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ANALYSIS OF FARMERS' LEVEL OF AWARENESS OF THE EFFECTS OF RAINFALL VARIABILITY ON THE YIELD OF SORGHUM IN SUDAN SAVANNA REGION OF NIGERIA

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Abstract

Rainfall stands out as perhaps the single unique element of all the climatic elements such that its variability, spatial and temporal distribution influences the type of agriculture and the productivity of crops in Nigeria. The farmer's awareness of the effects of rainfall variability on crop yield is important as it prepare farmers to employ appropriate adaptations to maximize yield. This study therefore assessed the farmers' level of awareness of the effect of rainfall variability on the yield of sorghum in Sudan savanna region of Nigeria. Fourteen rural settlements were selected from seven states via stratified sampling technique, two from each Theison polygon. Rainfall data from 1956 – 2018 and yield data for sorghum were analyzed to show the trend of rainfall and yield. A non-parametric test (Kruskal-wallis) was used to test the difference in farmers' level of awareness of rainfall trend and its effects on the yield of sorghum. 384 farmers were sampled and administered questionnaire. The results show an increasing rainfall trend in Bauchi, Gusau, Kano and Potiskum stations. The results also indicate an increase in the yield of sorghum in Bauchi, Gusau, Katsina and Potiskum. A significant relationship between annual rainfall and Sorghum yield was observed in the study area; 73% of the farmers have knowledge of rainfall trend, while 60% have knowledge of the effect of rainfall on sorghum yield. The results further disclosed that there is a significant difference in the level of awareness among farmers and the effects of rainfall variability on sorghum yield. The study concluded that majority of the rural farmers have basic knowledge of rainfall variability and its effects on the yield of sorghum. The study therefore recommended a continuous public enlightenment on the effects of rainfall variability by the farm extension workers and adopting new hybrids of short-duration varieties in order to minimize the impacts of rainfall variability on crop yield in the study area.

Keywords: Awareness, Climate, Farmers, Rainfall and Variability

1. Introduction

Sorghum is a widely grown rain-fed cereal crop in the arid and semi-arid regions of Africa and Asia. Nigeria is the largest sorghum producer in West Africa, accounting for about 71% of the total regional sorghum output which also accounted for 35% of the African production in 2007 (Ogbonna, 2011). The country is the third largest world producer after the United States and India (Food and Agricultural Organization Statistical Database, [FAOSTAT, 2014]). In Nigeria, sorghum is the third cereal in terms of production after maize and millet (FAOSTAT, 2012), with more than 4.5 million tones harvested in 2010 representing 25% of the total cereal production (FAOSTAT, 2012). In virtually all the North of the country, it is the primary food crop (USAID, 2011).

With regard to the growing conditions, sorghum grows well on deep, fertile and well-drained loamy soils (USAID, 2009). In Nigeria, these soils are common in the Northern Guinea Savannah and in the Sudan Savannah of Nigeria (Ogbonna, 2011).

Sorghum is grown mostly in the North-west and North-east of the country. The crop, sorghum require rainfall amount of 600-1,000mm with duration of at least five (5) months spread over eighty (80) rainy days (Odjugo, 2009). That means where rainfall totals fall below 600mm, effective sorghum production will be affected. It also implies that sorghum production will also be affected where the amount of rainfall exceeds the require maximum. The development of the plant takes 110 to 170 days, and is frequently considered to have 3 stages: emergence to floral initiation to flowering, and flowering to physiological maturity. The crop does better when it is dry and cool. Sorghum is a thermophilic (26°C-40°C), drought-resistant plant, which grows slowly at 16-20°C, and stops growing under 14°C (Iren, 2004).

The productivity of Sorghum is dependent on quantity of rains during pre-sowing season and water holding capacity of soil. Soil moisture conservation, use of high yielding cultivars and fertilizer management plays a major role in improving the productivity of Sorghum. Crop grown in irrigated conditions with 2-5 irrigations with higher productivity potential may yield up to 3.0 to 3.5T/ha (Indorama, 2020). Sorghum is widely grown both for food and as a feed grain. The stems are used for fuel and building of fences and local huts, hence, the reason for its wide cultivation in northern Nigeria. It therefore suggests that Nigeria will henceforth, have to supply all its demand and for this to happen, the country must double its production capacity and equally address the challenges facing the agricultural sector particularly, those associated with rainfall variability.

Despite modern technological advancement in agriculture, there are still challenges for farmers and scientist to predict precipitation pattern in sub-Saharan Africa (IPCC, 2001). The fluctuation in rainfall pattern as reported by Adejuwon (2004) has put Nigeria's agricultural production under serious threat, since agriculture in Nigeria is mostly rain-fed. This situation would adversely affect the sustainability of the variety of agricultural crops cultivated in Nigeria and notably in Northern Nigeria (Sowunmi and Akintola, 2010).

The Sudano-Sahelian zone of Nigeria is generally characterized by short rainfall periods and a long dry season (Otegbeye, 2004). The annual precipitation in this area varies from less than 500mm in the extreme northeastern part to about 1000mm in the southern part. Recent studies have indicated that the Sudano-Sahelian zone of Nigeria has suffered decrease in rainfall in the range of about 30-40 per cent since the beginning of the nineteenth century (Federal Ministry of Environment [FME], 2003). Oladipo (1989) established that since the 1963-1973, rainfall in the Sudano-Sahelian region has been irregular and unpredictably low in drought prone areas of northern Nigeria while temperatures increased.

For many smallholder farmers who form the bulk of the rural population in the northern part of Nigeria, crop yield depreciation is a matter of survival as farming is mainly in a subsistence form. Many of these farmers lack the capacity to adapt farming practices and are therefore vulnerable to rainfall variability (Oladipo, 2008). The farmer's main concern is that the rains should be consistent enough to guarantee sufficient soil moisture at planting and that those conditions are maintained or improved in the course of the season. This confirms the observation that variability in seasonal characteristics such as onset, cessation, length of raining season and dry spell frequency is damaging to agriculture (Shisanya and Mofongoya, 2017).

Awareness is having a knowledge or understanding of a subject, issue or situation. It is instructive to note that individuals understand certain situations or phenomena in different ways using very similar or dissimilar sets of information. Banjade (2003) opined that knowledge, interest, culture and many other social processes can shape the behaviour of an actor who uses information and attempts to influence that particular situation or phenomenon. Assessing the level of awareness of farmers on rainfall variability and it effect on the yield of sorghum is a major step toward knowing their ability to adapt (Hassan and Nhemachena, 2008).

Do the farmers perceive rainfall variability to have occurred? What are their sources of information? Do age and educational level of the farmers affect their knowledge of rainfall variability and its effects on the yield of sorghum? What, if any, is the role of government, individuals and farm extension workers in addressing the impacts of rainfall variability in the study area? This study therefore examines farmers' level of awareness of the effect of rainfall variability on sorghum yield in the Sudan Savanna region of Nigeria.

2. The Study Area

The Sudan Savanna region is located in northern Nigeria, approximately between Latitudes 10°N to14°N and Longitudes 4°E to 15°E. The Sudan Savanna accounts for more than 25% (230,942 Km Sq.) of the entire land area of Nigeria (Federal Ministry of Environment, 2003). Politically, this area covers by twelve states: part of Adamawa, Bauchi, part of Borno, Gombe, Jigawa, Kano, Katsina, part of Kebbi, Sokoto, part of Taraba, Yobe and Zamfara States. This area borders Sahel Savanna at the extreme north and Northern Guinea Savanna to the south. It stretches from Benin Republic to the west, Niger Republic to the north and the Republic of Cameroun to the east (see Fig.1).

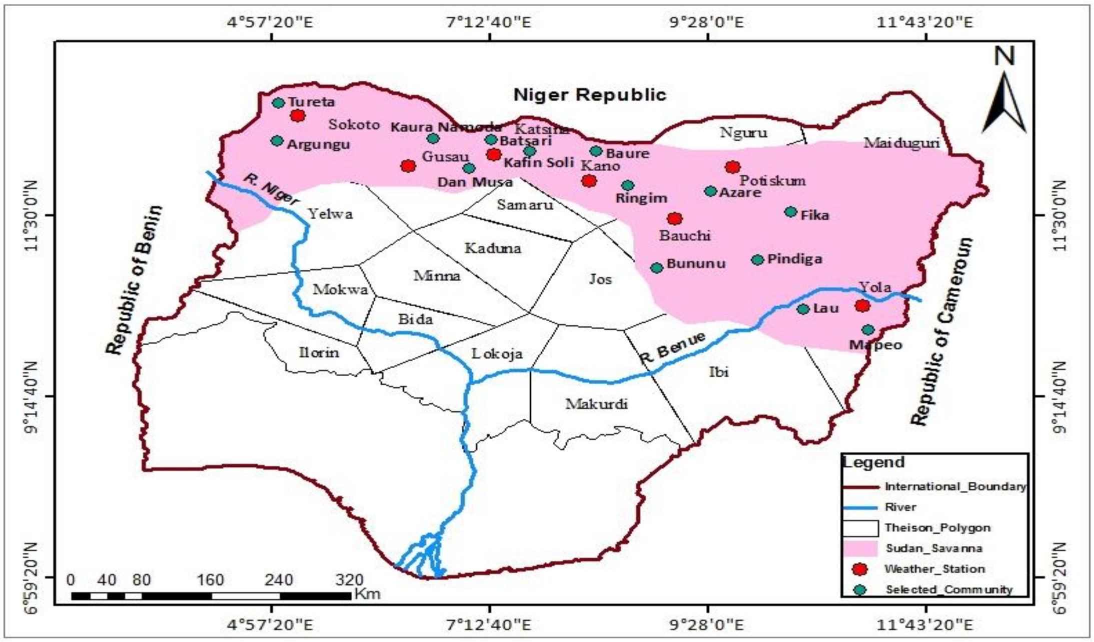

Figure 1: Study Area
Source: Adopted and Modified from the Administrative Map of Nigeria

The climate of this ecological region is the tropical wet and dry type as classified by Koppen (1918) (Aw). The rainfall onset dates are mostly in May; the cessation dates are often in September. The average annual rainfall is between 500mm in the northern part to 1000mm in the southern part of the ecological zone. The rainfall intensity is high between the months of July and August, with wet season of 5 to 6 months annually. The pattern of rainfall in this region is highly variable in spatial and temporal dimensions with inter-annual variability of between 15 and 20 percent (Sawa, 2010).

The region is characterized by abundant short grasses of 1.5 – 2m and few stunted trees hardly above 15m. It is by far the most densely human populated zone of Northern Nigeria. The Sudan savanna land forms an excellent natural habitat for a large number of grazing livestock such as cattle, goats, horses, sheep, camels, and donkeys. Agriculture is the most dominant economic activity in the region (Sawa, 2010).

3. Materials and Method

Seven Theison polygons with long meteorological records were adopted from Agroclimatological Atlas of Northern Nigeria. Rainfall data (1956-2018) for the selected stations were acquired from Nigerian Meteorological Agency. Sorghum yields were acquired from Kano State Agriculture and Rural Development Authority (KNARDA), Sokoto Agricultural Development Project (SADP), Katsina State Agricultural and Rural Development Authority (KATARDA), other States Agricultural Development Programmes (ADPs) and National Bureau of Statistic (NBS).

Table 1: Selected Communities in each Theison Polygon

	Meteorological Station	Major Communities Under the Theison Polygon
1	Bauchi, (10º17'N, 09º49'E)	**Bununu**, Burra, Gombe and **Pindiga**
2	Gusau, (12º10'N, 06º42'E)	**Dan-Musa**, Faskari, Isa, **Kaura Namoda** and Talata Mafara
3	Kano (12º03'N, 08º32'E)	**Baure**, Bichi, Danbarta, **Ringim** and Wudil
4	Katsina (13º01'N, 07º41'E)	**Batsari**, Dankama, Daura, **Kafinsoli**, Matazu, and Musawa
5	Potiskum (11º43'N, 11º07'E)	**Azare**, Damaturu, Darazo, **Fika**, Gujba, Kwaya Tera and Misau.
6	Sokoto (12º55'N, 05º12'E)	**Argungu,** Birnin Kebbi, Tambuwal **Tureta** and Yabo
7	Yola (09º14'N, 12º28'E)	Jalingo, **Lau**, **Mapeo** and Mubi.

Source: Author's Sampling, 2019

Major communities in each Theison polygon meteorological station were arranged alphabetically and the first and fourth settlements were selected. State capitals were not selected based on the assumption that those in state capitals are mostly engaged in non-agricultural activities. In the Yola Theison polygon, there are only four major settlements, two (Lau and Mapeo) were picked. Yola and Jalingo are State capitals and Mubi are an urban setting where it is assumed agricultural activities are not predominant, hence, the reason why they were not picked. A total of fourteen (14) settlements were therefore selected and administered questionnaire (see Table 1).

To determine the sample size, the 1991 National Population Commission (NPC) official population gazette was used. This is because the 1991 population census gives population of localities unlike the 2006. The total population of these selected locations was 158,568 as at 1991. To project the population of this area to 2019, geometrical method of population projection at 3% was adopted to project the population to 333,043. Three hundred and eighty-four respondents were sampled based on Krejcie and Morgan (1970)'s sampling size technique at 95% confidence level and 5% margin of error. To determine the distribution of the number of respondents per settlement selected, the settlement population over the total was multiplied by the sample size (384).

Trend graphs were used to depict rainfall and sorghum yield trend. To establish the relationship between rainfall and sorghum yield as a bases for comparison of farmers level of awareness, simple correlation analysis was carried out using SPSS package. Questionnaire were used to elicit information from the farmers on the level of awareness and the proportion of their knowledge on rainfall trend, and awareness on the impacts of rainfall variability on sorghum yield. The results were presented using frequencies, percentages and tables. Kruskal-Wallis test was employed to test if there is any statistically significant difference at 0.05.

4. Results and Discussion

4.1 Rainfall trend for the study area

Trend in the total annual rainfall of the study area is presented in figure 2 and 3

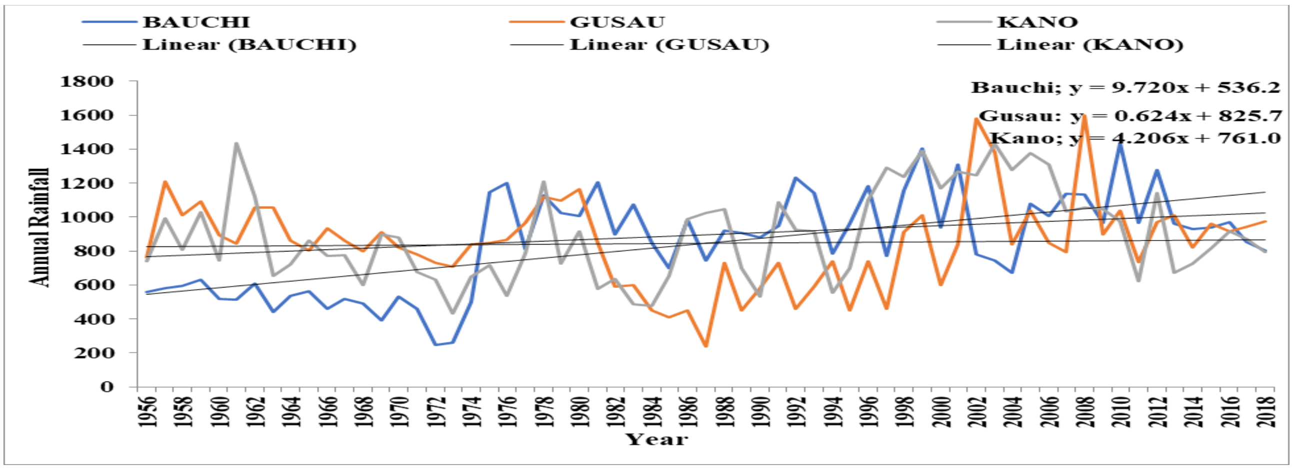

Figure 2: Trend in Total Annual Rainfall for Bauchi, Gusau and Kano Stations
Source: Fieldwork (2019)

The trends show a fluctuating pattern in the total annual rainfall for the 62 years for Bauchi, Gusau, and Kano (Fig. 2). The best fit trendlines shows a positive equation (9.720x + 536.2, 0.624x + 825.7 and 4.206x + 761.0 for Bauchi, Gusau and Kano respectively), which implies that the total annual rainfall is on the increase. Figure 3 also show an increasing trend in the total rainfall amount for Yola meteorological stations. These results are further supported by Ati, Stiger, Iguisi and Afolayan (2009) which stated that evidence from nine stations in northern Nigeria shows that there is a significant increase in annual rainfall amount in the last decade of their study. The result further coincided with the findings of Sawa (2010) which reported that most parts of northern Nigeria experienced an increase in rainfall between 1990 and 2000. Trends in rainfall pattern (Fig. 2 and 3) further show a decreasing annual rainfall in Katsina, Potiskum and Sokoto stations (-1.684x + 641.7, -1.521x + 722.2 and -2.455x + 678.9 respectively). This result agrees with the findings of Emeghara (2015) which reported that the annual rainfall of Sokoto State was characterized by inconsistencies and inter-annual variability. The results further disagree with the findings of Ikpe, Sawa, Idoma, Ejeh and Meshubi (2016) which reported an increasing annual rainfall in Sokoto State.

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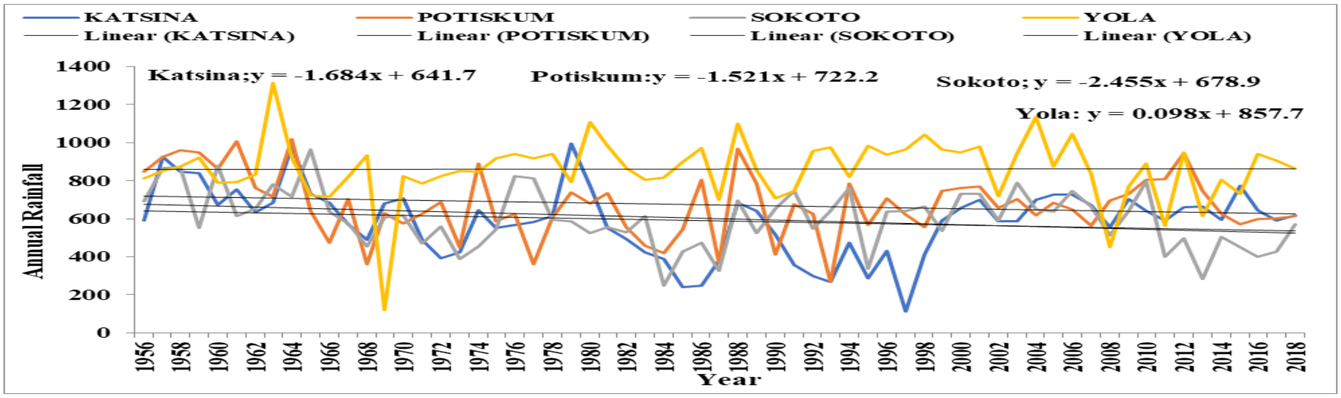

Figure 3: Total Annual Rainfall Trend for Katsina, Potiskum, Sokoto and Yola Stations
Source: Fieldwork (2019)

4.2 Trend in the Yield of Sorghum in the Study Area

Trends in the yield of sorghum in the seven selected states are presented in Figure 4 and 5.

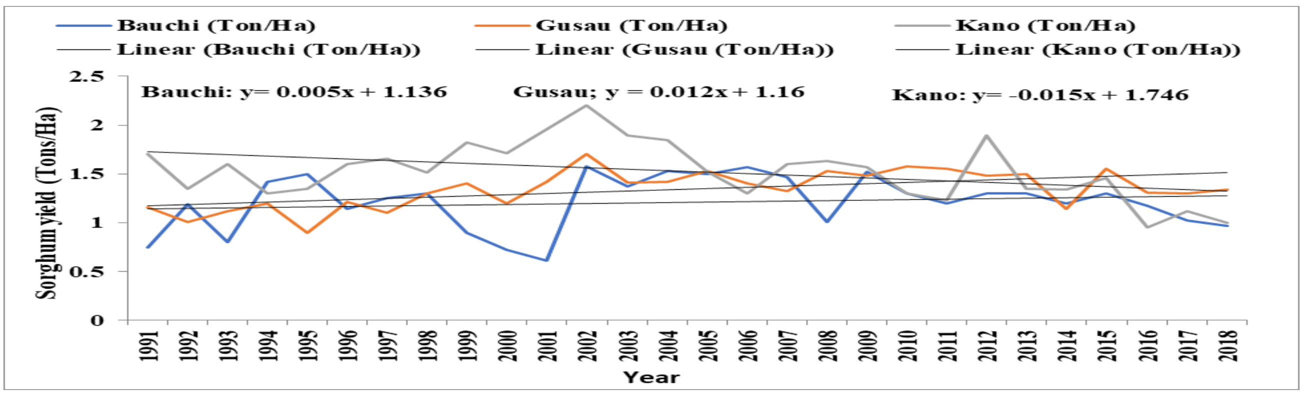

Figure 4: Sorghum Yield Trend for Bauchi, Gusau and Kano
Source: Fieldwork 2020.

Figures 4 and 5 shows the yield pattern of sorghum for the study area. The trend lines indicate a positive linear trend equation for Bauchi, Gusau, Katsina and Potiskum (0.005x + 1.136, 0.012x + 1.16, 0.032x + 0.903 and 0.034x + 0.640) respectively. The result further shows a negative trend in the yield of sorghum for Kano, Sokoto and Yola stations.

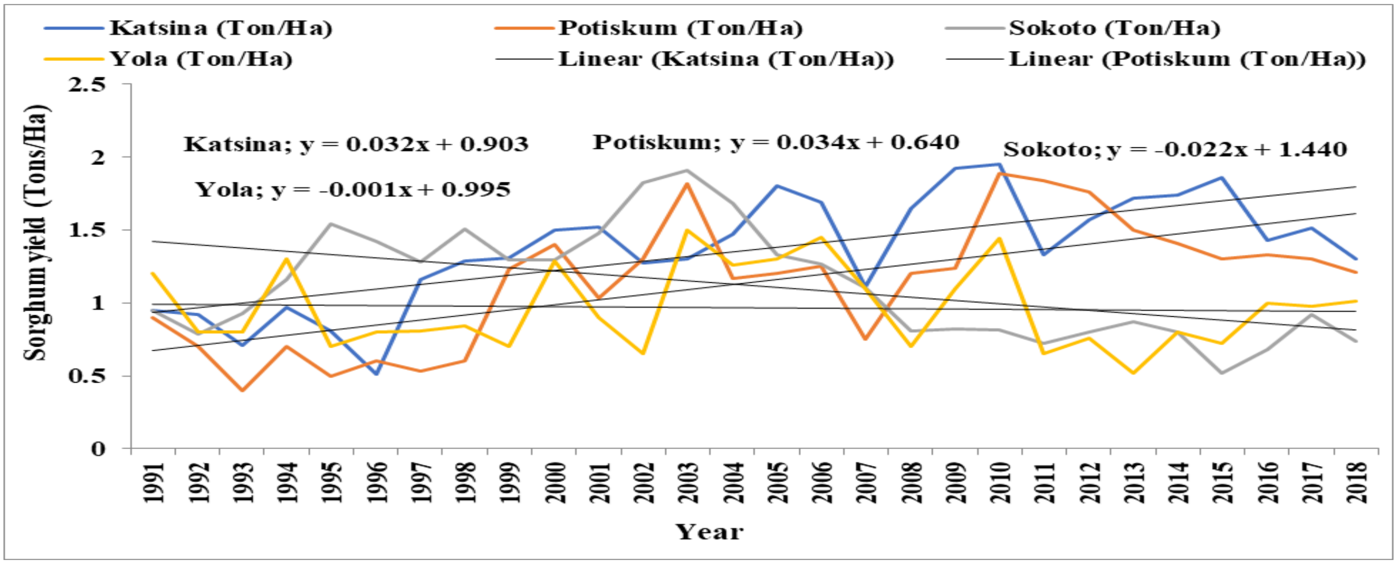

Figure 5: Sorghum yield Trend for Katsina, Potiskum and Sokoto
Source: Fieldwork (2019)

4.3 Relationship between Rainfall and Sorghum Yield in Sudan Savanna Region of Nigeria

The relationship between rainfall trend and sorghum yield is presented in Table 2. As indicated in Table 2, there is a significant relationship between sorghum yield and total annual rainfall in all the Theison polygons except Bauchi. This is an indication that rainfall has a significant effect on sorghum yield and is one of the major determining factors of sorghum production in the ecological zone. In other words, increase in rainfall may lead to increase in sorghum yield and decreased in rainfall may also lead to decrease in sorghum yield.

Table 2 Correlation Test Results between Rainfall and Sorghum Yield in the Selected Theison Polygon in Sudan Savanna Region of Nigeria

Theison Polygon	DF	Sig. Level	Critical-r	Observed-r
Bauchi	26	0.05	0.396	0.319
Gusau	26	0.05	0.396	0.768*
Kano	26	0.05	0.396	0.666*
Katsina	26	0.05	0.396	0.741*
Potiskum	26	0.05	0.396	0.600*
Sokoto	26	0.05	0.396	0.409*
Yola	26	0.05	0.396	0.397*
Average	**26**	**0.05**	**0.396**	**0.711***

*Correlation is significant at the 0.05 level
Source: Fieldwork (2019)

This result confirmed the result of Abdulhamed et al. (2011) on their study on the effects of climate on the growth and yield of Sorghum in Wailo, Ganjuwa local government area, and their result show a significant relationship between rainfall and sorghum yield in Wailo. Similarly, the result also confirmed the assertion of Sultan, Baron, Dingkuhn and Janicot (2005) which reported that rainfall has significant influence on agricultural productivity in West Africa. This result revealed the sensitivity of sorghum production to rainfall in this ecological zone, and calls for proper education of rural farmers on the need to adopt sorghum varieties that are resistant to any decline in rainfall. This will go a long way to reduce the loss of sorghum productivity that may result from rainfall shortage.

4.4 Demographic Characteristics of the Respondents

The demographic characteristics of the respondents are presented in Table 3. The result shows that male respondents constitute 89% of the sampled population with Potiskum having the highest proportion of male (98%). The wide disparity between male and female respondents may be due to cultural factor, which keeps female indoors while the male goes to farm to produce for the entire family. However, the culture is not completely homogenous; though the Hausa-Fulani dominate the study area, some minor tribes that allow women participation in farming activities are found doted in the study area. That majority of the farmers were male has implications for gender equality and calls for mainstreaming of women especially in agriculture where women constitute a bulk of the workforce. These findings disagree with the study of Nhemachena and Hassan (2007) and Gbetibouo (2009) which reported that female farmers are more into small-scale farming in southern Africa and are more likely to take up climate change adaptation measures.

Table 3 Distribution of Respondents by Sex, Age Group, Marital and Social Status

Theison Polygon	Bauchi	Gusau	Kano	Katsina	Potiskum	Sokoto	Yola	Total
Sex	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**
Male	79	86	93	89	98	87	62	89
Female	21	14	7	11	2	13	38	11
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Age								
18-25	42	15	23	8	20	25	15	20
26-33	15	34	53	34	39	44	46	38
34-42	32	28	3	21	24	21	8	22
43-50	11	19	7	32	11	10	31	16
>50	0	4	3	5	6	0	0	4
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Marital Status								
Single	21	15	7	16	13	1	2	11
Married	68	72	87	84	82	95	100	82
Divorced	5	9	0	0	0	2	0	3
Others	5	4	7	0	5	2	0	4
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Social Status								
C/ Head	0	1	0	0	0	0	0	0.26
V/ Head	11	0	7	5	1	3	15	3
F/ Head	63	91	87	82	96	81	46	87
Others	26	8	7	13	3	14	38	10
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Fieldwork (2019)

Thirty-eight percent of the respondents fall between the ages of 26 - 33 years and 22% are between the ages of 34 - 42. This finding is not strange because these age groups are the youthful age-group who must have taken farming as occupation in order to earn a living. The result indicates that over 80% of the respondents are of the youthful age (18 - 40 years). According to Deressa, Hassan, Alemu, Yesuf and Ringler (2008), the age of the respondents represent experience on climate change in an area. The older the respondent, the more experienced he was in knowledge of climatic condition and the more exposed to past and present climatic conditions over a longer horizon of his lifespan. These results imply that the sampled farmers in the study area were above the dependent age. The results further indicate that the proportion of the respondents that are single is 11%. Bauchi had the highest average (with 21%). The proportion of those that are married is 82%. The proportion of those that are divorced is 3%.

The distribution of respondents based on their level of education, duration of residency and farming experience are presented on Table 4. The result shows that the proportion of respondents that had primary education as their highest level of education is 7%. Those that had secondary school as their highest level of education form 54%. Yola and Sokoto areas have the highest proportion of respondents that have attended secondary school as their highest level of education (80% and 65% respectively); while Gusau, Bauchi, Katsina Potiskum and Kano have 39%, 58%, 55%, 54% and 60% proportion of respondents that have secondary school as their highest educational qualification respectively. The proportion of those that have tertiary education is 8%. The proportion of the respondents that have only Quranic education is 23%. The proportion of those that have no formal education is 8%. According to Oruonye (2014) the educational level of a respondent is very important as it increases an individual's ability to obtain, analyze and interpret information on their environment and use their resources efficiently.

A good proportion of the respondents have lived in the study area for over 30 years. This implies that they should have observed changes in rainfall trend and other form of variability and their concomitant effects on crop yield in this agro-ecological zone. This study differs from other studies on climate change awareness (Odjugo, 2012; Adeola, 2014 and Oruenye, 2014) who only considered the ages of respondents' without minding the duration of residency; someone could be 100 years old but have lived in a place for just 2 years which may affect his knowledge and perception of climate in an area. According to Maddison (2006) the number of years a farmer lived in an area have positive effect on the perception and awareness of the farmers on the climatic characteristics of an area and its implication on crop yield, that is, the higher the number of years lived in an area, the more experienced the farmer in coping with the change in climate. He further stated that farmers' awareness of changes in climate attributes (temperature and precipitation) is important for adaptation decision making.

Table 4: Distribution of Respondents by Level of Education, Duration of Residency and Farming experience

Theison polygon	Bauchi	Gusau	Kano	Katsina	Potiskum	Sokoto	Yola	Total
Educ. Level	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**
Primary	0	7	13	0	12	0	0	7
Secondary	58	39	60	55	54	65	77	54
Tertiary	16	9	0	5	7	8	23	8
Quranic	21	33	27	32	14	27	0	23
No Formal	5	12	0	8	11	0	0	8
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Duration (years)								
1- 10	5	5	0	3	7	6	0	5
11-20	16	7	50	0	5	29	38	14
21-30	16	54	13	29	38	40	0	37
31-40	53	25	30	37	27	16	54	28
41-50	10	6	7	32	15	10	8	13
>50	0	2	0	0	2	0	0	1
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Experience (Years)								
1-10	47	26	53	58	24	19	23	30
11-20	16	28	17	26	38	60	54	36
21-30	26	39	23	11	32	14	15	27
>30	11	7	7	5	6	6	8	7
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Fieldwork, (2019)

The result in Table 4 further indicates that 30% of the respondents have 1 - 10 years of farming experience with Katsina area having the highest (58%). The proportion of the respondents that have farming experience of 11 - 20 years is 36%. The proportions of farmers that have 20 years farming experience constitute 34% of the total sample. The duration of residency of the respondents is related to the years of farming experience, since Gusau Polygon leads in both proportions of respondents that have lived long and have longer years of farming experience. According to Ikpe (2014), the result on farmers years of experience in farming and the duration lived in the study area helped to elicit information on climate change and rainfall variability. This agree with the findings of Tijanni (2007) who indicated that majority of farmers in north eastern state of Borno, Nigeria have reasonable farming experience during the 2006/2007 cropping season.

4.5 Farmers Level of Awareness of Rainfall Variability and Source of Information

Table 5 presents farmers' level of awareness of rainfall trend and variability in the Sudan Savanna region of Nigeria and their major sources of information on the variability. The proportion of farmers that are highly aware of rainfall variability and trend is 21%. The proportion of farmers that are not highly aware, but have some level of awareness of rainfall trend and variability is 64%. The proportion of the respondents that are either unaware or highly unaware of rainfall trend and variability constitute 15% of the total population. Bauchi and Kano have the highest proportion of farmers who are ignorant of rainfall trend and variability. This may be due to relatively low literacy level in those areas.

Table 5: Farmers Level of Awareness of Rainfall Variability and Source of Information on the Variability

Theison Polygon	Bauchi (%)	Gusau (%)	Kano (%)	Katsina (%)	Potiskum (%)	Sokoto (%)	Yola (%)	Total (%)
Level of Awareness								
Highly Aware	32	17	17	26	23	21	16	21
Aware	42	72	50	55	66	63	62	64
Unaware	21	9	13	18	7	14	23	12
Highly Unaware	5	2	20	0	2	2	0	3
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Source of information								
Radio	68	61	80	71	56	52	46	60
Television	11	33	10	21	35	27	15	28
Newspaper	5	0	3	5	6	11	8	5
Extension officers	16	6	7	3	1	8	8	5
Others	0	0	0	0	2	2	23	2
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Fieldwork (2019)

Although it appears that, most respondents are either aware or highly aware of the rainfall trend and variability, a good proportion of the respondents fall under the category of those that are either unaware or highly unaware of the rainfall trend. This level of ignorance of rainfall variability in this region is a potential problem to the socio-economic development of the peasant and subsistence farmers, since majority of the farmers depend highly on farming as their means of livelihood.

On the sources of information on rainfall variability in the study area, radio was the major source of information (Table 5). This category of electronic medium provides information for about 60% of the farmers. Kano polygon has more respondents (80%) whose main source of information is radio, followed by Katsina (71%). Radio as the source of information may be due to its wide coverage and easy means of powering it. Next to radio is television (28%). The proportions of the respondents that obtain information through print media constitute 5%. Five percent of the farmers got their information about rainfall variability from Agricultural extension workers; 2% got information on rainfall variability from social media and other sources. The result that radio is the major source of information on rainfall variability in the study area agrees with the findings of Ejeh (2014) which reported that 70% of farmers in Kano got information about climate change from the radio. It is therefore important for major stakeholders to use this medium effectively to disseminate climate related information to the rural farmers in order to combat the adverse effects that may affect crop production due to rainfall and other forms of climatic variability. This result disagrees with the findings of Ikpe (2018) who reported that majority of farmers (38.8%) in Niger State; Nigeria got their information on climate change from personal observation.

4.6 Variability in Farmers' Level of Awareness of the Effect of Rainfall on Sorghum Yield

Table 6 presents a test result of the variation in farmers' level of awareness of the effect of rainfall variability on the yield of sorghum in the ecological zone.

Table 6: Level of Awareness of Effect of Rainfall Variability on Sorghum Yield

Theison Polygon		**Average Level of Awareness**		
Bauchi		Unaware		
Gusau		Aware		
Kano		Unaware		
Katsina		Unaware		
Potiskum		Aware		
Sokoto		Aware		
Yola		Aware		
C	**Df=C-1**	**Observed H**	**Critical H**	**Sig Level**
7	6	22.28	12.59	0.05

Source: Fieldwork, 2019

Table 6 showed that Bauchi, Kano and Katsina theison polygons are averagely unaware of the effect of rainfall variability and trend on sorghum yield in the study area. The result also showed that Gusau, Potiskum, Sokoto and Yola theison polygons are averagely aware of the effect of rainfall variability and trend on sorghum yield in the study area. The results further disclosed that there is a significant difference in the level of awareness of the effects of rainfall variability and trend on sorghum yield in the study area. The result shows that the observed-$H_{7\ 6}$ 22.28 is greater than the critical H (12.59). The null hypothesis is therefore rejected. The study therefore concludes that there is a significant difference in farmers' level of awareness of the effect of rainfall trend on sorghum yield in Sudan savanna region of Nigeria

5. Conclusion

This study assessed farmers' level of awareness of the effects of rainfall variability on the yield of sorghum in Sudan savannah area of Nigeria. The trendlines of rainfall and sorghum yield indicate increase in rainfall and yield data in the study area. The findings illustrated a positive relationship between rainfall and the yield in sorghum. The findings of the study show that majority (over 70%) of the farmers are aware of the changing trend in rainfall in the study area. The level of unawareness of the effect of rainfall is relatively high. The level of awareness of farmers of the effect of rainfall trend and variability on sorghum yield in the study area is statistically significant at 0.05 level. From the result, it can be concluded that farmers that are aware of rainfall trend and variability constitute 85%; however, the difference in the level of farmers' awareness of rainfall trend in the study area is not statistically significant; but the level of farmers' awareness of the effect of rainfall trend on sorghum yield in the study area is statistically significant implying that the level of awareness varies from one Theison polygon to the other.

6. Recommendations

Based on the above facts, the recommendations of this study are majorly adaptive for agriculturalists and planners in the area which include;

i. adoption of viable adaptation strategies in line with the increasing trends in the occurrence of rainfall variability such as planting the best and new hybrids of short-duration or drought-resistant crop varieties, crop rotation, shifting cultivation, application of organic manure and fertilizer, terracing, cover cropping etc.
ii. establishment of meteorological research institutes for training and enlightenments on the impacts of increasing rainfall variability in the study area for public awareness and agricultural planning.

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