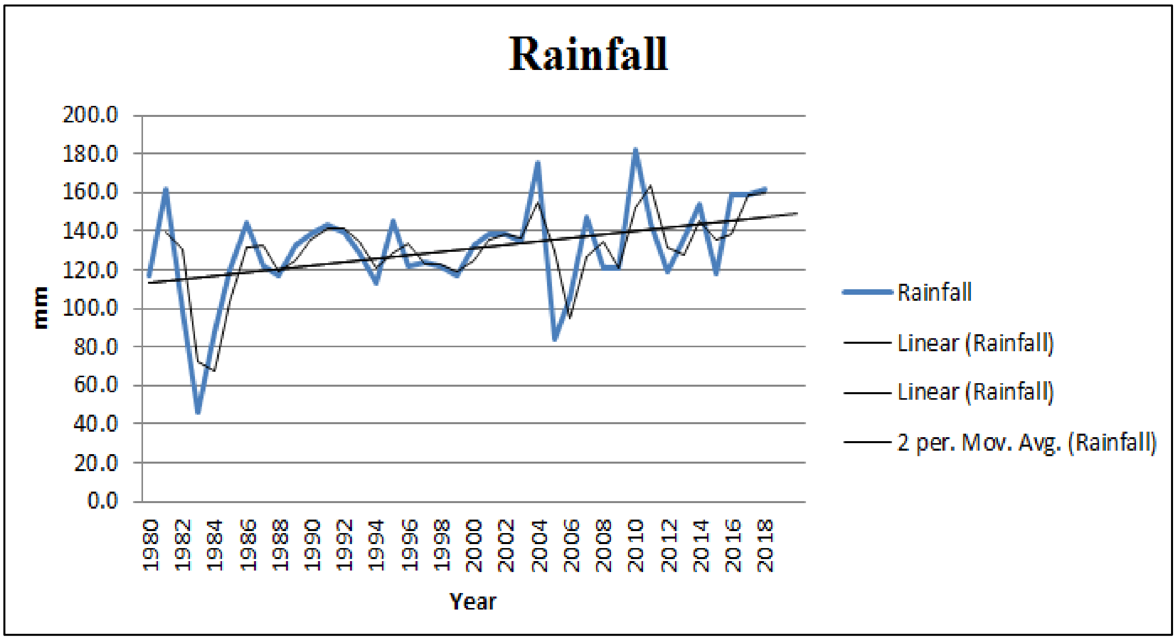
Sorghum appeared to be the worst hit of four crops selected in Benue State during the flooding period:1981,1986,1991,1995,2004,2007,2010,2011,2016,2017 and 2018. In Table 4 below, sorghum production in metric tonnes for the above-mentioned years of flooding revealed the following:140mt in 1981, 130.5mt in 1986,130.5mt in 1991,160mt in 1995,190mt in 2004, 181.5mt in 2007,200mt in 2010,declined to 145mt in 2011 and greatly declined to 15.6mt in 2016, 15.0mt in 2017 and 14.9mt in 2018 respectively. The implication of this is lack of sorghum field, sorghum head and sorghum grain leading to crop production failure for farmers and low supply in commercial quantities, if any, due to the sharp decline in crop yield especially in the last five years that Benue State has experienced consistent flooding.

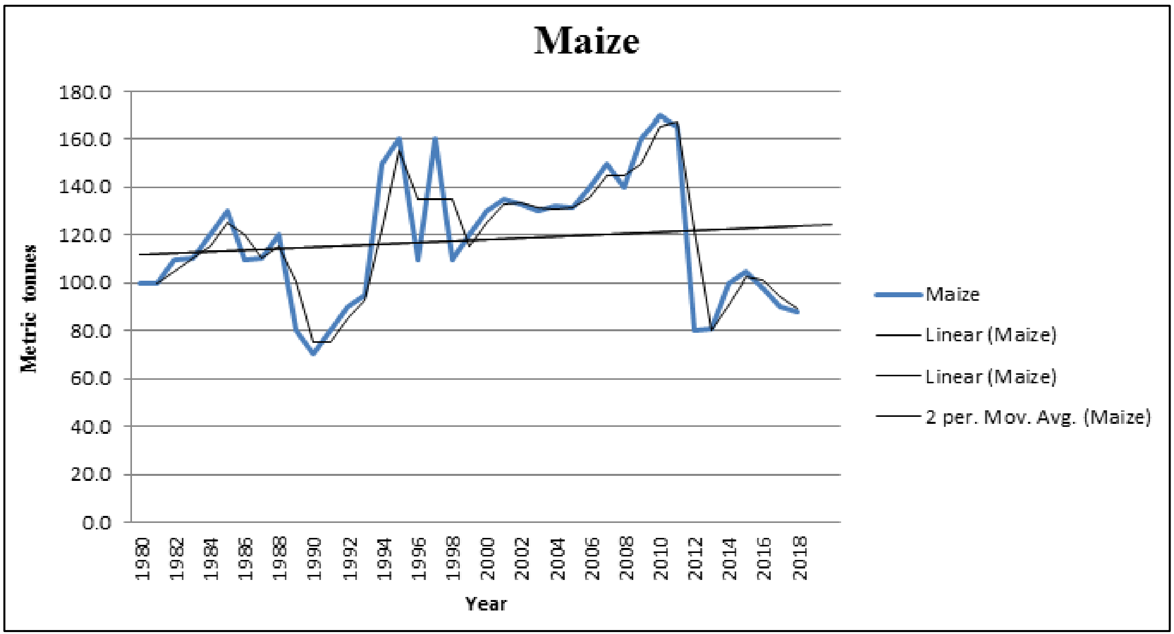
Yam appeared to fare better in yields with little drops in yields when compared to other crops studied. This is revealed in table below. This may not be unconnected with the planting of Yams in mounds or heaps in the study area which made the planting of Yam one of the options during flooding .The implication is to expect more of yam crop production as against other crops (Maize, Rice and Sorghum) during flooding.

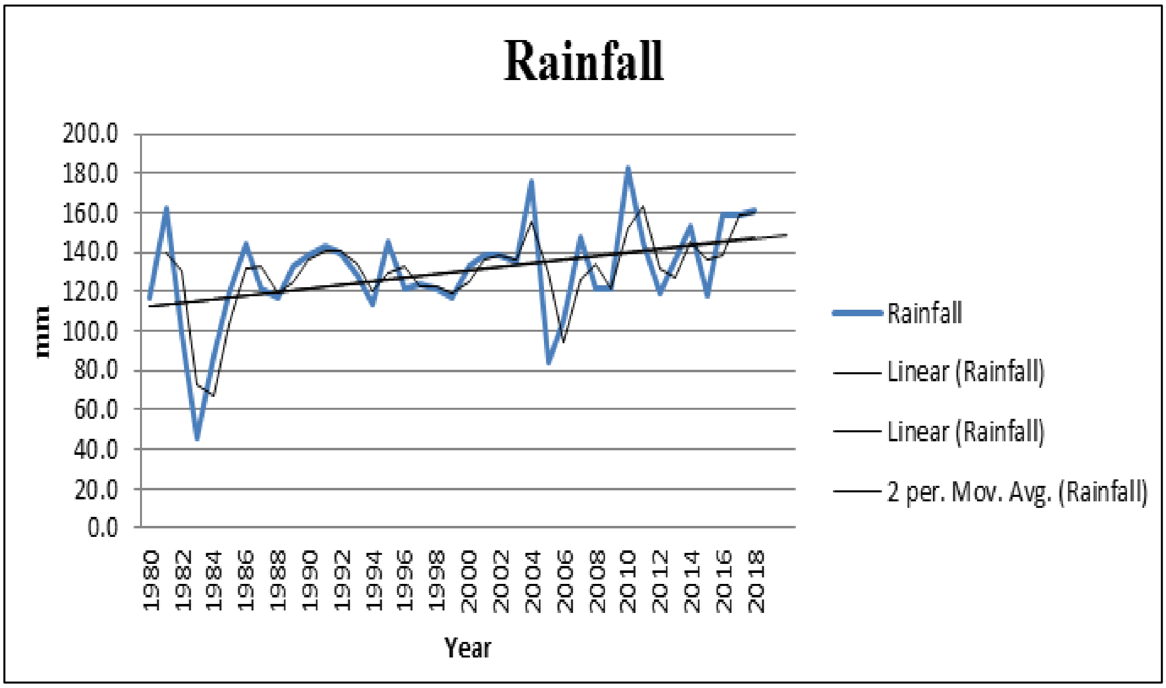
Table-4. Rainfall Data and Yields of Crops (1980-2018)

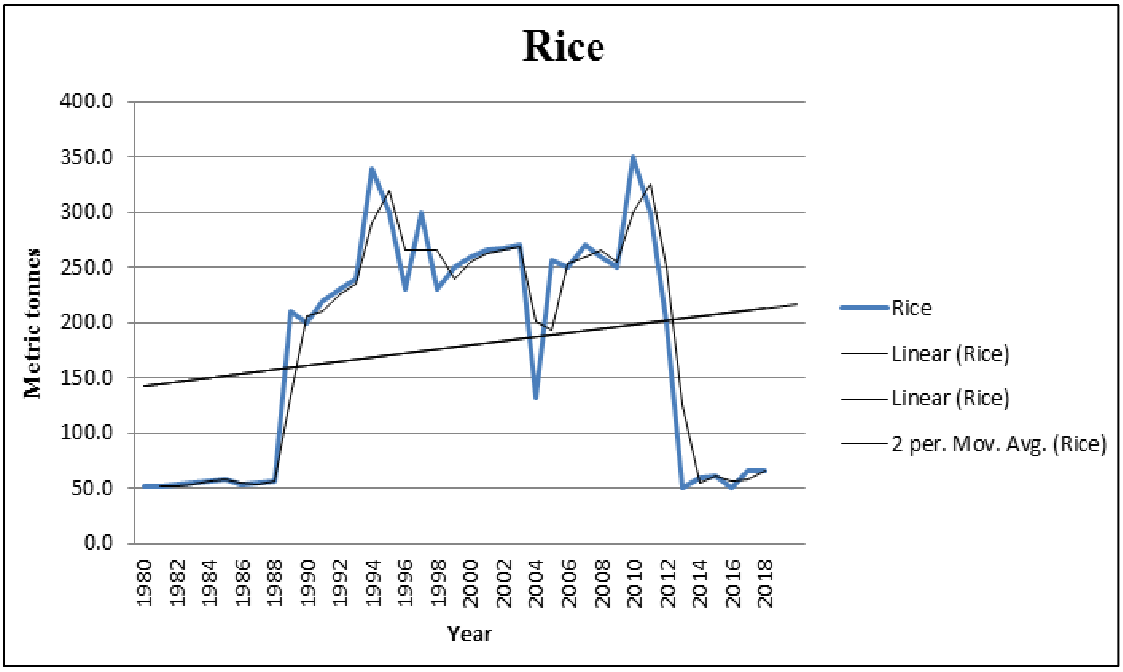
Year	Rainfall(mm)	Maize(mt)	Rice(mt)	Sorghum(mt)	Yam(mt)	Total yield of crops (mt)
1980	117.4	99.5	51.5	155.5	1500.0	1923.9
1981	161.9	100.0	52.0	140.0	1754.0	2207.9
1982	98.9	110.0	52.5	130.5	1700.0	2091.9
1983	46.2	110.5	55.0	135.0	1880.0	2226.7
1984	88.1	120.5	56.5	120.0	1890.0	2275.1
1985	119.6	130.0	58.0	100.0	1875.0	2282.6
1986	143.9	110.0	52.5	130.5	1886.0	2322.9
1987	121.6	110.5	55.0	135.0	1900.0	2322.1
1988	116.8	120.5	56.5	120.0	1876.0	2289.8
1989	132.9	80	210	160	1860	2442.9
1990	138.9	70	200	156	1790	2354.9
1991	142.9	80	220	158	1850	2450.9
1992	139.5	90	230	150	1900	2509.5
1993	128.6	95	240	150	1950	2563.6
1994	113.2	150	340	150	1890	2643.2
1995	144.7	160	300	160	2000	2764.7
1996	121.9	110	230	150	2530	3141.9
1997	123.6	160	300	160	2448	3191.6
1998	121.6	110	230	150	2450	3061.6
1999	116.8	120.0	250.0	170.0	2400.0	3056.8
2000	132.9	130.0	260.0	180.0	2868.9	3571.7
2001	138.9	135.0	265.0	190.0	2873.4	3602.2
2002	138.4	132.5	267.0	180.5	2865.4	3583.7
2003	134.8	130.0	270.0	185.0	2870.7	3590.5
2004	175.3	132.0	132.0	190.0	2854.0	3483.3
2005	84.1	131.5	255.5	185.0	2882.0	3538.0
2006	105.7	140.0	250.0	180.0	2794.3	3470.0
2007	147.3	150.0	270.0	181.5	2802.2	3551.0
2008	121.3	140.0	260.0	201.5	2703.7	3426.6
2009	121.1	160.0	250.0	201.5	2802.8	3535.4
2010	182.5	170.0	350.0	200.0	2857.2	3759.7
2011	144.7	165.0	300.0	145.0	2869.9	3624.6
2012	118.8	80.0	200.0	100.0	2411.5	2910.2
2013	136.4	80.7	49.5	12.5	2655.7	2934.8
2014	153.7	100.0	60.0	16.2	2874.8	3204.7
2015	118.0	105.0	61.5	16.5	2750.0	3051.0
2016	159.0	98.0	50.4	15.6	2800.0	3123.0
2017	158.3	90.0	65.0	15.0	2650.0	2978.3
2018	161.2	88.0	65.7	14.9	2400.0	2729.8

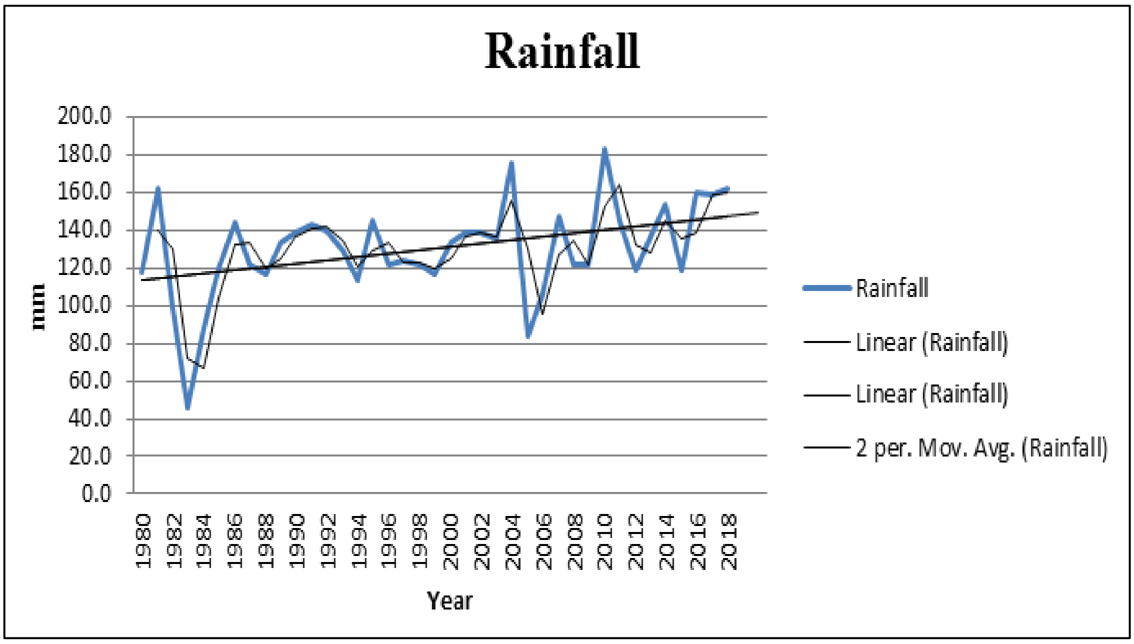
Source: NIMET and BNARDA 2019

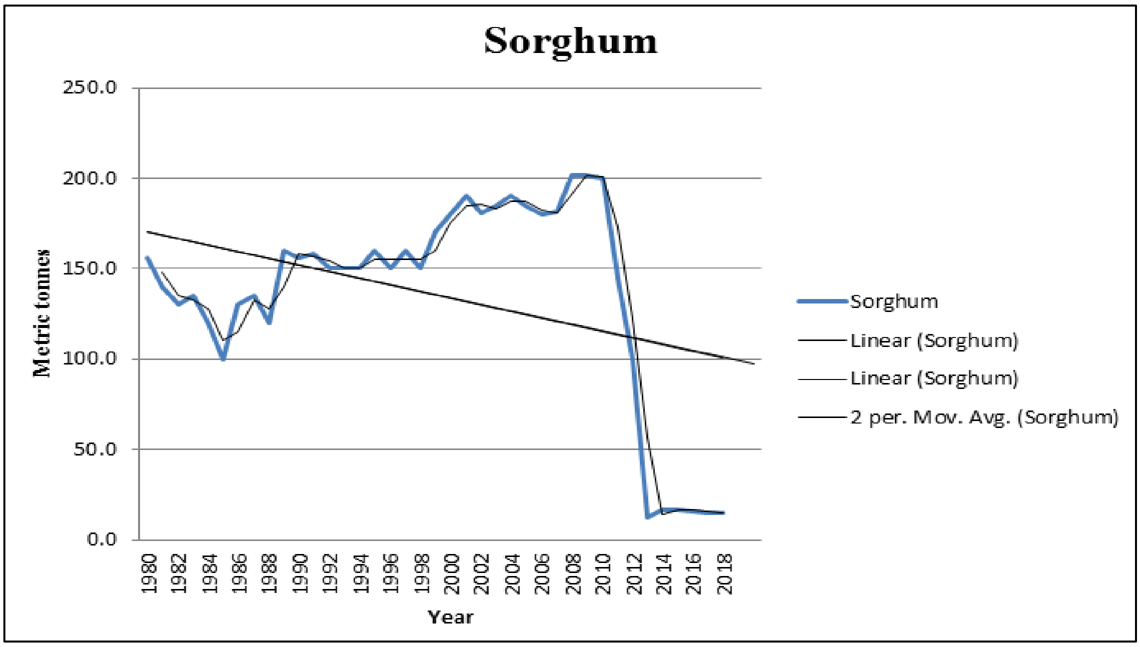

Rainfall
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
mm
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Year
Rainfall
Linear (Rainfall)
Linear (Rainfall)
2 per. Mov. Avg. (Rainfall)

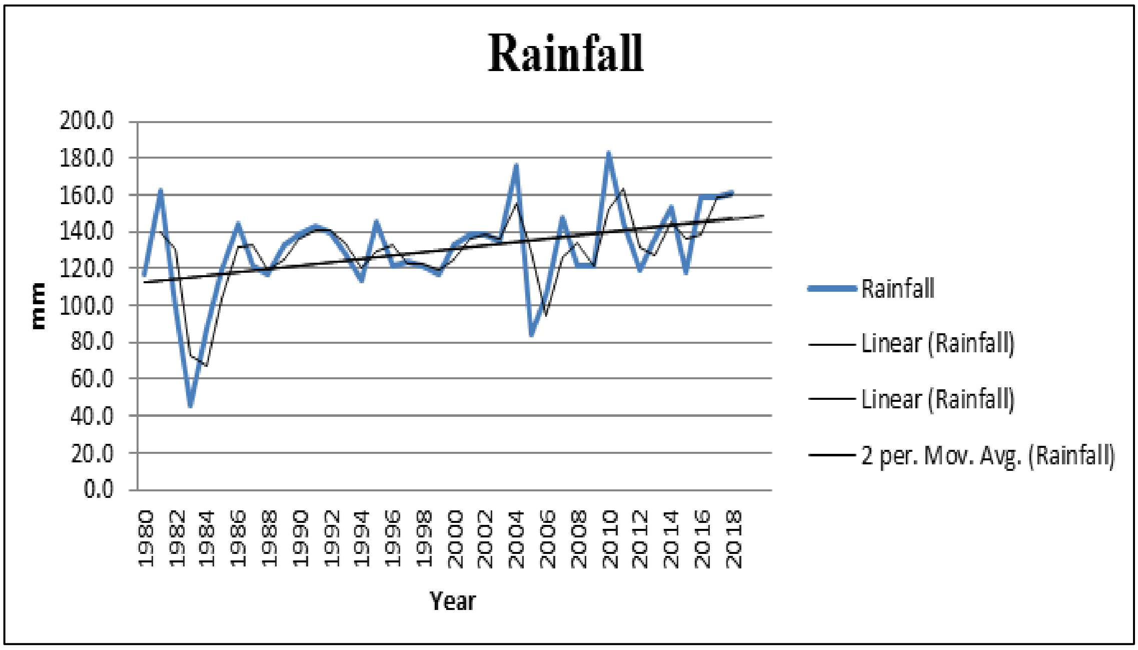

Maize
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Metric tonnes
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Year
Maize
Linear (Maize)
Linear (Maize)
2 per. Mov. Avg. (Maize)

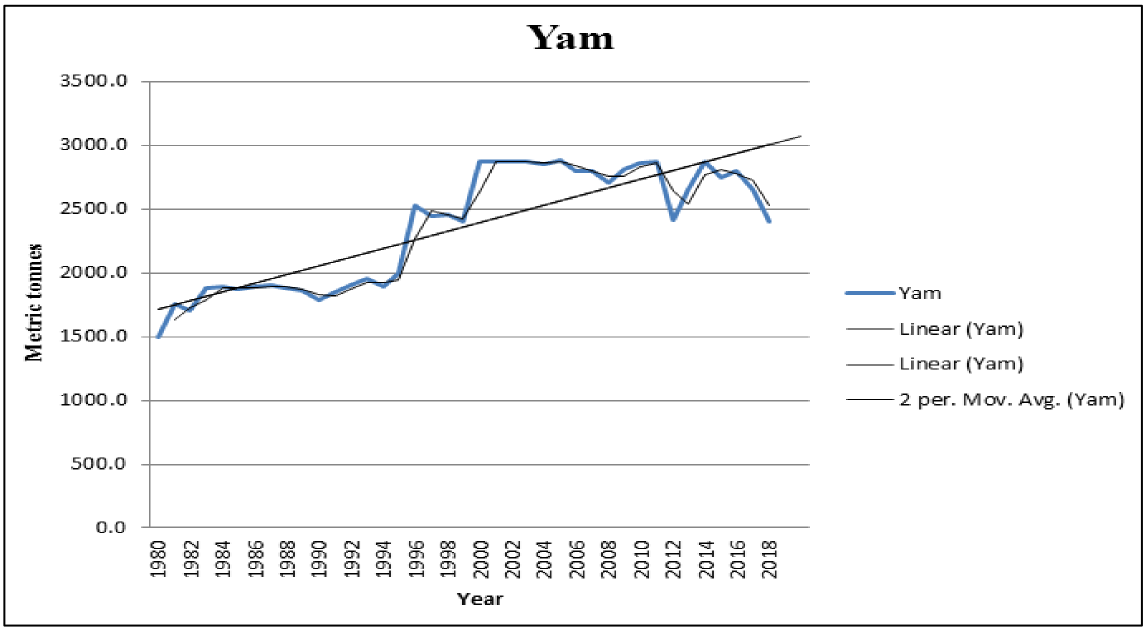

Rainfall
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
mm
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Year
Rainfall
Linear (Rainfall)
Linear (Rainfall)
2 per. Mov. Avg. (Rainfall)


Rice
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Metric tonnes
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Year
Rice
Linear (Rice)
Linear (Rice)
2 per. Mov. Avg. (Rice)


Rainfall
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
mm
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Year
Rainfall
Linear (Rainfall)
Linear (Rainfall)
2 per. Mov. Avg. (Rainfall)


Sorghum
250.0
200.0
150.0
100.0
50.0
0.0
Metric tonnes
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Year
Sorghum
Linear (Sorghum)
Linear (Sorghum)
2 per. Mov. Avg. (Sorghum)





The climatic variables (rainfall, maximum and minimum temperature, relative humidity) that is, the explanatory variables, on crop yields(dependent variables: Rice, Maize, Sorghum and Yam) was done by running OLS (Ordinary Least Squares).The unit root test was done using the ADF static, before the Auto Regressive Distributed Lag(ARDL) that is, Co-integration test was conducted. The unit root test as depicted in table .showed the natural logarithms of the variables in level and first difference forms. Order of integration is a mixture of I (0) and I (1). In other words, the results indicate that rainfall, temperature and relative humidity are stationary at levels I(0) while total crop yields (Rice, Sorghum, Maize and Yam) are stationary at first difference. These results are explained below respectively:

4.2.4. ARDL Co-Integration Test Results for Rice

Table 5 contains ARDL co-integration test results. Critical values for F-Statistic are presented in Peseran *et al.* (2001). On the bases of F-test at 1%,5%, 10% levels of significance, with the critical values stated below which are less than the F-calculated of 11.02056,we reject the null hypothesis and conclude that the regression line for crop yield is statistically significant. From the economic theory it means explanatory variables (rainfall, temperature and relative humidity) are influential factors that can explain a larger percentage of crop yield in Benue State and it is good for forecasting. The bottom part of Table 6 contains diagnostic test results of the selected ARDL model. The adjusted R2 value of 70% suggests that rainfall, temperature and relative humidity jointly explain a significant part of the variation in rice yield and 30% was explained by unknown variables that were not included in the model. This means the predictive power of this model is very high and good for policy making. The Durbin Watson test showed that there is no serial correlation in our crop yield model. Next are the results of the short run ARDL estimate are presented in Table 7. The impact of climatic variables on rice yield was estimated using the Autoregressive

Distributed Lag (ARDL) approach. In this study, the increase in precipitation had a positive impact, while the increase in temperature has a negative impact on rice yield.

Table-5. ARDL Co-integration Test Results

Test statistic	**Value**	**k**
F Statistics	11.02056	3
Critical Value Bounds (Peseran *et al.*, 2001)		
Significance	I0 Bound	I1 Bound
10 %	3.38	4.02
5%	3.88	4.61
1%	4.99	5.85

Table-5a. Long-Run ARDL Estimates

Dependent variable is Rice		
Regressor	Coefficient	T-statistics (Probability)
RAF	-0.550007	-1.101481(0.2801)*
TEMP	-15.05546	-1.147287 (0.2610)**
REH	-456.8786	-1.655619(0.1090s)*
Diagnostic test statistics		
R2	0.779848	
Adj.R2	0.709085	
F-statistic	11.02056(0.000000)	
Durbin-Watson	2.327882	

Note: * and ** indicate significance levels of 5% and 10%, respectively

Table-6. Short-run ARDL Estimate

Dependent variable is Rice		
Variable	**Coefficient**	**T-statistics (Probability)**
RICE(-1))	0.881952	9.291311 (0.0000)
RICE(- 1)	0.84997	8.645599(0.0000)
TEMP	-15.05546	-1.147287(0.2610)
TEMP(-1)	0.713514	0.051381(0.9594)
REH	-456.8786	-1.655619(0.1090)
REH(-1)	-1.185350	-0.004386(0.9965)
C	302.3004	0.941910(0.3533)

4.2.5. Ardl Co-Integration Test for Maize

Table 7 contains ARDL co-integration test results. Critical values for F-Statistic are presented in Peseran *et al.* (2001).The adjusted R2 value of 51.27% suggests that rainfall, temperature and relative humidity jointly explain a significant part of the variation in Maize yield. The results of the short run ARDL estimate and the coefficient of the error correction terms are presented in Table 8

On the bases of F-test at 1%,5%, 10% levels of significance, with the critical values stated below which are less than the F-calculated of 3.273677,we accept the null hypothesis and conclude that the regression line for crop yield is statistically insignificant. From the economic theory it means explanatory variables (rainfall, temperature and relative humidity) are influential factors that can explain a percentage of crop yield (51.27% of the adjusted R2 value) in Benue State and it is good for forecasting. The bottom part of Table 9 contains diagnostic test results of the selected ARDL model. The adjusted R2 value of 51.27% suggests that rainfall, temperature and relative humidity jointly explain a significant part of the variation in maize yield and 48.73% was explained by unknown variables that were not included in the model. This means the predictive power of this model is very high and good for policy making. The Durbin Watson test showed that there is no serial correlation in our crop yield model.

Next are the results of the short run ARDL estimate are presented in Table 9. The impact of climatic variables on maize yield was estimated using the Autoregressive Distributed Lag (ARDL) approach. In this study, the increase in precipitation had a negative impact, while the increase in temperature has a positive impact on maize yield.

Table-7. ARDL Cointegration Test Results

Test statistic	**Value**	**k**
F Statistics	3.273677	3
Critical Value Bounds (Peseran *et al.*, 2001)		
Significance	I0 Bound	I1 Bound
10 %	3.38	4.02
5%	3.88	4.61
1%	4.99	5.85

Table-8. Long-Run ARDL Estimates

Dependent variable is Maize		
Regressor	Coefficien	T-statistics (Probability)
RAF	-0.106314	-0.543342 (0.5912)*
TEMP	-2.168593	-0.397208 (0.6942)**
REH	-95.95026	-0.921585 (0.3646)*
Diagnostic test statistics		
R2	0.512731	
Adj.R2	0.356108	
F-statistic	3.273677(0.007630)	
Durbin-Watson	2.136855	

Note: * and ** indicate significance levels of 5% and 10%, respectively

Table-9. Short-run ARDL Estimate

Dependent variable is Maize		
Variable	Coefficient	T-statistics (Probability)
(MAIZ(-1))	0.591521	4.156458(0.2053)
(MAIZ(-2))	0.641326	4.517897 (0.0001)
(RAIN)	-0.106314	-0.543342 (0.5912)
(RAIN(-1))	-0.382068	-1.941681(0.0623)
(TEMP)	-5.095917	-0.992757 (0.3293)
(REH)	-95.95026	-0.921585 (0.3646)
(REH(-1)	21.67210	0.206831 (0.8376)
C	133.2403	0.856963 (0.3987)

4.2.6. Ardl Co-Integration Test For Sorghum

Table-10. Contains ARDL co-integration test results and critical values for F-Statistic are presented in Peseran *et al.* (2001)

Test statistic	**Value**	**k**
F Statistics	27.61707	3
Critical Value Bounds (Peseran *et al.*, 2001)		
Significance	I0 Bound	I1 Bound
10 %	3.38	4.02
5%	3.88	4.61
1%	4.99	5.85

Note: k shows the number of explanatory variables.

As seen in Table 10, the calculated F statistic values are above the critical values. This implies that there is a long-run relationship between the mentioned variables in the period covered. Long term coefficients calculated according to the estimation results of ARDL model are shown in Table 11. The results of long run estimates are presented in Table 11. The results show that the rainfall has a negative and significant impact on the sorghum yield, in the long run.

Table-11. Long-Run ARDL Estimates

Dependent variable is Sorghum		
Regressor	Coefficient	T-statistics (Probability)
RAF	-0.058346	-0.302553 (0.7645)*
TEMP	-4.181885	-0.834327 (0.4112)**
REH	-177.8620	-1.741109(0.0926)*
Diagnostic test statistics		
R2	0.898754	
Adj.R2	0.866210	
F-statistic	27.61707 (0.000000)	
Durbin-Watson	2.119431	

Note: * and ** indicate significance levels of 5% and 10%, respectively.

The bottom part of Table 11 contains diagnostic test results of the selected ARDL model. The adjusted R2 value of 86.62% suggests that rainfall, temperature and relative humidity jointly explain a significant part of the variation in Sorghum yield.

Next the results of the short run ARDL estimate and the coefficient of the error correction terms are presented in

Table-12. Short-run ARDL Estimate

Dependent variable is Sorghum		
Variable	Coefficient	T-statistics (Probability)
(SORG(-1))	0.978678	15.48792(0.0000)
(SORG(-2))	0.960916	14.51000(0.0000)
(RAF)	-0.058346	-0.302553 (0.7645)
(RAF(-1))	-0.090284	(0.6454)
(TEMP)	-4.181885	-0.834327 (0.4112)
(TEMP(-1))	0.440821	0.082931(0.9345)
(REH)	-177.8620	-1.741109(0.0926)
(REH(-1)	-123.6337	-1.210265 (0.2363)
C	-26.71921	-0.182976(0.8561)

4.2.7. Ardl Co-Integration for Yam

Table-13. Contains the result of ARDL CO-INTEGRATION FOR YAM and critical values for F-Statistic are presented in Peseran *et al.* (2001)

Results Test statistic	**Value**	**k**
F Statistics	28.23111	3
Critical Value Bounds (Peseran *et al.*, 2001)		
Significance	I0 Bound	I1 Bound
10 %	3.38	4.02
5%	3.88	4.61
1%	4.99	5.85

Note: k shows the number of explanatory variables.

As seen in Table 13, the calculated F statistic values are above the critical values. This implies that there is a long-run relationship between the mentioned variables in the period covered. Long term coefficients calculated according to the estimation results of ARDL model are shown in Table 13. The results of long run estimates are presented in Table 14. The results show that the temperature has a negative and significant impact on the yields of Yam, in the long run. The coefficient of temperature implies that an increase of 1% in temperature, will cause a decrease of 11.75% in yields of Yam in the long run in Benue State. However, the results show that the rainfall has a positive and significant impact on the yield of Yam, in the long run. The coefficient of rainfall implies that an increase of 1% in rainfall leads to an increase of 33.32% on Yam yield, in the long run in Benue State. The coefficient of relative humidity implies that an increase of 1% in relative humidity leads to an increase of 987.50% on Yam yield.

Table-14. Long-Run ARDL Estimates

Dependent variable is Yam		
Regressor	Coefficient	T-statistics (Probability)
TEMP	-11.75461	-0.283376 (0.7790)*
RAF	0.333277	0.229708(0.8200)**
REH	987.5077	1.244556(0.2236)
Diagnostic test statistics		
R2	0.900737	
Adj.R2	0.868832	
F-statistic	28.23111 (0.0000)	
Durbin-Watson	2.376739	

Note: * and ** indicate significance levels of 5% and 10%, respectively.

The bottom part of Table 14 contains diagnostic test results of the selected ARDL model. The adjusted R2 value of 86.88% suggests that rainfall, temperature and relative humidity jointly explain a significant part of the variation in yield of Yam. Next are the results of the short run ARDL estimate and the coefficients are presented in Table 15.

Table-15. Short-run ARDL Estimate

Dependent variable is Yam		
Variable	Coefficient	T-statistics (Probability)
YAM(-1))	0.876052	9.833330(0.0000)
YAM(-1))	0.938692	10.47671(0.0000)
RAF	0.333277	0.229708(0.8200)
RAF(-1)	-0.766306	-0.523912(0.6045)
TEMP	-11.75461	-0.283376(0.7790)
TEMP(-1)	31.29039	0.783129(0.4401)
REH	987.5077	1.244556(0.2236)
REH(-1)	1568.016	2.019422 (0.0531)
C	-2061.493	-1.303045(0.2032)

4.3. Identified Flooding Adaptation Strategies Employed by Farmers in Benue State

4.3.1. Identification of Flooding Adaptation Strategies Employed by Farmers in Benue State

Table 16 shows the significant perceived flooding adaptation strategies employed by farmers in the study area which include: crop diversification (M= 2.78), changing crop pattern (M= 3.41) and tillage practice (M= 2.70). These results agree with Adger *et al.* (2003) that said adaptation measures are important to help communities to better face extreme weather conditions and associated climatic variations. This however depends on the level of awareness, knowledge and perception levels of the rural people on the causes, mitigation and adaptive techniques to climate change.

Even though adaptation strategies are managed by various farming households, there is a general sequencing of the experiences of adaptation strategies shown by farmers. When planning for excessive rainfall (flooding), adaptation strategies employed could be based on change in strategies (that is, resorting to tillage practice, crop diversification and changing crop pattern.

Table-16. Identification of Adaptation Strategies

Adaptation Strategy	VE	E	SE	NE	Total	Mean	S.D	Var.	Dec.
Crop diversification	97	75	121	22	875	2.78*	0.76	0.55	Sig.
Changing crop pattern	163	96	17	9	1074	3.41*	0.88	0.79	Sig.
Tillage practice	83	75	135	22	850	2.70*	0.70	0.74	Sig.
Planting during off season	1	30	187	97	567	1.80	0.81	0.68	NS

VE=Very effective, E=Effective, SE= Slightly effective, NE=Not effective, Sig=Significant, NS=Not Significant, S.D = Standard deviation, Var. = Variance and Dec.=Decision

4.4. Perceived Constraints to choice of Adaptation Strategies in Benue State

Table 17 shows that the significant perceived constraints to choice of adaptation strategies employed by farmers in the study area which include: lack of proximity to farm areas (M= 2.76), unease of usage of adaptation strategies (M= 3.27) and unease of tillage practice (M= 2.75). The Mean of unease of adaptation strategies with the Mean of 3.27 was major constraint or problem faced by farmers. This is not unconnected with the lack of adequate dissemination of information and training of farmers by Extension Agents. The slow pace of learning displayed by farmers also contributed to this major constraint.

Table-17. Perceived Constraints of choice of adaptation strategies

Constraint	GE	SE	LE	NA	Total	Mean	St.D	Var.	Dec.
Lack of proximity to farm areas	89	80	128	18	870	2.76*	0.71	0.69	Sig.
Unease of usage of adaptation strategies	135	142	27	11	1030	3.27*	0.50	0.82	Sig.
Unease of tillage practices	90	76	129	19	866	2.75*	0.83	0.77	Sig.
Area adaptation of crops to usage	2	27	177	109	551	1.75	0.76	0.69	NS
Other reasons	5	17	120	173	485	1.54	0.68	0.73	NS

GE=Great extent, SE=Some extent, LE= Little extent, NA=Not at all, Sig=Significant, NS=Not Significant, St.D = Standard deviation, Var. = Variance and Dec.=Decision

5. Summary Conclusion and Recommendations

5.1. Summary of the Findings

The study dwelt on an Ex- post evaluaton of the flooding impact on crop production in Benue State, Nigeria,. The specific objectives of the study were to: determine the trends of climatic variables and yields of crops in the study area, estimate the impact of flooding on crop yields in the study area, inventorize the flooding adaptation strategies employed by farmers in the study area, determine the socio-economic factors driving adaptation strategies used in the study area, and identify the constraints to choice of adaptation strategies in the study area. Cross sectional and time series data were used. Also, the primary data were collected using questionnaires. Interview schedules were also used. The questionnaires were administered to 360 respondents (farmers) using multi stage sampling method. 315 questionnaires were returned and worked on.

The data were analyzed using descriptive statistics, and ordinary least square (OLS) method of estimation method, farming household were spread within the 23 Local Government Areas of Benue State and divided into three Agricultural zones. These were Zone A: include Makurdi, Gboko, Gwer-Eat and Giver West, Zone B; Ado, Agatu, Apa and Ogbadigbo and Zone C :Katsina Ala, Konshisha, Otukpo and Vandeikya respectively. The results of the socio-economic characteristics show that a greater proportion (71%) of the farmers affected by flooding were males while (73.8%) of these farmers fall between the age group of 42 and 51 years. 79.0% of farmers were married and 45.7% of the farmers have primary education. Furthermore, 52.1% fall (6-9) number of households, while 79.1% of farmers earned their living from farming.

The result of the preliminary test showed that limit root test was used to test for the stationary of the time series data collected for research to avoid spurious regression. Using the Augmented Dickey Fuller test, the result showed that some of the variables (Rainfall, temperature, relative humidity are stationary at level I(0). Meanwhile, the variables of (total crop yields, rice, maize, sorghum and yam) are not stationary at their levels, that is, at first difference. The trends of the climatic variables on yields revealed a decreasing trend especially during SPIKES which were often triggered by excessive rainfall (flooding) at different years, with the impact felt one or two more years after.

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Appendix

Department of Agricultural Economics
Faculty of Agriculture
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Questionnaire on Ex-Post Evaluation of Flooding Impact on Crop Production in Benue State, Nigeria

Dear Respondent

The researcher is a post graduate student of the above named department conducting research on "Ex-post evaluation of flooding impact on crop production in Benue State, Nigeria". He solicits your kind cooperation in answering all the questions contained in this questionnaire.

Your answer will help in understanding the needs of the people in the affected communities. Please be assured that all the information provided is meant to be used for the purpose of this research.

DEPARTMENT OF AGRICULTURAL ECONOMICS, FACULTY OF AGRICULTURE, UNIVERSITY OF ABUJA, ABUJA

QUESTIONNAIRE FOR FARMERS

Research Topic: EX-POST EVALUATION OF FLOODING IMPACT ON CROP PRODUCTION IN BENUE STATE, NIGERIA

We request that the longitude and latitude be taken at each local area council

Name of the Respondent…………………………………...................

Area Council ………………………………………………………………

Town ……………………………………………………………………………….

Instructions: Please tick (√) or fill in the gaps as appropriate.

Section A: Socio Economic Characteristics of the Respondents

(1) Sex: (a) Male ☐ (b) Female☐

(2) Age of Respondent: ……………………………… Years

(3) Marital Status:

(a) Married☐ (c) Single☐

(b) Widowed☐ (d) Divorced☐

(e) Others (Specify)……………………………

(4) Educational Qualification I.e. (Number of years spent in school)…….. Years

(5) Household Size……………………………; Children…………… Adults…………….

(6) What is your Kinship to the Head of Household?

(a) Head of Household☐ (b) Spouse of the Head of Household☐

(c) Son/ Daughter of the Head of Household ☐

(d) Nephew/ Niece of the Head of Household or his Spouse ☐

(e) Father/ Mother of the Head or Head's Spouse☐

(f) Brother / Sister of the Head of Household or His Spouse ☐

(g) Others (Specify)………………………………………………………..

(7) What is Your Main Livelihood Activity?

(a) Agriculture (Farming Work) ☐ (b) Housework ☐

(c) Merchant ☐ (d) Craftsman ☐

(e) Laborer ☐ (f) Student/Pupil ☐

(f) Government ☐ (h) Private ☐

(i) Others (Specify)…………………………………….

(8) Are you responsible for supplying the income of the Household (at least 50%)

(a) Yes ☐ (b) No ☐

(9) If yes to (8) above, about how much does your household spend each week on crop production…………………………. (in Naira)

Section B: Estimating the impact of flooding as a result of climatic variables on crop yields

(10) Where is your farm located?

(a) Urban (city) ☐ (b) Village ☐

(c) Others (Specify)………………………………………………….

(11) How often do you experience flooding on your farm?

(a) Once a year☐ (b) Once in two years☐ (c) Once in three years☐

(d) Above three years☐ (e) others specify…………………

(12) What is the reason for your choice in (10) above?

(a) Being family land ☐ (b) Owned by self☐

(c) Ease of payment on land use☐ (d) Cooperative land☐

(e) Others (Specify)………………………………………..

(13) What is the frequency of flood in your area?

(a) Yearly ☐ (b) Biannually ☐ (c) Others (Specify)……………

(14) What crops are you growing…………………………..?

(15) What yield of crops in kg do you have?

(a) Before flooding ………………… (b) During flooding…………………….

(c) After flooding……………………

(16)Based on question (14), what is your daily household man-days per plot, on such crops? ....

(17) Please indicate the crops whose yields are mostly affected

(a)Yam ☐ (b) Cassava☐ (c) Rice☐ (d) Sesame☐

(e) Sugarcane☐ (f) Others (Specify)……………………………………

(18) Can you specify crop yields (output/unit area (kg/ha)………………………..

(19) What is the annual mean time series data of yield 1980-2018(yam, cassava ,rice, sesame, sugarcane ,others)?...........................

(20) Please indicate the degree to which you agree or disagree with the following perception statements in the table below, (Tick appropriately).

Perception Statements	Strongly Agree (5)	Agree (4)	Disagree (3)	Strongly Disagree (2)	Neutral (1)
My farm has been affected by flood in recent times					
Flooding has a negative economic effect on my farm					
I am willing to use more of coping strategies to survive on my farm					
I will have more profit but for flooding					

(21) What is your annual mean rainfall on each crop grown?…………………………………..

(22) What is your annual mean temperature on each crop grown?…………………………

(23) What is your maximum temperature on each crop grown?...................

(24a) What is your annual mean relative humidity on each crop grown?..............................

(24b) In the table below, rate the level at which **CHANGES in TEMPERATURE** (i.e. variations in the degree of ***coldness and hotness***) **AFFECT** the production of listed crops in your area

Crops	Very Severe (4)	Severe (3)	Moderately (2)	Mild (1)	No effect (0)
Maize					
Rice					
Sorghum					
Millet					
Wheat					
Yam					
Cassava					
Potato					
Cowpea(beans)					
Soya Beans					
Groundnut					

Section C: Investigating the adaptation strategies employed in your areas

(25) How many adaptation strategies are used for crops in the season?...

(26) Specify the (adaptation) strategy(ies) used

(a) crop diversification☐ (b) changing cropping patterns☐ (c) Tillage practices ☐ (d) combinations of (a) and (b) ☐ (e) combination of a, b, c. ☐ (f) others specify……………………..

(27) Please indicate the factor(s) influencing the choice of these adaptation strategies

(a) Proximity to farm areas ☐ (b) Ease of usage☐ (c) Expertise in usage☐

(d) The area adaptation of crops to usage☐ (e) other reasons………………

(28) Which of the Crops adapt better with this strategy(ies)………………………………………………………….

Section D: Determining the socio-economic factors due to adaptation strategies used in your areas

(29) After the usage of the adaptation strategy (ies), what is your opinion of crops cultivated based on the following options ? (a) High☐ (b) Low☐ (c) Very low☐ (d) Others☐

(30) What is the estimated quantity of crops produced after the adaptation strategy (ies) in kg/ha…………………………..

(31) Which of the crop is more tolerant to flood?

(a) Yam☐ (b) Cassava☐ (c) Rice☐ (d) Sesame ☐ ☐e) sugarcane

(32) Are you willing to plant more of flood tolerant crops?

(a) Yes ☐ (b) No ☐

(33) How many times do you have extension agents visit to assess such level of efficiency ?

(a) Once in a month☐ (b) once every two months☐

(c) Once in three month☐ (d) others☐

(34) Are there fertilizers given to aid level of efficiency on crops in your area?

(a) Yes☐ (b) No☐(c) Indifferent☐

(35) Who is responsible for the provision of such fertilizers application on farm?

(a) ADP☐ (b) Cooperative Society☐ (c) Others☐

(36) If the fertilizers are bought, how much does it cost...........

(37) When there is low technical and profit efficiency who do you report such to?

(a) Ministry of Agriculture☐ (b) ADP☐

(c) Extension Agents☐ (d) Others☐

(38) Is it possible to estimate the level of technical and profit efficiency on crops individually or collectively ?

(a) Yes ☐ (b) No ☐

(39) If the answer is yes, state the quantity…………………………………… cost must be imputed

(40) What is the cost of seeds in Naira per kilogram?..........................

(41) What is the cost of Agro-chemicals in Naira per liter...................?

(42) What is the average wage rate in Naira per man-day....................?

(43) Mention the years of farming experience of the crop production......... ?

(44a) Do you have access to credits? Yes☐ No☐

(44b) In the table below, indicate how frequent the listed factors occur in your area compared with what it used to be ***10 years ago(or more)***?

Sources	Very Often (5)	Often (4)	Some times (3)	Rare (2)	Very Rare (1)	None (0)
Flooding during rainy season						
Drought						
Erosion during rainy season						
Crop pest attack						
Crop disease outbreak						

Wind Blow						
Bush burning						

Section E: Identifying the constraints to choice of adaptation strategies in your areas

(45) What are the constraints to choice of adaptation strategies that you have experienced?

(a) Lack of proximity to farm areas☐ (b) Inadequate knowledge to cope with adaptation strategies☐ (c) Lack of money☐ (d) Area adaptation of crops to usage☐ (e) Other reasons ☐

(46) State the period of constraints ……………….

(47) Can you quantify the losses in Naira due to the constraints? …………………………………………………

(48) Rate the following attributes (characteristics) that contribute to losses of crop production to flooding

Attributes (Quality Characteristics)	**Great Extent (4)**	**Some Extent (3)**	**Little Extent (2)**	**No Extent (1)**
Lack of awareness				
Absence of proper guidance to farmers before flooding, during flooding and after flooding				
Lack of Government support				
Non-planting water resistant crops				

(49) Your income before flooding has been…………..

(50) Your income after flooding has been……………………………..

(51) With the above stated, will you agree that the impact of flooding on your farm is positive or has the impact been negative?

(a) Yes ☐ (b) No ☐

(52) If not sure, why? ....

(53) Will it be right to say, your level of Income after flooding has:

(a) Increased ☐ (b) Decreased ☐ (c) Not sure ☐

Table-4.5. Result of Climatic Variables on Crop Yields

Dependent Variable: RICE				
Method: Least Squares				
Date: 03/13/20 Time: 17:01				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
RICE(-1)	0.881952	0.094922	9.291311	0.0000
RAF	-0.529601	0.502562	-1.053802	0.2999
MAT	-9.562824	10.34514	-0.924379	0.3622
MIT	23.55767	22.49333	1.047318	0.3028
REH	-607.8959	257.0486	-2.364907	0.0243
C	302.3004	320.9442	0.941910	0.3533
R-squared	0.743805	Mean dependent var		180.7789
Adjusted R-squared	0.703775	S.D. dependent var		103.0178
S.E. of regression	56.06901	Akaike info criterion		11.03498
Sum squared resid	100599.5	Schwarz criterion		11.29355
Log likelihood	-203.6647	Hannan-Quinn criter.		11.12698
F-statistic	18.58101	Durbin-Watson stat		2.407480
Prob(F-statistic)	0.000000			

Dependent Variable: RICE				
Method: ARDL				
Date: 03/13/20 Time: 17:03				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Dependent lags: 1 (Fixed)				
Dynamic regressors (1 lag, fixed): RAF MAT MIT REH				
Fixed regressors: C				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
RICE(-1)	0.849977	0.098313	8.645599	0.0000
RAF	-0.550007	0.499334	-1.101481	0.2801
RAF(-1)	-0.211804	0.504174	-0.420100	0.6776
MAT	-15.05546	13.12267	-1.147287	0.2610
MAT(-1)	0.713514	13.88677	0.051381	0.9594

MIT	3.948274	25.04124	0.157671	0.8758
MIT(-1)	40.99097	24.87875	1.647630	0.1106
REH	-456.8786	275.9564	-1.655619	0.1090
REH(-1)	-1.185350	270.2345	-0.004386	0.9965
C	-39.86911	378.2075	-0.105416	0.9168
R-squared	0.779848	Mean dependent var		180.7789
Adjusted R-squared	0.709085	S.D. dependent var		103.0178
S.E. of regression	55.56417	Akaike info criterion		11.09389
Sum squared resid	86446.57	Schwarz criterion		11.52483
Log likelihood	-200.7839	Hannan-Quinn criter.		11.24721
F-statistic	11.02056	Durbin-Watson stat		2.327882
Prob(F-statistic)	0.000000			
*Note: p-values and any subsequent tests do not account for model selection.				

Dependent Variable: MAIZ				
Method: Least Squares				
Date: 03/13/20 Time: 17:07				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
MAIZ(-1)	0.591521	0.142314	4.156458	0.0002
RAF	-0.109392	0.203380	-0.537871	0.5944
MAT	-3.325379	4.144244	-0.802409	0.4282
MIT	1.659980	9.199735	0.180438	0.8579
REH	-139.9716	102.1711	-1.369972	0.1802
C	229.7707	133.6758	1.718865	0.0953
R-squared	0.395271	Mean dependent var		118.2816
Adjusted R-squared	0.300782	S.D. dependent var		27.09033
S.E. of regression	22.65273	Akaike info criterion		9.222377
Sum squared resid	16420.68	Schwarz criterion		9.480943
Log likelihood	-169.2252	Hannan-Quinn criter.		9.314373
F-statistic	4.183252	Durbin-Watson stat		1.962808
Prob(F-statistic)	0.004885			

Dependent Variable: MAIZ				
Method: ARDL				
Date: 03/13/20 Time: 17:07				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Dependent lags: 1 (Fixed)				
Dynamic regressors (1 lag, fixed): RAF MAT MIT REH				
Fixed regressors: C				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
MAIZ(-1)	0.641326	0.141952	4.517897	0.0001
RAF	-0.106314	0.195668	-0.543342	0.5912
RAF(-1)	-0.382068	0.196772	-1.941681	0.0623
MAT	-5.095917	5.133094	-0.992757	0.3293
MAT(-1)	-2.168593	5.459585	-0.397208	0.6942
MIT	-5.538883	9.788485	-0.565857	0.5760
MIT(-1)	18.37884	9.541118	1.926278	0.0643
REH	-95.95026	104.1144	-0.921585	0.3646
REH(-1)	21.67210	104.7816	0.206831	0.8376
C	133.2403	155.4797	0.856963	0.3987
R-squared	0.512731	Mean dependent var		118.2816
Adjusted R-squared	0.356108	S.D. dependent var		27.09033
S.E. of regression	21.73805	Akaike info criterion		9.216940
Sum squared resid	13231.20	Schwarz criterion		9.647884
Log likelihood	-165.1219	Hannan-Quinn criter.		9.370266
F-statistic	3.273677	Durbin-Watson stat		2.136855
Prob(F-statistic)	0.007630			
*Note: p-values and any subsequent tests do not account for model selection.				

Dependent Variable: YAM				
Method: ARDL				
Date: 03/13/20 Time: 17:09				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Dependent lags: 1 (Fixed)				
Dynamic regressors (1 lag, fixed): RAF MAT MIT REH				
Fixed regressors: C				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
YAM(-1)	0.938692	0.089598	10.47671	0.0000
RAF	0.333277	1.450874	0.229708	0.8200
RAF(-1)	-0.766306	1.462660	-0.523912	0.6045
MAT	-11.75461	41.48069	-0.283376	0.7790
MAT(-1)	31.29039	39.95558	0.783129	0.4401
MIT	-39.35992	72.51939	-0.542750	0.5916
MIT(-1)	40.25078	70.99392	0.566961	0.5753
REH	987.5077	793.4618	1.244556	0.2236
REH(-1)	1568.016	776.4679	2.019422	0.0531
C	-2061.493	1582.058	-1.303045	0.2032
R-squared	0.900737	Mean dependent var		2379.355
Adjusted R-squared	0.868832	S.D. dependent var		444.3215
S.E. of regression	160.9207	Akaike info criterion		13.22064
Sum squared resid	725073.6	Schwarz criterion		13.65158
Log likelihood	-241.1921	Hannan-Quinn criter.		13.37396
F-statistic	28.23111	Durbin-Watson stat		2.376739
Prob(F-statistic)	0.000000			
***Note:** p-values and any subsequent tests do not account for model selection.				

Dependent Variable: YAM				
Method: Least Squares				
Date: 03/13/20 Time: 17:10				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
YAM(-1)	0.876052	0.089090	9.833330	0.0000
RAF	0.128792	1.498274	0.085961	0.9320
MAT	-12.41557	35.21581	-0.352557	0.7267
MIT	27.93467	66.75131	0.418489	0.6784
REH	945.4503	776.5305	1.217531	0.2323
C	-443.2032	1404.190	-0.315629	0.7543
R-squared	0.878131	Mean dependent var		2379.355
Adjusted R-squared	0.859089	S.D. dependent var		444.3215
S.E. of regression	166.7899	Akaike info criterion		13.21529
Sum squared resid	890203.8	Schwarz criterion		13.47385
Log likelihood	-245.0904	Hannan-Quinn criter.		13.30728
F-statistic	46.11542	Durbin-Watson stat		2.147637
Prob(F-statistic)	0.000000			

Dependent Variable: SORG				
Method: Least Squares				
Date: 03/13/20 Time: 17:12				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
SORG(-1)	0.978678	0.063190	15.48792	0.0000
RAF	-0.039994	0.186701	-0.214212	0.8317
MAT	-1.530297	3.810095	-0.401643	0.6906
MIT	11.64866	8.329514	1.398480	0.1716
REH	-207.6097	93.48378	-2.220809	0.0336
C	-59.84451	119.3377	-0.501472	0.6195
R-squared	0.890844	Mean dependent var		135.1500
Adjusted R-squared	0.873789	S.D. dependent var		58.56481

S.E. of regression	20.80587	Akaike info criterion	9.052286
Sum squared resid	13852.29	Schwarz criterion	9.310852
Log likelihood	-165.9934	Hannan-Quinn criter.	9.144282
F-statistic	52.23185	Durbin-Watson stat	2.077997
Prob(F-statistic)	0.000000		

Dependent Variable: SORG				
Method: ARDL				
Date: 03/13/20 Time: 17:13				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Dependent lags: 1 (Fixed)				
Dynamic regressors (1 lag, fixed): RAF MAT MIT REH				
Fixed regressors: C				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
SORG(-1)	0.960916	0.066224	14.51000	0.0000
RAF	-0.058346	0.192844	-0.302553	0.7645
RAF(-1)	-0.090284	0.194061	-0.465234	0.6454
MAT	-4.181885	5.012287	-0.834327	0.4112
MAT(-1)	0.440821	5.315536	0.082931	0.9345
MIT	12.94258	9.639050	1.342724	0.1901
MIT(-1)	4.330043	9.434139	0.458976	0.6498
REH	-177.8620	102.1544	-1.741109	0.0926
REH(-1)	-123.6337	102.1542	-1.210265	0.2363
C	-26.71921	146.0256	-0.182976	0.8561
R-squared	0.898754	Mean dependent var		135.1500
Adjusted R-squared	0.866210	S.D. dependent var		58.56481
S.E. of regression	21.42140	Akaike info criterion		9.187592
Sum squared resid	12848.54	Schwarz criterion		9.618536
Log likelihood	-164.5643	Hannan-Quinn criter.		9.340919
F-statistic	27.61707	Durbin-Watson stat		2.119431
Prob(F-statistic)	0.000000			
*Note: p-values and any subsequent tests do not account for model Selection.				

Unitroot Test
Log
Total Yield

Null Hypothesis: LNTY has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-0.991768	0.9333
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
* MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LNTY)				
Method: Least Squares				
Date: 01/21/20 Time: 14:23				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNTY(-1)	-0.077902	0.078549	-0.991768	0.3281
C	0.550881	0.480156	1.147297	0.2590
@TREND("1980")	-0.005101	0.003146	-1.621359	0.1139
R-squared	0.089053	Mean dependent var		-0.015789
Adjusted R-squared	0.036999	S.D. dependent var		0.216266
S.E. of regression	0.212228	Akaike info criterion		-0.186659
Sum squared resid	1.576418	Schwarz criterion		-0.057376

Log likelihood	6.546524	Hannan-Quinn criter.		-0.140661
F-statistic	1.710774	Durbin-Watson stat		1.855393
Prob(F-statistic)	0.195493			

2ND DIFF

Null Hypothesis: D(LNTY) has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-5.707117	0.0002
Test critical values:	1% level		-4.226815	
	5% level		-3.536601	
	10% level		-3.200320	
* MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LNTY,2)				
Method: Least Squares				
Date: 01/21/20 Time: 14:24				
Sample (adjusted): 1982 2018				
Included observations: 37 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNTY(-1))	-0.980514	0.171806	-5.707117	0.0000
C	0.086791	0.077659	1.117598	0.2716
@TREND("1980")	-0.005135	0.003480	-1.475586	0.1493
R-squared	0.489282	Mean dependent var		0.000000
Adjusted R-squared	0.459240	S.D. dependent var		0.296273
S.E. of regression	0.217869	Akaike info criterion		-0.132245
Sum squared resid	1.613868	Schwarz criterion		-0.001630
Log likelihood	5.446532	Hannan-Quinn criter.		-0.086197
F-statistic	16.28649	Durbin-Watson stat		1.993650
Prob(F-statistic)	0.000011			

Rice

Null Hypothesis: LNR has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=0)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-1.443811	0.8311
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
* MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LNR)				
Method: Least Squares				
Date: 01/21/20 Time: 13:31				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNR(-1)	-0.123106	0.085264	-1.443811	0.1577
C	0.723122	0.411841	1.755827	0.0879
@TREND("1980")	-0.005362	0.005765	-0.930063	0.3587
R-squared	0.101661	Mean dependent var		0.007895
Adjusted R-squared	0.050328	S.D. dependent var		0.385116
S.E. of regression	0.375300	Akaike info criterion		0.953474
Sum squared resid	4.929751	Schwarz criterion		1.082757
Log likelihood	-15.11601	Hannan-Quinn criter.		0.999472
F-statistic	1.980405	Durbin-Watson stat		2.117445
Prob(F-statistic)	0.153180			

2ND DIFF

Null Hypothesis: D(LNR) has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-6.654921	0.0000
Test critical values:	1% level		-4.226815	
	5% level		-3.536601	
	10% level		-3.200320	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LNR,2)				
Method: Least Squares				
Date: 01/21/20 Time: 13:32				
Sample (adjusted): 1982 2018				
Included observations: 37 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNR(-1))	-1.133042	0.170256	-6.654921	0.0000
C	0.184783	0.138711	1.332148	0.1917
@TREND("1980")	-0.008915	0.006141	-1.451707	0.1557
R-squared	0.565728	Mean dependent var		-0.002703
Adjusted R-squared	0.540183	S.D. dependent var		0.572755
S.E. of regression	0.388384	Akaike info criterion		1.023960
Sum squared resid	5.128632	Schwarz criterion		1.154575
Log likelihood	-15.94326	Hannan-Quinn criter.		1.070008
F-statistic	22.14600	Durbin-Watson stat		2.005192
Prob(F-statistic)	0.000001			

Maize

Null Hypothesis: LNM has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=0)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-2.846999	0.1904
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LNM)				
Method: Least Squares				
Date: 01/21/20 Time: 13:34				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNM(-1)	-0.395667	0.138977	-2.846999	0.0073
C	1.885854	0.654852	2.879816	0.0067
@TREND("1980")	-0.000358	0.002903	-0.123396	0.9025
R-squared	0.194586	Mean dependent var		-0.002632
Adjusted R-squared	0.148562	S.D. dependent var		0.209874
S.E. of regression	0.193658	Akaike info criterion		-0.369794
Sum squared resid	1.312614	Schwarz criterion		-0.240511
Log likelihood	10.02609	Hannan-Quinn criter.		-0.323796
F-statistic	4.227944	Durbin-Watson stat		1.971549
Prob(F-statistic)	0.022664			

2ND DIFF

Null Hypothesis: D(LNM) has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-7.101356	0.0000
Test critical values:	1% level		-4.226815	
	5% level		-3.536601	
	10% level		-3.200320	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LNM,2)				
Method: Least Squares				
Date: 01/21/20 Time: 13:43				
Sample (adjusted): 1982 2018				
Included observations: 37 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNM(-1))	-1.194706	0.168236	-7.101356	0.0000
C	0.040482	0.074863	0.540751	0.5922
@TREND("1980")	-0.002186	0.003307	-0.660905	0.5131
R-squared	0.597296	Mean dependent var		0.000000
Adjusted R-squared	0.573608	S.D. dependent var		0.327448
S.E. of regression	0.213819	Akaike info criterion		-0.169766
Sum squared resid	1.554437	Schwarz criterion		-0.039151
Log likelihood	6.140663	Hannan-Quinn criter.		-0.123718
F-statistic	25.21465	Durbin-Watson stat		2.059399
Prob(F-statistic)	0.000000			

Sorghum

Null Hypothesis: LNS has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=0)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-1.055432	0.9234
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LNS)				
Method: Least Squares				
Date: 01/21/20 Time: 13:45				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNS(-1)	-0.087432	0.082840	-1.055432	0.2985
C	0.551587	0.464897	1.186470	0.2434
@TREND("1980")	-0.010175	0.006110	-1.665237	0.1048
R-squared	0.075498	Mean dependent var		-0.060526
Adjusted R-squared	0.022669	S.D. dependent var		0.366532
S.E. of regression	0.362354	Akaike info criterion		0.883264
Sum squared resid	4.595506	Schwarz criterion		1.012548
Log likelihood	-13.78203	Hannan-Quinn criter.		0.929262
F-statistic	1.429105	Durbin-Watson stat		1.964692
Prob(F-statistic)	0.253157			

2ND

Null Hypothesis: D(LNS) has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-6.104549	0.0001
Test critical values:	1% level		-4.226815	
	5% level		-3.536601	
	10% level		-3.200320	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LNS,2)				
Method: Least Squares				
Date: 01/21/20 Time: 13:46				
Sample (adjusted): 1982 2018				
Included observations: 37 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNS(-1))	-1.046723	0.171466	-6.104549	0.0000
C	0.102004	0.130832	0.779657	0.4410
@TREND("1980")	-0.008218	0.005884	-1.396736	0.1715
R-squared	0.522913	Mean dependent var		0.002703
Adjusted R-squared	0.494849	S.D. dependent var		0.523071
S.E. of regression	0.371768	Akaike info criterion		0.936509
Sum squared resid	4.699181	Schwarz criterion		1.067124
Log likelihood	-14.32543	Hannan-Quinn criter.		0.982557
F-statistic	18.63289	Durbin-Watson stat		1.995091
Prob(F-statistic)	0.000003			

LNY

Null Hypothesis: LNY has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=0)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-1.795710	0.6871
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LNY)				
Method: Least Squares				
Date: 01/21/20 Time: 13:47				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNY(-1)	-0.214331	0.119357	-1.795710	0.0812
C	1.630363	0.883296	1.845771	0.0734
@TREND("1980")	0.002134	0.002415	0.883512	0.3830
R-squared	0.126579	Mean dependent var		0.013158
Adjusted R-squared	0.076669	S.D. dependent var		0.084377
S.E. of regression	0.081078	Akaike info criterion		-2.111153
Sum squared resid	0.230078	Schwarz criterion		-1.981870
Log likelihood	43.11191	Hannan-Quinn criter.		-2.065155
F-statistic	2.536151	Durbin-Watson stat		2.042608
Prob(F-statistic)	0.093630			

2ND

Null Hypothesis: D(LNY) has a unit root	
Exogenous: Constant, Linear Trend	
Lag Length: 1 (Automatic - based on SIC, maxlag=9)	

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-5.929087	0.0001
Test critical values:	1% level		-4.234972	
	5% level		-3.540328	
	10% level		-3.202445	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LNY,2)				
Method: Least Squares				
Date: 01/21/20 Time: 13:51				
Sample (adjusted): 1983 2018				
Included observations: 36 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNY(-1))	-1.536106	0.259080	-5.929087	0.0000
D(LNY(-1),2)	0.283967	0.158091	1.796225	0.0819
C	0.059798	0.029048	2.058599	0.0478
@TREND("1980")	-0.002007	0.001232	-1.628783	0.1132
R-squared	0.636450	Mean dependent var		2.24E-17
Adjusted R-squared	0.602367	S.D. dependent var		0.119523
S.E. of regression	0.075369	Akaike info criterion		-2.228405
Sum squared resid	0.181775	Schwarz criterion		-2.052458
Log likelihood	44.11129	Hannan-Quinn criter.		-2.166995
F-statistic	18.67362	Durbin-Watson stat		1.789098
Prob(F-statistic)	0.000000			

Rainfall

Null Hypothesis: LNRF has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=0)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-5.054423	0.0011
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
* MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LNRF)				
Method: Least Squares				
Date: 01/21/20 Time: 13:52				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRF(-1)	-0.843565	0.166896	-5.054423	0.0000
C	3.952859	0.787414	5.020049	0.0000
@TREND("1980")	0.007276	0.003624	2.008028	0.0524
R-squared	0.422527	Mean dependent var		0.007895
Adjusted R-squared	0.389528	S.D. dependent var		0.293517
S.E. of regression	0.229333	Akaike info criterion		-0.031629
Sum squared resid	1.840772	Schwarz criterion		0.097654
Log likelihood	3.600959	Hannan-Quinn criter.		0.014369
F-statistic	12.80444	Durbin-Watson stat		1.862195
Prob(F-statistic)	0.000067			

Maximum Temperature

Null Hypothesis: LNMT has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-4.766461	0.0024
Test critical values:	1% level		-4.219126	

	5% level		-3.533083	
	10% level		-3.198312	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LNMT)				
Method: Least Squares				
Date: 01/21/20 Time: 13:53				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNMT(-1)	-0.434641	0.091187	-4.766461	0.0000
C	1.583438	0.330379	4.792798	0.0000
@TREND("1980")	-0.001958	0.000413	-4.734760	0.0000
R-squared	0.422876	Mean dependent var		0.000000
Adjusted R-squared	0.389898	S.D. dependent var		0.023250
S.E. of regression	0.018160	Akaike info criterion		-5.103536
Sum squared resid	0.011542	Schwarz criterion		-4.974253
Log likelihood	99.96719	Hannan-Quinn criter.		-5.057538
F-statistic	12.82280	Durbin-Watson stat		1.398564
Prob(F-statistic)	0.000066			

Minimum Temperature

Null Hypothesis: LNMIT has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-4.173484	0.0112
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LNMIT)				
Method: Least Squares				
Date: 01/21/20 Time: 13:55				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNMIT(-1)	-0.565410	0.135477	-4.173484	0.0002
C	1.760371	0.420106	4.190303	0.0002
@TREND("1980")	-0.001916	0.000617	-3.105811	0.0037
R-squared	0.340181	Mean dependent var		0.000000
Adjusted R-squared	0.302477	S.D. dependent var		0.040269
S.E. of regression	0.033632	Akaike info criterion		-3.871014
Sum squared resid	0.039589	Schwarz criterion		-3.741731
Log likelihood	76.54927	Hannan-Quinn criter.		-3.825016
F-statistic	9.022413	Durbin-Watson stat		1.762517
Prob(F-statistic)	0.000692			

Relative Humidity

Null Hypothesis: LNRH has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-5.072602	0.0011
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				

Dependent Variable: D(LNRH)				
Method: Least Squares				
Date: 01/21/20 Time: 13:58				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRH(-1)	-0.781829	0.154128	-5.072602	0.0000
C	-0.389668	0.076395	-5.100690	0.0000
@TREND("1980")	0.000645	0.000573	1.125975	0.2678
R-squared	0.425550	Mean dependent var		-0.002632
Adjusted R-squared	0.392724	S.D. dependent var		0.049248
S.E. of regression	0.038378	Akaike info criterion		-3.607030
Sum squared resid	0.051549	Schwarz criterion		-3.477746
Log likelihood	71.53356	Hannan-Quinn criter.		-3.561032
F-statistic	12.96390	Durbin-Watson stat		1.804056
Prob(F-statistic)	0.000061			

Linear Rainfall

Null Hypothesis: RAF has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-5.405565	0.0004
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(RAF)				
Method: Least Squares				
Date: 01/21/20 Time: 14:03				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
RAF(-1)	-0.914830	0.169239	-5.405565	0.0000
C	102.8281	20.69390	4.969003	0.0000
@TREND("1980")	0.847949	0.383888	2.208843	0.0338
R-squared	0.455417	Mean dependent var		1.152632
Adjusted R-squared	0.424297	S.D. dependent var		31.76681
S.E. of regression	24.10309	Akaike info criterion		9.278213
Sum squared resid	20333.56	Schwarz criterion		9.407497
Log likelihood	-173.2861	Hannan-Quinn criter.		9.324211
F-statistic	14.63465	Durbin-Watson stat		1.845395
Prob(F-statistic)	0.000024			

Maximum Temperature

Null Hypothesis: MAT has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-3.796478	0.0277
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(MAT)				
Method: Least Squares				
Date: 01/21/20 Time: 14:04				
Sample (adjusted): 1981 2018				

Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
MAT(-1)	-0.441182	0.116208	-3.796478	0.0006
C	16.61547	4.328393	3.838716	0.0005
@TREND("1980")	-0.064552	0.018375	-3.512953	0.0012
R-squared	0.306424	Mean dependent var		-0.028947
Adjusted R-squared	0.266791	S.D. dependent var		0.966998
S.E. of regression	0.828018	Akaike info criterion		2.536092
Sum squared resid	23.99647	Schwarz criterion		2.665375
Log likelihood	-45.18575	Hannan-Quinn criter.		2.582090
F-statistic	7.731537	Durbin-Watson stat		1.559068
Prob(F-statistic)	0.001656			

Minimum Temperature

Null Hypothesis: MIT has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-3.449245	0.0599
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(MIT)				
Method: Least Squares				
Date: 01/21/20 Time: 14:05				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
MIT(-1)	-0.489572	0.141936	-3.449245	0.0015
C	10.68161	3.092734	3.453775	0.0015
@TREND("1980")	-0.017642	0.009044	-1.950600	0.0591
R-squared	0.254592	Mean dependent var		-0.005263
Adjusted R-squared	0.211997	S.D. dependent var		0.594091
S.E. of regression	0.527372	Akaike info criterion		1.633836
Sum squared resid	9.734246	Schwarz criterion		1.763119
Log likelihood	-28.04288	Hannan-Quinn criter.		1.679834
F-statistic	5.977070	Durbin-Watson stat		1.974265
Prob(F-statistic)	0.005847			

Relative Humidity

Null Hypothesis: REH has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-5.072602	0.0011
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(REH)				
Method: Least Squares				
Date: 01/21/20 Time: 14:08				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
REH(-1)	-0.781829	0.154128	-5.072602	0.0000
C	0.470344	0.095061	4.947812	0.0000

@TREND("1980")	0.000645	0.000573	1.125975	0.2678
R-squared	0.425550	Mean dependent var		-0.002632
Adjusted R-squared	0.392724	S.D. dependent var		0.049248
S.E. of regression	0.038378	Akaike info criterion		-3.607030
Sum squared resid	0.051549	Schwarz criterion		-3.477746
Log likelihood	71.53356	Hannan-Quinn criter.		-3.561032
F-statistic	12.96390	Durbin-Watson stat		1.804056
Prob(F-statistic)	0.000061			

Rice

Null Hypothesis: RICE has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-1.590453	0.7781
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(RICE)				
Method: Least Squares				
Date: 01/21/20 Time: 14:09				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
RICE(-1)	-0.152411	0.095828	-1.590453	0.1207
C	40.33160	23.05377	1.749458	0.0890
@TREND("1980")	-0.639089	0.892238	-0.716277	0.4786
R-squared	0.100711	Mean dependent var		0.373684
Adjusted R-squared	0.049323	S.D. dependent var		59.65465
S.E. of regression	58.16488	Akaike info criterion		11.04010
Sum squared resid	118410.4	Schwarz criterion		11.16938
Log likelihood	-206.7618	Hannan-Quinn criter.		11.08610
F-statistic	1.959810	Durbin-Watson stat		2.174187
Prob(F-statistic)	0.156042			

2ND DIFF

Null Hypothesis: D(RICE) has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-7.034445	0.0000
Test critical values:	1% level		-4.226815	
	5% level		-3.536601	
	10% level		-3.200320	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(RICE,2)				
Method: Least Squares				
Date: 01/21/20 Time: 14:10				
Sample (adjusted): 1982 2018				
Included observations: 37 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RICE(-1))	-1.185542	0.168534	-7.034445	0.0000
C	26.49092	21.26693	1.245639	0.2214
@TREND("1980")	-1.302648	0.941627	-1.383401	0.1756
R-squared	0.592734	Mean dependent var		0.005405
Adjusted R-squared	0.568777	S.D. dependent var		91.30375
S.E. of regression	59.95698	Akaike info criterion		11.10274
Sum squared resid	122224.5	Schwarz criterion		11.23335

Log likelihood	-202.4006	Hannan-Quinn criter.	11.14878
F-statistic	24.74171	Durbin-Watson stat	2.032384
Prob(F-statistic)	0.000000		

Maize

Null Hypothesis: MAIZ has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-2.873308	0.1820
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(MAIZ)				
Method: Least Squares				
Date: 01/21/20 Time: 14:10				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
MAIZ(-1)	-0.404413	0.140748	-2.873308	0.0069
C	48.05375	17.14356	2.803021	0.0082
@TREND("1980")	-0.020478	0.339497	-0.060319	0.9522
R-squared	0.197893	Mean dependent var		-0.302632
Adjusted R-squared	0.152058	S.D. dependent var		24.47103
S.E. of regression	22.53384	Akaike info criterion		9.143570
Sum squared resid	17772.09	Schwarz criterion		9.272853
Log likelihood	-170.7278	Hannan-Quinn criter.		9.189568
F-statistic	4.317528	Durbin-Watson stat		1.999370
Prob(F-statistic)	0.021090			

2ND DIFF

Null Hypothesis: D(MAIZ) has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-7.293014	0.0000
Test critical values:	1% level		-4.226815	
	5% level		-3.536601	
	10% level		-3.200320	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(MAIZ,2)				
Method: Least Squares				
Date: 01/21/20 Time: 14:11				
Sample (adjusted): 1982 2018				
Included observations: 37 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MAIZ(-1))	-1.219961	0.167278	-7.293014	0.0000
C	4.938871	8.679517	0.569026	0.5731
@TREND("1980")	-0.265984	0.383363	-0.693817	0.4925
R-squared	0.610039	Mean dependent var		-0.067568
Adjusted R-squared	0.587100	S.D. dependent var		38.57677
S.E. of regression	24.78839	Akaike info criterion		9.336233
Sum squared resid	20891.79	Schwarz criterion		9.466848
Log likelihood	-169.7203	Hannan-Quinn criter.		9.382281
F-statistic	26.59408	Durbin-Watson stat		2.079386

Sorghum

Null Hypothesis: SORG has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-0.632145	0.9710
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(SORG)				
Method: Least Squares				
Date: 01/21/20 Time: 14:12				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
SORG(-1)	-0.042971	0.067977	-0.632145	0.5314
C	11.89153	13.46612	0.883070	0.3832
@TREND("1980")	-0.493589	0.337046	-1.464456	0.1520
R-squared	0.058851	Mean dependent var		-3.700000
Adjusted R-squared	0.005071	S.D. dependent var		21.82624
S.E. of regression	21.77083	Akaike info criterion		9.074675
Sum squared resid	16588.91	Schwarz criterion		9.203959
Log likelihood	-169.4188	Hannan-Quinn criter.		9.120673
F-statistic	1.094299	Durbin-Watson stat		1.517880
Prob(F-statistic)	0.345955			

2ND DIFF

Null Hypothesis: D(SORG) has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 2 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-3.147871	0.1115
Test critical values:	1% level		-4.243644	
	5% level		-3.544284	
	10% level		-3.204699	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(SORG,2)				
Method: Least Squares				
Date: 01/21/20 Time: 14:13				
Sample (adjusted): 1984 2018				
Included observations: 35 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SORG(-1))	-0.827530	0.262886	-3.147871	0.0037
D(SORG(-1),2)	0.011099	0.232561	0.047725	0.9623
D(SORG(-2),2)	0.164771	0.178610	0.922515	0.3636
C	7.262881	9.052799	0.802280	0.4287
@TREND("1980")	-0.485558	0.408345	-1.189086	0.2437
R-squared	0.429620	Mean dependent var		-0.131429
Adjusted R-squared	0.353569	S.D. dependent var		27.67175
S.E. of regression	22.24835	Akaike info criterion		9.173976
Sum squared resid	14849.67	Schwarz criterion		9.396169
Log likelihood	-155.5446	Hannan-Quinn criter.		9.250677
F-statistic	5.649120	Durbin-Watson stat		1.997393
Prob(F-statistic)	0.001638			

YAM

Null Hypothesis: YAM has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-1.441900	0.8318
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(YAM)				
Method: Least Squares				
Date: 01/21/20 Time: 14:14				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
YAM(-1)	-0.173033	0.120003	-1.441900	0.1582
C	375.1885	204.3090	1.836378	0.0748
@TREND("1980")	2.877127	5.038739	0.571001	0.5716
R-squared	0.104594	Mean dependent var		23.68421
Adjusted R-squared	0.053428	S.D. dependent var		170.1829
S.E. of regression	165.5742	Akaike info criterion		13.13237
Sum squared resid	959518.9	Schwarz criterion		13.26166
Log likelihood	-246.5151	Hannan-Quinn criter.		13.17837
F-statistic	2.044207	Durbin-Watson stat		2.001005
Prob(F-statistic)	0.144660			

2ND DIFF

Null Hypothesis: D(YAM) has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-6.831006	0.0000
Test critical values:	1% level		-4.226815	
	5% level		-3.536601	
	10% level		-3.200320	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(YAM,2)				
Method: Least Squares				
Date: 01/21/20 Time: 14:15				
Sample (adjusted): 1982 2018				
Included observations: 37 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(YAM(-1))	-1.166271	0.170732	-6.831006	0.0000
C	85.51430	60.26390	1.418997	0.1650
@TREND("1980")	-3.144348	2.621814	-1.199302	0.2387
R-squared	0.578521	Mean dependent var		-13.62162
Adjusted R-squared	0.553728	S.D. dependent var		251.4125
S.E. of regression	167.9525	Akaike info criterion		13.16284
Sum squared resid	959073.4	Schwarz criterion		13.29346
Log likelihood	-240.5126	Hannan-Quinn criter.		13.20889
F-statistic	23.33418	Durbin-Watson stat		1.966749
Prob(F-statistic)	0.000000			

Total Yield

Null Hypothesis: TOY has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-1.164645	0.9036
Test critical values:	1% level		-4.219126	
	5% level		-3.533083	
	10% level		-3.198312	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(TOY)				
Method: Least Squares				
Date: 01/21/20 Time: 14:19				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
TOY(-1)	-0.099281	0.085246	-1.164645	0.2520
C	69.20256	44.69459	1.548343	0.1305
@TREND("1980")	-1.505759	1.254215	-1.200559	0.2380
R-squared	0.081494	Mean dependent var		-3.628947
Adjusted R-squared	0.029008	S.D. dependent var		85.61606
S.E. of regression	84.36513	Akaike info criterion		11.78384
Sum squared resid	249111.6	Schwarz criterion		11.91313
Log likelihood	-220.8930	Hannan-Quinn criter.		11.82984
F-statistic	1.552688	Durbin-Watson stat		1.949293
Prob(F-statistic)	0.225908			

2ND DIFF

Null Hypothesis: D(TOY) has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-6.089631	0.0001
Test critical values:	1% level		-4.226815	
	5% level		-3.536601	
	10% level		-3.200320	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(TOY,2)				
Method: Least Squares				
Date: 01/21/20 Time: 14:20				
Sample (adjusted): 1982 2018				
Included observations: 37 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(TOY(-1))	-1.041994	0.171110	-6.089631	0.0000
C	34.76076	30.81342	1.128104	0.2672
@TREND("1980")	-1.912541	1.372059	-1.393920	0.1724
R-squared	0.521696	Mean dependent var		0.354054
Adjusted R-squared	0.493560	S.D. dependent var		122.0279
S.E. of regression	86.84063	Akaike info criterion		11.84363
Sum squared resid	256404.0	Schwarz criterion		11.97425
Log likelihood	-216.1072	Hannan-Quinn criter.		11.88968
F-statistic	18.54223	Durbin-Watson stat		2.006900
Prob(F-statistic)	0.000004			

Cross-Sectional Properties

	ASC	AGE	EDQ	SEX	MLA	HSWC
Mean	1.952381	42.21270	10.73651	0.714286	2.158730	6865.397
Median	2.000000	40.00000	12.00000	1.000000	1.000000	5000.000
Maximum	4.000000	74.00000	18.00000	1.000000	10.00000	80000.00
Minimum	1.000000	22.00000	3.000000	0.000000	1.000000	800.0000
Std. Dev.	0.782544	10.11569	4.658097	0.452473	2.456023	8217.496
Skewness	0.402731	0.624401	-0.115939	-0.948683	1.911692	5.628880
Kurtosis	2.538030	3.340622	1.450094	1.900000	5.180709	45.47544
Jarque-Bera	11.31616	21.99134	32.23467	63.13125	254.2806	25343.06
Probability	0.003489	0.000017	0.000000	0.000000	0.000000	0.000000
Sum	615.0000	13297.00	3382.000	225.0000	680.0000	2162600.
Sum Sq. Dev.	192.2857	32130.75	6813.130	64.28571	1894.063	2.12E+10
Observations	315	315	315	315	315	315

CLIMATIC VARIABILITY(MAX.TEMP.,MIN.TEMP,RAINFALL & RELATIVE HUMIDITY (1980 – 2018)

Rainfall	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Jan	0.0	4.9	10.0	0.0	0.2	4.0	0.8	0.6	2.5	0.0	4.0	0.8	0.0	0.0	2.9	0.4	1.8	3.0	43.2
Feb.	4.8	5.2	8.7	1.2	0.6	0.5	10.2	21.9	37.4	0.6	20.3	17.6	1.0	9.2	0.7	21.6	11.8	0.0	0.6
March	35.2	19.2	19.0	43.2	47.2	60.9	38.5	146.8	40.9	41.3	12.9	15.4	47.6	23.8	4.5	24.7	40.5	167.7	5.0
April	22.1	91.0	314.9	29.0	144.8	121.5	196.1	14.6	313.7	139.6	138.3	153.4	299.1	176.7	98.6	136.3	129.6	155.7	48.5
May	207.9	145.5	338.5	95.0	176.9	226.3	189.3	112.4	418.8	204.1	185.4	404.3	350.6	253.7	121.0	176.5	479.1	196.4	218.2
June	165.9	223.0	274.0	252.1	114.0	228.8	140.6	162.2	310.7	145.4	211.9	141.7	172.2	135.6	347.6	257.5	137.8	268.3	289.7
July	266.5	264.2	391.3	115.3	209.9	352.6	253.1	332.2	378.0	248.2	285.6	313.1	311.2	257.0	303.8	332.5	260.8	135.0	292.7
August	491.4	316.4	254.6	206.4	279.9	396.7	243.6	320.1	246.1	462.6	200.2	237.9	220.7	279.1	351.8	426.4	242.8	164.1	322.8
September	249.9	416.5	303.3	218.8	252.8	306.2	320.8	241.0	357.2	288.9	319.2	267.3	330.0	175.7	409.9	271.1	506.0	167.0	380.2
October	204.9	130.5	187.5	39.0	37.0	65.2	59.9	91.4	79.7	204.9	34.3	81.3	80.2	96.1	254.0	236.8	124.2	135.5	339.8
November	11.1	1.5	1.3	4.6	1.7	4.3	3.1	9.1	2.2	0.7	9.7	3.9	31.5	6.6	13.6	15.9	0.0	7.5	1.5
December	0.5	0.2	0.0	4.1	3.3	0.2	0.0	0.8	3.2	0.2	3.3	0.2	0.1	1.9	0.0	0.2	0.4	8.2	0.4
	138.4	134.8	175.3	84.1	105.7	147.3	121.3	121.1	182.5	144.7	118.8	136.4	153.7	118.0	159.0	158.3	161.2	117.4	161.9
Max Temp	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	38.3	37.1	38.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6	38.6	39.1	40.0
	40.0	39.7	38.4	40.9	39.3	38.1	40.8	39.7	39.4	39.1	39.7	40.1	39.5	39.1	39.9	38.2	39.5	40.7	41.9
	39.6	39.2	38.8	39.7	40.2	37.7	38.0	39.6	39.3	39.1	41.8	40.1	37.4	38.4	41.0	40.4	38.3	38.6	42.6
	38.5	38.8	37.3	39.7	36.3	36.7	39.1	39.2	37.3	38.3	35.5	36.1	35.9	36.7	35.9	37.2	37.1	34.9	42.1
	33.2	32.1	31.7	35.8	33.8	35.0	34.6	36.1	34.3	33.0	33.3	31.1	32.1	35.3	34.5	32.8	33.6	31.6	36.2
	30.3	31.0	29.6	29.6	32.8	30.9	31.2	30.7	29.9	31.2	31.6	32.0	30.7	30.5	30.8	29.8	29.4	29.9	33.2
	26.1	26.2	26.8	27.2	29.3	25.7	26.6	29.9	26.0	27.3	27.1	27.3	27.0	27.8	26.8	26.4	27.2	29.3	30.4
	26.2	26.3	26.0	24.8	29.6	27.2	27.7	26.5	24.5	25.9	28.1	26.9	25.1	26.5	25.4	26.1	26.4	28.4	28.1
	28.0	27.7	27.3	27.4	29.4	27.9	27.8	28.2	26.8	27.9	30.0	29.1	27.0	28.8	27.4	28.1	26.9	30.1	28.4
	28.7	30.2	27.9	31.1	30.8	31.7	29.6	30.5	29.7	30.1	32.8	30.4	29.2	30.1	29.4	29.6	29.8	31.8	31.2
	33.0	33.1	32.6	32.8	33.9	34.6	32.4	34.2	35.1	34.4	35.5	33.5	32.1	33.1	32.3	32.6	33.7	35.6	36.4
	35.4	36.8	36.0	35.5	35.5	35.6	34.8	36.4	36.0	35.9	35.9	35.4	35.3	35.1	35.5	36.3	36.1	37.0	37.3
	32.9	32.9	32.3	33.4	34.0	33.1	33.3	33.9	33.0	33.2	34.0	33.2	32.2	33.2	32.9	32.7	32.8	33.9	35.6
Min Temp	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	16.5	17.1	18.4	14.8	14.9	17.6	15.7	15.8	18.3	14.2	16.3	17.8	15.8	14.7	18.7	16.1	16.9	18.1	18.1
	19.0	17.2	18.2	16.9	15.2	13.8	20.1	20.6	18.9	14.1	17.3	21.0	13.9	17.5	16.6	19.9	21.6	15.0	20.8
	21.7	21.1	22.4	17.7	22.1	20.5	23.1	22.1	23.6	20.7	17.6	23.0	20.0	21.7	22.7	23.3	23.4	22.6	21.1
	24.3	22.2	23.5	23.4	23.3	22.8	23.9	23.0	23.9	23.2	23.8	23.0	23.5	23.2	24.0	23.9	23.4	23.5	24.0
	23.1	22.4	22.4	22.9	23.0	22.3	22.5	22.8	22.9	22.1	22.1	22.2	22.3	23.1	23.3	22.5	22.9	22.6	24.4
	21.5	21.5	21.8	22.0	21.5	21.0	21.1	21.4	21.9	21.6	21.6	22.0	21.5	21.8	21.6	22.1	21.2	21.9	22.7
	20.3	20.2	20.8	20.6	20.6	19.8	20.0	21.6	20.7	20.5	20.7	20.8	20.8	20.6	20.5	21.0	20.6	21.0	21.7
	20.6	20.4	20.6	20.1	20.9	20.8	20.3	21.3	20.2	20.7	20.3	20.6	20.0	20.5	20.4	21.0	20.4	21.0	21.3
	20.9	21.1	20.7	20.5	21.1	21.1	20.5	21.3	21.2	20.9	21.2	21.4	20.7	21.2	21.4	21.5	20.9	22.2	21.7
	21.2	21.5	20.8	20.1	20.7	20.7	20.8	21.7	20.8	21.1	21.6	21.0	20.6	21.3	21.6	21.5	20.9	22.4	22.0
	19.8	18.6	18.3	18.9	18.3	20.3	18.9	19.8	18.9	18.8	20.9	18.7	19.4	20.8	19.2	18.8	17.0	22.1	20.7
	17.9	16.4	17.6	19.0	16.4	17.8	16.3	17.9	18.8	17.1	20.4	17.6	16.8	18.8	16.7	17.6	16.2	19.9	18.0
	20.8	20.3	20.7	19.8	20.1	20.1	20.6	21.0	21.0	19.8	20.3	21.0	19.9	20.6	20.9	21.1	20.8	21.0	21.4
Relative hu	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
	0.3	0.4	0.4	0.2	0.2	0.4	0.4	0.3	0.4	0.2	0.4	0.3	0.3	0.3	0.4	0.3	0.4	0.4	0.3
	0.4	0.4	0.4	0.4	0.4	0.3	0.5	0.5	0.5	0.3	0.4	0.5	0.3	0.4	0.4	0.5	0.5	0.3	0.3
	0.5	0.6	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.4
	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6
	0.7	0.8	0.8	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.8	0.8	0.7	0.7	0.8	0.7	0.8	0.7
	0.8	0.8	0.9	0.9	0.7	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	0.9	0.9	0.9	0.9	0.8	0.9	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
	0.9	0.9	0.9	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
	0.9	0.9	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.8	0.8	0.9	0.9	0.9	0.9	0.8	0.9	0.8
	0.7	0.6	0.6	0.7	0.6	0.7	0.7	0.7	0.6	0.6	0.7	0.7	0.7	0.8	0.7	0.6	0.5	0.7	0.6
	0.4	0.3	0.4	0.5	0.4	0.4	0.3	0.4	0.5	0.4	0.6	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.3
	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6

Rainfall	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Jan	3.3	1.0	0.0	0.0	7.8	2.6	0.4	12.3	0.0	3.4	8.6	7.7	0.0	0.1	8.3	7.2	2.6	0.4	12.3	0.0
Feb.	6.5	0.2	0.0	3.9	1.0	3.9	22.8	6.7	8.5	1.2	7.2	9.1	6.5	10.4	6.9	12.3	3.9	22.8	6.7	8.5
March	11.6	0.2	2.0	5.9	16.2	9.1	32.9	14.0	6.3	18.6	37.1	36.8	6.9	7.1	15.1	39.6	9.1	32.9	14.0	6.3
April	17.0	10.0	117.1	26.3	113.9	116.1	126.1	66.2	17.6	177.5	242.6	112.8	202.3	125.1	152.2	59.0	116.1	126.1	66.2	17.6
May	265.7	57.7	137.8	28.5	65.8	209.7	117.3	131.8	286.7	105.9	132.8	112.9	109.2	155.8	119.4	177.1	209.7	117.3	131.8	286.7
June	146.6	69.0	123.0	356.1	302.3	113.8	251.6	163.1	201.9	107.8	144.8	160.8	154.4	160.6	141.0	121.9	113.8	251.6	163.1	201.9
July	166.4	81.7	220.4	219.3	277.4	320.0	364.7	285.0	235.8	473.6	355.9	334.4	247.7	348.3	247.3	293.9	320.0	364.7	285.0	235.8
August	235.9	165.9	230.8	223.1	539.2	285.2	183.6	449.5	452.8	344.8	340.8	295.7	260.2	436.2	332.2	332.2	285.2	183.6	449.5	452.8
September	260.0	95.8	207.9	397.5	337.7	310.3	200.3	349.5	235.0	336.0	236.5	341.8	269.4	370.1	311.9	311.9	310.3	200.3	349.5	235.0
October	70.8	67.7	14.9	162.9	63.4	64.5	81.8	112.1	210.5	141.2	142.4	119.0	100.6	115.9	114.3	114.3	64.5	81.8	112.1	210.5
November	2.9	5.1	2.3	10.6	2.0	22.7	17.7	4.0	5.3	0.8	25.3	11.0	1.4	7.3	8.2	8.2	22.7	17.7	4.0	5.3
December	0.2	0.5	0.5	1.1	0.5	0.7	3.0	0.0	6.2	4.1	0.1	1.0	0.0	0.1	5.7	5.7	0.7	3.0	0.0	6.2
	98.9	46.2	88.1	119.6	143.9	121.6	116.8	132.9	138.9	142.9	139.5	128.6	113.2	144.7	121.9	123.6	121.6	116.8	132.9	138.9
Max Temp	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
	39.1	40.6	38.3	39.1	40.3	40.2	40.3	41.7	39.3	38.9	40.8	40.9	38.6	39.5	39.8	39.4	40.2	40.3	41.7	39.3
	42.4	41.9	41.4	42.6	43.2	41.0	44.4	43.2	42.4	41.7	42.0	42.6	41.2	41.4	41.6	40.4	41.0	44.4	43.2	42.4
	43.7	43.8	43.2	43.7	44.6	44.0	45.4	43.7	44.0	43.3	43.0	40.6	42.6	42.4	42.6	39.6	44.0	45.4	43.7	44.0
	40.9	45.1	38.9	39.9	40.3	41.6	41.8	42.9	40.4	39.6	35.4	41.3	40.2	38.5	37.0	38.7	41.6	41.8	42.9	40.4
	37.0	42.7	37.5	39.0	40.4	36.9	37.5	36.7	37.7	36.2	33.6	36.8	35.3	34.6	34.5	34.3	36.9	37.5	36.7	37.7
	35.3	33.7	34.7	35.4	34.4	35.3	35.0	37.7	34.5	33.0	31.9	34.2	34.0	32.9	32.5	33.8	35.3	35.0	37.7	34.5
	33.0	29.9	30.9	32.2	32.0	32.6	32.0	33.5	30.6	29.1	30.1	30.0	30.6	28.0	29.3	30.1	32.6	32.0	33.5	30.6
	30.8	29.4	28.0	30.4	30.9	29.9	31.2	28.7	27.2	27.4	28.4	28.4	28.3	27.4	28.1	28.1	29.9	31.2	28.7	27.2
	31.9	30.0	30.4	31.5	30.7	33.4	31.8	28.9	29.3	28.8	29.8	29.0	28.4	28.9	29.5	29.5	33.4	31.8	28.9	29.3
	34.9	32.3	34.7	32.8	34.5	36.6	34.5	31.7	30.7	32.3	30.3	31.0	30.8	31.3	31.7	31.7	36.6	34.5	31.7	30.7
	39.5	34.7	38.5	36.3	37.6	39.1	37.9	35.5	34.8	37.0	34.8	35.6	35.6	35.7	36.4	36.4	39.1	37.9	35.5	34.8
	39.1	36.3	39.0	39.2	38.8	40.3	39.7	37.6	37.3	38.6	37.8	37.2	36.7	37.4	36.2	36.2	40.3	39.7	37.6	37.3
	37.3	36.7	36.3	36.8	37.3	37.6	37.6	36.8	35.7	35.5	34.8	35.6	35.2	34.8	34.9	34.9	37.6	37.6	36.8	35.7
Min Temp	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
	18.1	16.3	16.5	14.9	19.3	19.9	15.0	21.3	15.5	17.8	20.2	18.9	16.1	16.3	19.8	19.0	19.3	19.9	15.0	21.3
	22.7	14.8	16.6	18.4	21.5	19.9	21.7	23.4	18.7	16.1	22.2	23.6	22.1	22.6	22.8	21.4	21.5	19.9	21.7	23.4
	23.9	18.2	23.8	24.4	23.3	21.5	24.2	24.7	21.4	22.5	23.9	24.1	23.7	22.6	25.2	24.4	23.3	21.5	24.2	24.7
	24.2	23.6	24.9	24.7	24.5	24.6	24.4	24.6	24.9	23.2	24.2	25.5	24.3	24.1	24.2	24.4	24.5	24.6	24.4	24.6
	22.7	23.6	24.1	24.4	23.6	23.8	24.0	23.7	23.9	23.7	23.6	24.4	23.5	22.9	23.0	22.9	23.6	23.8	24.0	23.7
	22.5	22.6	22.1	22.9	22.5	22.6	22.8	22.7	22.6	22.6	22.6	22.8	22.6	22.0	22.0	22.5	22.5	22.6	22.8	22.7
	21.2	21.4	21.7	22.0	21.6	21.6	21.9	22.3	21.9	21.7	22.2	21.8	21.7	21.2	21.4	21.6	21.6	21.6	21.9	22.3
	21.3	21.1	21.2	21.7	21.8	21.9	21.8	21.8	21.7	21.5	22.2	22.0	21.4	21.0	21.2	21.2	21.8	21.9	21.8	21.8
	21.4	21.6	21.5	22.0	21.8	22.2	22.2	22.4	22.1	22.1	22.2	22.1	21.5	21.4	21.7	21.7	21.8	22.2	22.2	22.4
	21.8	21.7	21.6	22.6	22.3	22.8	22.2	22.7	22.0	22.6	22.2	22.2	21.3	21.6	21.6	21.6	22.3	22.8	22.2	22.7
	20.7	20.7	20.2	20.7	21.7	22.5	20.0	19.6	21.9	20.4	21.7	22.3	18.9	21.6	21.5	21.5	21.7	22.5	20.0	19.6
	15.4	18.6	18.0	18.8	18.4	18.8	20.4	16.4	19.0	20.6	18.2	17.9	16.1	19.0	19.5	19.5	18.4	18.8	20.4	16.4
	21.3	20.4	21.0	21.5	21.9	21.8	21.7	22.1	21.3	21.2	22.1	22.3	21.1	21.4	22.0	21.8	21.9	21.8	21.7	22.1
Relative hu	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
	0.4	0.3	0.3	0.2	0.3	0.3	0.3	0.4	0.2	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.2	0.3
	0.5	0.2	0.3	0.4	0.4	0.3	0.4	0.5	0.4	0.3	0.5	0.4	0.5	0.5	0.4	0.3	0.4	0.5	0.4	0.3
	0.5	0.3	0.5	0.5	0.4	0.4	0.5	0.5	0.4	0.5	0.4	0.4	0.5	0.4	0.5	0.5	0.5	0.5	0.4	0.5
	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.6	0.7	0.6	0.5	0.6	0.6	0.6	0.6	0.5	0.5	0.6
	0.6	0.5	0.6	0.6	0.6	0.7	0.6	0.7	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.6	0.6
	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.8	0.7
	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.8	0.9	0.9	0.8	0.8	0.8	0.8	0.9
	0.8	0.9	0.9	0.8	0.9	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.9	0.9	0.9
	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.9	0.9	0.9
	0.7	0.8	0.7	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.9	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	0.6	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.7	0.5	0.6	0.7	0.5	0.6	0.6	0.5	0.5	0.5	0.7	0.5
	0.3	0.4	0.3	0.3	0.6	0.3	0.4	0.3	0.4	0.4	0.3	0.3	0.3	0.3	0.4	0.6	0.4	0.3	0.4	0.4
	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.6

Source: NIMET, 2019