IMPACT OF HUMIDITY ON TOMATO PRODUCTION IN ZARIA LOCAL GOVERNMENT AREA OF KADUNA STATE, NIGERIA

BY

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ABSTRACT

The study analysed the impact of humidity on tomato production in Zaria Local Government Area of Kaduna State. The study examined the impact of climate change on some climatic elements such as temperature, rainfall and sunlight but majorly humidity on tomato production. Ahypothesis was formulated to determine whether a significant relationship exists between tomato production and change in humidity. Primary data was collected directly from the tomato farmers in the study area through the use of structured questionnaires while secondary data in the form of weather data was obtained from Geography Department, Federal College of Education, Zaria for a period of 10 years (2008 to 2018).The data collected were analysed using percentages and the one-sample t-test. The results revealed that there has been a reduction in the relative humidity in the study area, there has also been an increase in temperature and rainfall resulting to the reduction of tomato production. In contrast, the result revealed that there has been an increase in sunlight intensity leading to increase in the tomato production. Hence, it is concluded that there exists a significant relationship between humidity and the production of tomato.

Keywords: humidity, tomato, production, Zaria, climate

1. INTRODUCTION

Climate change is one of the most significant challenges facing human society in the 21[st]century. Recent studies (Kardol, et al., 2011, Lynch, et al., 2016), and institutions such as the Inter-Governmental Panel on Climate Change (Lee, 2007), the United Nations Development Programme and the World Bank

(Woodward, *et al*., 2014) have demonstrated that climate change is a reality and a primary environmental threat to sustainable development in the 21stcentury.

Global industrialization has led to the release of Green House Gases (GHG's) into the atmosphere, with subsequent changes in the earth's temperature and weather systems. Mean global temperature is predicted to increase by a range of 3-5°C over the 21st century (Thomson, 2018), which will cause changes in the distribution of rainfall, frequency and intensity, extreme weather events, and sea-level rise. Many human systems will be affected by these changes, particularly agriculture, water resources, industry and human health. However, the impacts of climate change will not be uniform across the globe and considerable differences are expected among different regions (Brambilla, et al., 2019). Surprisingly, the poorest countries, which are the least contributors to global GHGs emissions, are amongst the most vulnerable to climate change. Poor communities are not only located in high-risk areas, but their lack of economic and social resources means they are ill-equipped to adjust to the long-term changes in climate (King & Harrington, 2018).

In the last few decades, cyclic patterns between drought and floods have become more frequent, while the severity and spatial distributions have also changed, with devastating impacts. The phenomenon and direction of trends in weather and climate events have become increasingly deviated from normal, with warmer and fewer cold days and nights, and more frequent hot days and nights over most land areas (Rogelj, et al., 2018). Similarly, heavy rainfall events over many areas have become more frequent and brought more devastating consequences. The impacts of these changes have manifested in decreased yields in crops, increased pest outbreaks, rampant soil erosion and water logging (especially in coastal and humid areas). Similarly, drought-affected areas have become vulnerable to land degradation, crop damage or failure and increased livestock deaths due to lack of forage and dehydration. In Africa, yields from rain-fed crops could be decreased by 39% which might result to 51% educational drop-outs due to poverty (Fuller*,* et al., 2018) and the net revenue from crops could fall by 90% by 2100 (Rogelj, et al., 2018)if the trend continues. This situation will engender poverty in Nigeria making her agriculture highly vulnerable to the impact of projected climate change.

It has been predicted that Africa will experience a rise in temperature of between 1-1.5°C (Rogelj, et al., 2018). Consequently, it is expected that there will be a haphazard shift in crop growing seasons, poor crop productivity and abrupt outbreaks of disease vectors. The country's population will, therefore, be at greater health and life risk than before. One of the present major development

problems facing Nigeria is persistent and increasing food insecurity linked to poverty. Almost 57 million or more Nigerian live below the poverty line, the majority of which live in the rural areas, with more than 70% of them relying on rain-fed subsistence or crude farming to survive (Oluwatayo, 2019). Evidence shows that continued climate change episodes may exacerbate the poverty level, leaving many local farmers, mainly the subsistence or smallholder, trapped in a cycle of poverty and vulnerability to climate change (Chandra, et al., 2017).While many attempts have been made to strengthen the adaptive or coping capacity of communities in dry land areas of Nigeria to climate change, many of these have failed due to a lack of awareness induced by endemic illiteracy and poverty level. Nigeria, therefore, needs innovative and proactive adaptation strategies that will empower the rural dwellers, especially the local farmers in coping with livelihood vulnerability often accompanying climate change. In general, to tackle the problem of food insecurity, the challenges and opportunities presented by climate change and innovative adaptation strategies must be related to the communities that interact directly with natural resources, especially the subsistence farmers who forms the majority of the population and live in the rural areas (Sedegah, et al., 2017).

One of the affected plants by the climate change is tomato. Tomato (*Lycopersicon escalentum*) is a fleshy berry belonging to the Solanaceae family. It is shaped like a globe or depressed at both ends. When young it is hairy but becomes smooth and shiny when ripe. Originating in Central and South America, the tomato was not recognized as a useful vegetable until the 1800s, when grown as staked plants. Tomato is green when mature and turns red or yellow when ripe. The colours are due to pigments, lycopene and carotenoids. Lycopene is responsible for the red colour reported that tomatoes are about 2 to 10cm diameter, and contain numerous seeds which are hairy and light brown. Ripe tomatoes contain about 94% water and are a good source of Vitamins A and C and low in calories. Tomato is one of the fruit often in great demand, consumed wholly by every household, used as an ingredient in soup and stew preparation and condiments in other food items (Heuvelink, 2019).

With the increase in the scarcity of tomato in Nigeria over the years, the need to investigate the factors responsible for the increase in its scarcity is important. With an annual increase of about 3% in Nigeria population comes a correlative increase in the consumption of tomato based on its various uses. However, several studies have shown that with climate change comes food insecurity and impact on the productivity of farm produce (Nelson, *et al*., 2010). As highlighted above, one of the changing factors over the years is the climate which is caused by global warming. This study is therefore aimed at analyzing the

impact of climate change particularly humidity on tomato production in Zaria Local Government Area of Kaduna State, Nigeria.

Research question

Do humidity variations across the years affect tomato yield?

Research Hypothesis
The hypothesis for this study is:

> There is no significant relationship between humidity variation over the years and tomato yield.

2. STUDY AREA

Zaria is situated on a plateau, at a height of about 762m above sea level in the centre of the northern guinea savannah zone. The Local Government Area (L.G.A) is located between Latitudes 11°01'30"N and 11°12'00"N and Longitudes 7°36'00"E and 7°46'30"E and covers an area of about11,120 sqkm (Ogunleye, 2006) with a population of 406,990 inhabitants according to the 2006 Nigeria Population Census (CityPopulation, 2017) which has been projected to 653,099 in 2021 using 3% growth rate. The mean annual temperature is 34°Cwith the hottest months between March and April (40°C) and the coldest period (13.2°C) is between December and January. The area has a typical tropical climate and the agricultural activities in the L.G.A are influenced by the two distinct climatic seasons which are the rainy season and dry season with a rainfall of about 1050mm(Climate-Data, 2018)which lasts between March to October while the dry season is from November to February(Onu, *et al.*, 2018). This is intervened by harmattan between November and February. Zaria is one of the 23 L.G. As of Kaduna State. See Fig. 1.

Farming is traditional and is the major occupation of the people in the study area; crops grown include cowpea, maize, sorghum, other principal crops such as rice, tomatoes, pepper, onion, lettuce etc. Another major occupation of the people is livestock farming due to the predominance of grasses and shrubs with a large number of civil servants and traders (Usman &Mohammed, 2014).
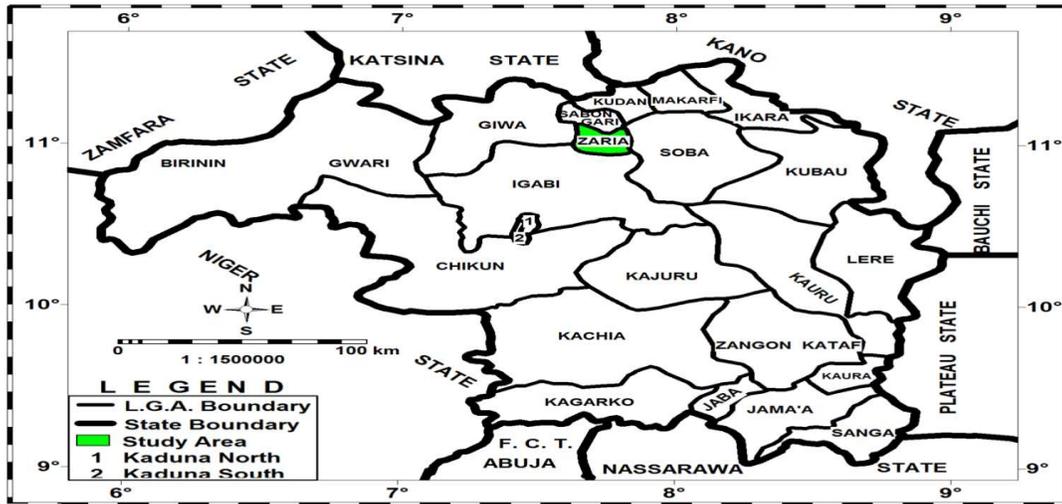
Fig.1: Map of Kaduna State, Showing the Study Area

Source: Modified from the Administrative Map of Kaduna State

3. MATERIALS AND METHODS

3.1 Sample Size and Sampling Technique.

The sample size is proportional to be used as representing the total population. The sample size (SS) used in this research in Zaria Local Government Area of Kaduna State, Nigeria, with an unknown population of tomato farmers was determined using Cochran's sampling formula for an unknown population (Cochran, 1963).

$$n = \frac{Z^2 pq}{e^2}$$

Where:

The Z value is determined from statistical tables which contain the area under the normal curve =1.96

p is the estimated proportion of an attribute that is present in the population = 0.5

q = 1-p

e is the desired level of precision = 0.1

Therefore,

$$n = \frac{(1.96)^2 * 0.5 * 0.5}{(0.1)^2} = 96.04$$

Hence, the sample size for this study is taken as one hundred (100) tomato farmers.

The sampling technique used in this study is the random sampling technique where every member of the population has an equal chance of being selected. This sampling method reduces selection bias and is considered the most straightforward method of probability sampling.

3.2 Types and Sources of Data Collected

A blend of primary and secondary data was adopted for this study due to its nature. Precedence was given to Primary data sourced through a structured interview designed for that purpose. The primary data sources were obtained directly from the field and it consists of a structured interview administered to one hundred (100) tomato farmers as obtained from the sample size. The questions in the structured interview were designed and formulated based on the stated hypothesis. The structured interview was divided into two sections;

- Section A: contains socio-demographic data such as gender, age group, academic qualification, and years of farming experience
- Section B: contains the respondents' opinion about the effect of humidity variations across the years on tomato yield, the effect of temperature variations across the years on tomato yield, the effect of rainfall variation across the years on tomato yield, and the effect of sunlight intensity variation across the years on tomato yield through the use of direct questions containing option on a nominal scale of Yes and No.

Secondary Data was obtained in the form of weather data that covers the basic climatic elements (humidity, temperature, rainfall, and sunlight intensity) that affects tomato production. This weather data was obtained from the Geography Department, Federal College of Education, Zaria for a period of 10 years (2008 to 2018). See Table 1.

Table 1: Data for Various Climatic Elements

Years	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Relative Humidity (%)											
January	71	63	54	55	65	67	57	61	66	52	55
February	60	59	57	49	59	58	60	50	54	45	56
March	58	60	55	56	55	58	56	49	62	43	54

April	63	85	52	50	78	77	70	51	72	64	69
May	81	82	82	83	83	83	83	81	81	83	81
June	83	86	85	85	83	83	83	83	84	84	86
July	91	88	88	93	92	89	88	88	93	91	92
August	94	87	94	91	94	88	94	92	95	93	85
September	87	86	83	82	86	83	87	87	87	87	82
October	82	75	75	75	75	75	87	87	85	73	84
November	65	65	67	69	68	65	75	62	69	65	55
December	65	50	59	50	59	63	64	56	54	52	50
Temperature (ºC)											
January	22	24	21	19	21	23	23	20	20	24	20
February	24	24	31	24	24	25	25	26	24	24	27
March	30	28	25	26	30	30	29	28	29	28	29
April	29	29	29	27	29	30	30	29	31	31	31
May	29	27	27	26	27	30	28	30	29	29	29
June	28	27	25	23	25	26	26	27	25	26	26
July	26	25	23	23	24	25	26	26	25	26	26
August	25	24	23	24	24	25	25	25	25	25	25
September	26	23	23	26	23	25	25	25	25	25	25
October	26	25	24	27	26	26	26	27	27	26	27
November	25	23	23	24	24	24	24	23	25	25	24
December	24	21	20	22	22	23	22	19	23	23	21
Rainfall (mm)											
January	0	0	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	10.8	35.6	0	0
April	25.1	29.9	52.1	1.2	100.4	83.5	58.3	0	7.5	28.9	1.8
May	67.1	75	144.9	149.9	197.1	54.7	106.9	53.3	80.8	141.6	83.8
June	81.4	125.8	171	131	111.7	195.8	167.6	63.7	269.7	203.4	223.4
July	123	240.1	233.3	123.1	121.9	155.6	117.6	121.5	266.4	232.2	242.2
August	373	431.3	317.3	303.4	285.3	91	389.4	493.1	222.6	188.3	302
September	182	127	241.4	263.2	245.3	244.5	259.8	351.1	228.2	198.9	338.4
October	22.6	86.1	48.5	38.2	30.2	24.4	22.4	47.6	1.8	3.7	130.9

November	0	0	0	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0	0	0	0
Sunlight Intensity (Kg/hr-m²)											
January	943.69	947.62	948.25	951.47	967.41	955.48	959.13	970.7	963.11	958.4	959.22
February	1043.31	1044.21	1046.32	1047.34	1049.16	1050.06	1053.63	1054.66	1053.4	1058.61	1053.96
March	1095.42	1095.42	1097.48	1099.82	1099.74	1099.85	1099.77	1099.92	1099.89	1099.9	1099.87
April	1035.65	1035.65	1035.04	1081.64	1034.59	1064.6	1049.98	1088.03	1060.64	1065.12	1067.75
May	849.87	849.87	827.54	819.66	818.6	819.76	819.88	819.42	818.94	819.68	819.73
June	832.52	832.52	840.33	845.31	844.83	847.43	846.46	845.59	848.39	846.41	847.27
July	746.25	755.52	756.52	757.75	751.99	752.54	788.84	786.96	765.9	768.59	769.16
August	715.51	705.76	698.32	701.48	698.78	703.94	706.74	708.07	706.85	706.26	701.06
September	805.93	806.73	811.94	818.37	816.64	820.79	824.92	823.29	817.46	821.02	821.25
October	923.23	930.73	935.06	943.02	936.64	945.45	941.64	939.98	948.18	939.09	944.18
November	952.16	949.76	947.45	949.79	943.96	947.96	946.95	945.92	946.54	947.83	946
December	902.9	903.14	903.35	905.9	902.97	904.67	906.11	906	904.88	905.64	905.49

Source: Geography Department, Federal College of Education, Zaria

3.3 Techniques of Data Analysis

Statistics was employed in the analysis of the data collected through the use of frequency counts and percentages. In answering the research questions, the mean response and standard deviation of the respondents were used. However, in the analysis of the research hypothesis, the one-sample independent t-test was used at a significant level of 10%. The one-sample independent t-test analysis was done using the Statistical Package for Social Sciences (SPSS) to obtain the computed t-value. With the help of the degree of freedom value, the critical t-value from the table ($t_{critical}$) is obtained.

The decision rule is such that the null hypothesis is accepted if the critical t-value value from the table ($t_{critical}$) is greater than the calculated t-value (t_{calc}) while the alternate hypothesis is rejected. In the case where the critical t-value value from the table($t_{critical}$) is less than the calculated t-value (t_{calc}), the alternate hypothesis is accepted and the null hypothesis is rejected. Similarly, if the p-value is greater than 0.1 (significant level), the null hypothesis is accepted and the alternate hypothesis is rejected, while, if the p-value is less than 0.1 (significant level), the null hypothesis is rejected and the alternate hypothesis is accepted.

4. RESULTS AND DISCUSSION

4.1 Bio-Data

Information about the gender, age group, academic qualification, years of farming experience and type of tomato farming practice of the respondents that represent the tomato farmers in Zaria Local Government Area of Kaduna State are presented in Figures 3- 7.
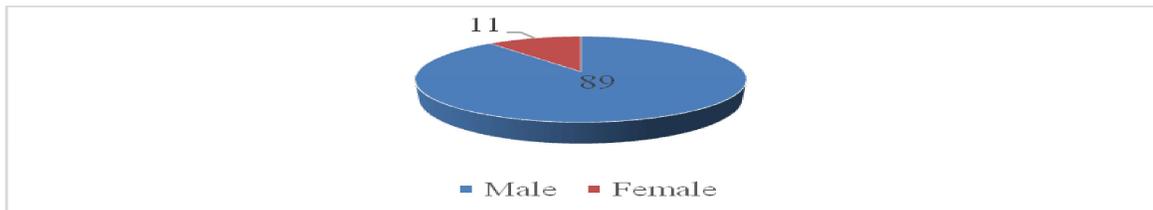
Gender Distribution of Tomato Farmers.

Figure 3: Gender distribution of respondents. (Source: Author Field Work, 2021)

From Figure 3, the gender distribution of the study area showed that the majority of the tomato farmers were male (89%) while only 11% of the responders were female. This study shows the low representation of the female gender in the farming of tomato. This could be attributed to the nature of the area where male dominate socio economic activities.

Age Group Distribution
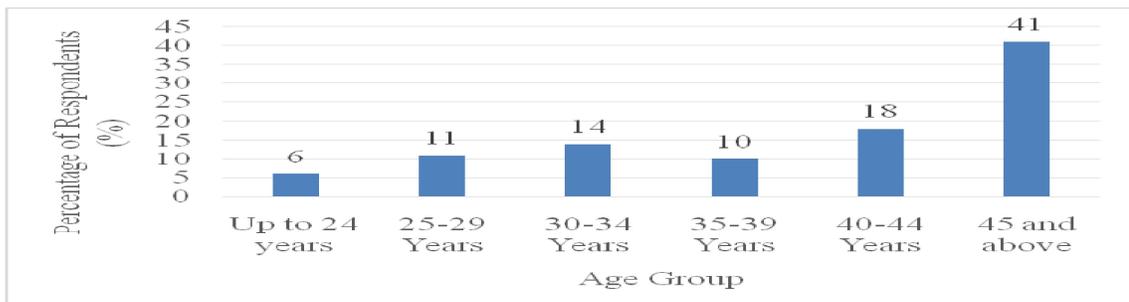
Figure 4: Age group distribution of respondents.

(Source: Authors' Field Work, 2021)

From Figure 4, it was observed that the age group distribution of the respondents had a maximum percentage of 41% for the age group of 45 years and above and 18% for the age group of up to 40-44 years, while the age group of up to 24 years had the smallest representation (6%) for the tomato farmers in the

study area. This result shows that a good percentage of the tomato farmers in the study area are the elderly people.
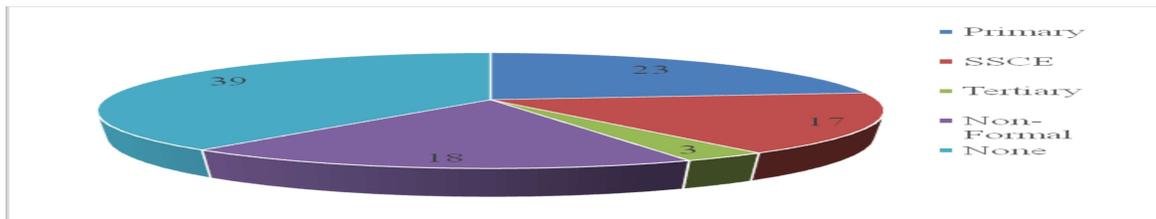
Academic Qualification

Figure 5: Academic Qualification of the respondents.
(Source: Authors' Field Work, 2021)

Figure 5 shows the distribution of the academic qualification of the respondents in which the educational level with the highest record was the no education group (39%) and Primary education (23%) qualifications. The Tertiary education group had the lowest representation of 3% from the academic qualification of the tomato farmers in the study area. This result shows that only a small percentage of tomato farmers in the study area have some form of educational exposure.

Years of Farming Experience
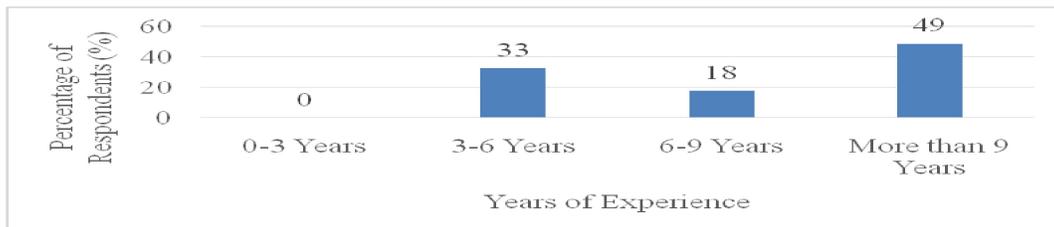
Figure 6: Distribution of years of work experience of respondent.

(Source: Authors' Field Work, 2021)

Figure 6 shows that the majority of the respondents (49%) each have more than 9 years of tomato farming experience, 3-6 years and 6-9 years of farming experience with 33% and 18% of the respondents respectively, while none of the respondents have 0-3 years of tomato farming experience. This result shows that the majority of the tomato farmers in this study have sufficient years of experience.

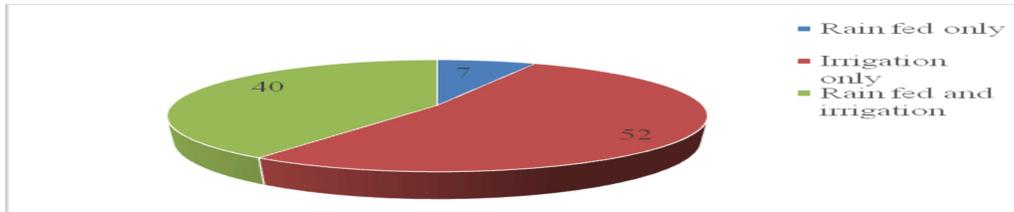**Type of Tomato Farming Practices**

Figure 7: Distribution of Tomato Farming Practice Type among the respondent.

(Source: Authors' Field Work, 2021)

Figure 7 shows that the majority of the respondents (52%) are involved in the irrigation only form of tomato farming, 40% are involved in the rain-fed and irrigation farming practice, while only 7% of the farmers practice the rain-fed only tomato farming process. This result shows that with the increase in the demand for tomato, farmers now depend more on irrigation farming method. It also reveals that demand for tomato is not seasonal but year round.

Analysis of research question
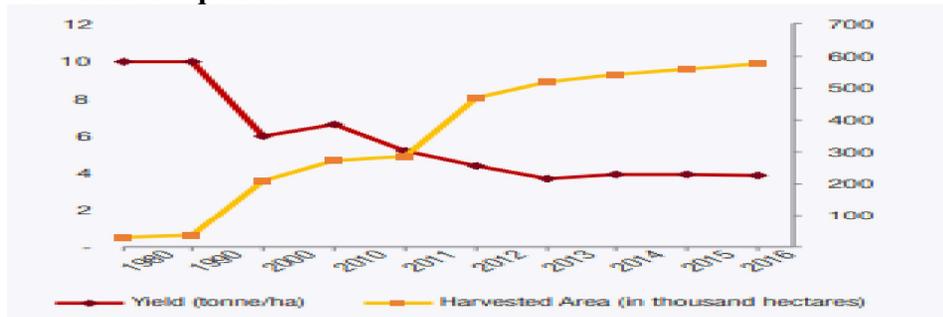
Figure 8: A Graph Showing Nigeria Yield Versus Harvested Area from 1980-2016.

Source: Adopted from Price Waterhouse Coopers (PWC), 2018.

A report carried out by Price Waterhouse Coopers (PWC) Limited (2018) as shown in figure 8, shows that the yield of tomatoes in Nigeria reduces over the years even though there is an increase in the harvested areas. This is a contradiction between area harvested and tomato yield can be attributed to climatic change over the years.

4.2 Effect of Humidity Variation across the Years on Tomato Yield

Figure 9 shows the response of the tomato farmers on their opinion on long-term changes in humidity over the past 10 years in the study area. Similarly, Figure 9 shows the opinion of the tomato farmers on the increase or decrease in humidity over the years, while Figure 10 shows the trend in humidity as obtained from the weather data obtained from the Geography Department, Federal College of Education, Zaria. Also, Figure 11 shows the opinions of the tomato farmers in the study area who believed that there has been variation in humidity, and how this variation has affected the production of tomato.
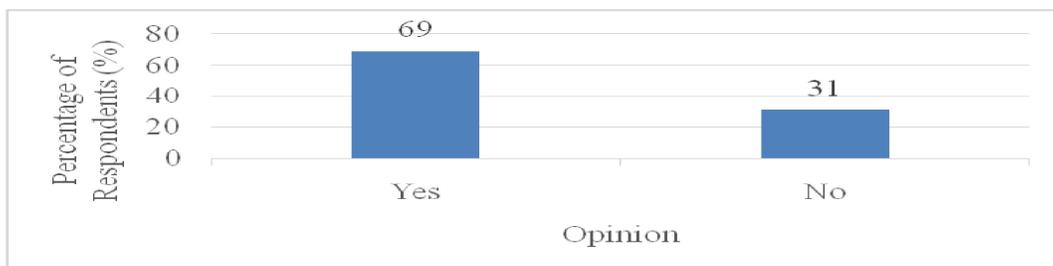

Figure 9: Opinion of the Tomato Farmers on long-term changes in humidity.
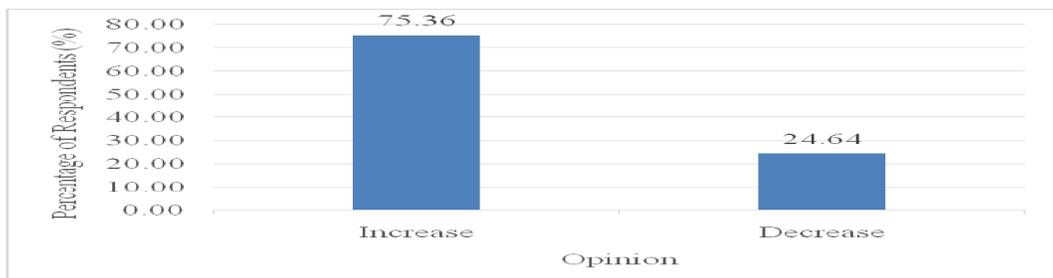
(Source: Authors' Field Work, 2021)

Figure 10: Opinion of the Tomato Farmers on Increase or Decrease in Humidity.
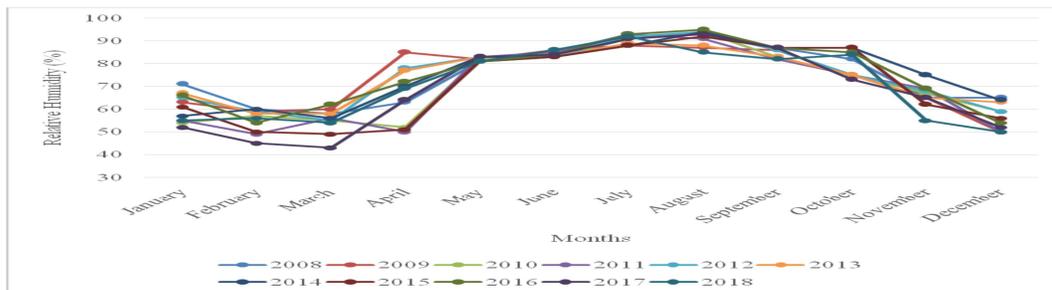
(Source: Authors'Field Work, 2021)

Figure 11: Trend in Relative Humidity Across the Year.
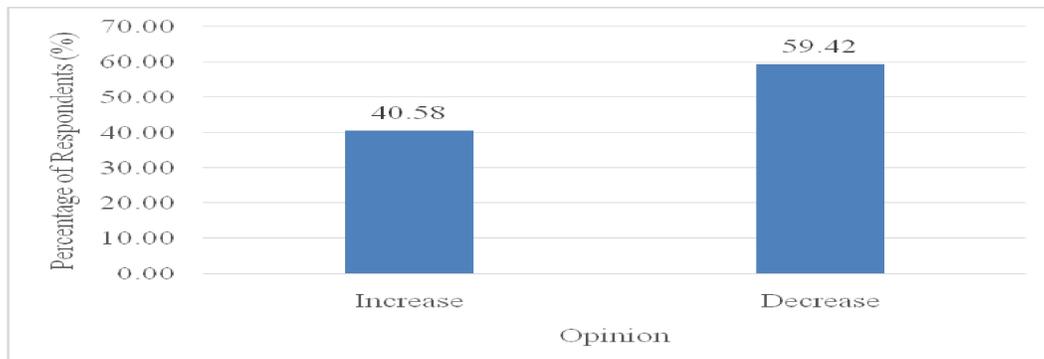
(Source: Authors'Field Work, 2021)

Figure 12: Opinion of the Tomato Farmers on Effect of Humidity on Tomato Production. (Source: Authors' Field Work, 2021).

From the results obtained (Figure 8- Figure 12), it was observed that 69% of the tomato farmers in the study area observed long-term changes in the relative humidity over the last 10 years, while 31% did not observe any changes. Of the 69% that noticed the changes in relative humidity, 75.36% of them believed that there has been an increase in relative humidity, while 24.64% of them believed that relative humidity decreases across the years. The majority opinion on the trend of relative humidity across the years is contrary to the weather data obtained which shows that from 2008 to 2018, relative humidity reduces across most of the months. Similarly, out of the 69% of the tomato farmers in the study area, 40.58% of them believe that the change in humidity increases tomato production, while 59.42% of them believed that change in humidity resulted in a decrease in tomato production. From this result, it can be deduced that there has been a reduction in the relative humidity in the study area, and this furthermore leads to a reduction in the tomato yield which is in line with the result of (Trigui *et al*., 1999).

Test of Hypothesis
Significant Relationship between Humidity Variation over the Years and Tomato Yield.

Table 1 shows the result of the one-sample t-test carried out on the Statistical Package for Social Sciences (SPSS) analytical tool based on the responses of the tomato farmers in Zaria Local Government Area to the effect of humidity variation over the years on tomato yield.

One-Sample Test

Test Value = 1.5

	t-calculated	t-tabulated	Df	Sig. (2-tailed)	Mean Difference	90% Confidence Interval of the Difference	
						Lower	Upper
Humidity	4.088	1.660	99	.000	.190	-.11	.27

Table 1: Hypothesis Result on Humidity Variation Effect over the Years.

(Source: Authors' Field Work, 2021)

The result of this study reveals that the t-calculated from the relationship between humidity variation over the years and tomato yield is 4.088, while the t-tabulated is 1.660. From the decision rule, the null hypothesis is rejected because the tabulated t-value from the table ($t_{tabulated}$) is less than the calculated t-value ((t_{calc}) while the alternate hypothesis is accepted. Similarly, since the p-value (0) is less than 0.1 (significant level), the null hypothesis is rejected and the alternate hypothesis is accepted. Hence, there exists a significant relationship between humidity variation over the years and tomato yield.

5. CONCLUSION/RECOMMENDATIONS

From the results there has been a reduction in the relative humidity in the study area, which leads to a reduction in the tomato yield. Hence, there exists a significant relationship between humidity variation over the years and tomato yield.

The following recommendations for further work are suggested:

- The impact of humidity on tomato production should be considered for other study areas.

- The impact of humidity on other crops production should be considered and researched.
- The impact of the type of farming type on tomato production is also recommended as a further study in this research line.

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