



## LOCAL WINDS, THUNDERSTORMS AND THEIR PERCEIVED EFFECTS ON SOME FARMING ACTIVITIES IN LOKOJA AREA, KOGI STATE, NIGERIA

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### ABSTRACT

This study analysed some characteristics of local winds, thunderstorms and their perceived effects on some farming activities in Lokoja area. The objectives were to; determine the prevailing local winds, determine some characteristics of local winds and thunderstorms and to assess their perceived effects on some farming activities in Lokoja area. Both primary and secondary data were used. The secondary data was obtained from Nigerian Meteorological Agency, while the primary data was obtained through the administration of 150 questionnaire to farmers in some settlements in Bassa, Lokoja, Ajaokuta, Kogi and Adavi LGAs. The Beaufort Wind scale was used to categorise the local winds. Also Thunderstorm Spectrum was used in classifying the thunderstorms. Results show the wind directions that dominated in Lokoja area as S/W and N/E with mean speed of 1.858 and 1.122 respectively. Results further indicated local winds of Lokoja as *calm*. It was found out that the thunderstorms fall within range of 1000-2500 J/kg with a mean of 1221.4 J/kg. This places the category of thunderstorms under *ordinary* with some *pulse severe*. However the thunderstorms cannot be dissociated from the *Multicell* types being at the boundary between the two. Some of the perceived effects of local winds include damages to stalks of plants, dropping of unripe fruits amongst others. The advantages of early thunderstorm include, making the soil easy for tillage and ready for seed planting, while its disadvantages include dumping of dried leaves on farm sites, surface run off leading to flash floods and so on.

**Keywords:** Effects, Farming, Local Winds, Perceived, Thunderstorms

### INTRODUCTION

The movement of air caused by differences in air pressure is called wind. The greater the air pressure, the faster the wind speed. Wind can also be referred to as air in motion over the ground and it has direction and speed (Adger, 2003). Winds that cover large regions of the earth surface and usually for long periods are planetary winds, while winds that affect only small regions and probably for short periods are called local winds. Local winds are created as a result of physical features of relief or topography that include mountains, vegetation, and water bodies. Local windstorms tend to have serious environmental and economic implications. High gusts can result in mortality, the uprooting of trees and considerable structural damage to buildings, power and telephone lines, communication masts and other urban infrastructure (Adejo, 2007). In West Africa, the occurrence of strong winds is primarily associated with rainstorms generated by isolated thunderstorms or line squalls or disturbance lines (Gomez, 2005). An example of how local winds affect the activities of the inhabitants of Lokoja area can be heard in some of the day to day phrases used by the people. For instance, the Bassa-Nge people say "*Biti juru be lazhi, aza iya e daun kaarai; biti juru be isogudui, nimmo aza iya beno*" this

means "*red sky in the morning, sailors take warning; red sky at night, sailors' delight*". This helps to explain the extent to which human activities, not only fishing and sailing are affected by local winds in Lokoja area. The consequences of the local winds sometimes become dire when associated with thunderstorms.

Thunderstorms are small, intense weather systems that produce strong winds, lightning, thunder and heavy rains (Adger, 2003). There are only two atmospheric conditions required to produce thunderstorms; warm and moist air near the earth's surface and unstable atmosphere. The atmosphere is unstable when surrounding air is colder than the rising air mass. The air mass will continue to rise so long as the surrounding air is colder than the air mass. When the rising air mass reaches its dew point, the water vapor in the air condenses and forms cumulus clouds (Doswell, 1985). If the atmosphere is extremely unstable as is sometimes in Lokoja area during rainy season, the warm air will continue to rise, which causes the cloud to grow into a dark cumulonimbus cloud. Cumulonimbus cloud can reach heights of more than 15 km and are responsible for thunderstorms in Lokoja area as elsewhere (NiMet, 2016). Many hazardous weather events are associated with thunderstorms. Under the right

conditions, rainfall from thunderstorms causes flash flooding, killing more people each year than hurricanes, tornadoes or lightning. Strong (up to more than 120 mph) straight-line winds associated with thunderstorms knock down trees, power lines and houses (Gomez, 2005). Thunderstorms have wide-ranging effects on human life, including electrocution, shock, and deaths. They normally lead to local atmospheric instability, and just a single thunderstorm can produce lightning, catastrophic flooding, tornadoes, very strong winds, and hail (Bruce, 2009). It is also worth noting that thunderstorms have some positive effects. For instance, lightning creates the ozone layer from oxygen which makes life possible on earth's surface. Otherwise, we couldn't survive the sun's ultraviolet radiation. Moreover, lightning creates nitrate from nitrogen. Nitrate is a fertilizer essential for plants to grow and thrive on earth (Bruce, 2009). One of the hazards lightning can pose is the wildfires they are capable of igniting causing several fatalities per year, most commonly to people working outside their houses (Bruce, 2009).

In Southern Nigeria, thunderstorms produced by line squalls are most frequent at the beginning (March to May) and end (late September/October) of the wet season. In the northern parts of the country, much of the rainfall during the short wet season is produced by isolated thunderstorms and line squalls that reach their peak between June and August. There is, however, limited knowledge of the wind climate over Nigeria. This is because climate research in Nigeria has hitherto focused for the most part on the analysis of rainfall and temperature parameters. (Olayinka, 2007) Analysis of observed highest wind gusts for the period 1995–2014 shows that, generally, higher values of extreme winds were recorded for the northern parts of the country than for the southern parts. During this period, southern locations in the country recorded highest wind gusts of not more than 50 knots (Olayinka, 2007).

Storms are regular feature of our weather system in Nigeria as there is hardly any year that disaster caused by thunderstorm is not reported across the country. For instance, NEMA (2010) reported that in Abia state, 180 houses and other properties were destroyed by windstorm; in Adamawa state, 1,562 families were displaced and properties destroyed by windstorm; 1,010 persons displaced in Anambra state by flood and windstorm; in Benue state flood and rainstorm displaced people, schools, buildings and properties were also destroyed, economic trees destroyed and 119 people displaced; in Cross River state, 1132 persons were displaced with 383 houses destroyed by flood, landslide, windstorm and fire; in Delta state, flood and windstorm destroyed 500 houses and displaced 1225 persons; in Enugu, 480 houses were affected and 231 families displaced by windstorm; in Kano, windstorm displaced 478 persons and destroyed

properties; in Kwara state, fire / rainstorm displaced 9,000 people and destroyed properties; while in Yobe state, 800 households were displaced and properties destroyed by wind / rainstorm. All these losses were as a result of storms of various types. All these indicate the extent of destruction caused by storms (Audu, 2012). Record of thunder and rain storms in Lokoja area, Kogi State is also that of destruction and loss of lives. For instance, the rainstorm of 8<sup>th</sup> May, 2011 resulted in the destruction of houses, properties and crops amongst others. It led to displacement of people and rendered them homeless for some days (Audu et al, 2013). Also according to Nwachukwu (2017), rainstorm killed five people in Lokoja while a similar incident was recorded in Okehi and Ogori/Magongo that destroyed property worth millions of naira and rendered several people homeless. It is in the light of this that this research has become necessary not only to highlight the characteristics of the prevailing winds and thunderstorms but also their perceived effects by farmers on some farming activities in Lokoja area. It is with this background that this study aimed to analyse the occurrence, characteristics of local winds and thunderstorms as well as the perception of farmers on their effects on farming activities in Lokoja area. The objectives include to:

- i. determine the prevailing local winds in Lokoja area.
- ii. determine the characteristics of local winds and thunderstorms in Lokoja during the study period (1995 – 2014)
- iii. assess farmers perceived effects of the characteristics of local winds and thunderstorms on some farming activities in Lokoja area

#### STUDY AREA

Lokoja is located between latitudes 7°45' N and 7°51' N of the Equator and also between longitudes 6°41' E and 6°45' E of the Prime Meridian (Figure 1). It has an area of 63.82 km<sup>2</sup> (Adeoye, 2012). It is a town by the confluence of Rivers Niger and Benue. The study area includes Lokoja metropolis and some suburban settlements in parts of Lokoja, Bassa, Ajaokuta, Kogi and Adavi Local Government Areas. Bassa Local Government Area lies to the east of Lokoja town and includes villages such as Shintaku, Gbobe and Gboloko all being part of Lokoja region (16 km radius) and therefore the study area. Also Kogi LGA lies to the east of Lokoja town but extends towards the north of the town. Ukparake village in Kogi Local Government Area is part of Lokoja region. Ajaokuta Local Government Area lies directly to the south of Lokoja town. Parts of its area form a good portion of Lokoja urban area; such areas include 200 Units, 500 Units, Ganaja Village and Emi Woro. Adavi Local Government Area lies to the west of Lokoja town. Settlements in it that form part of Lokoja region include Zango-Daji and Zariagi.

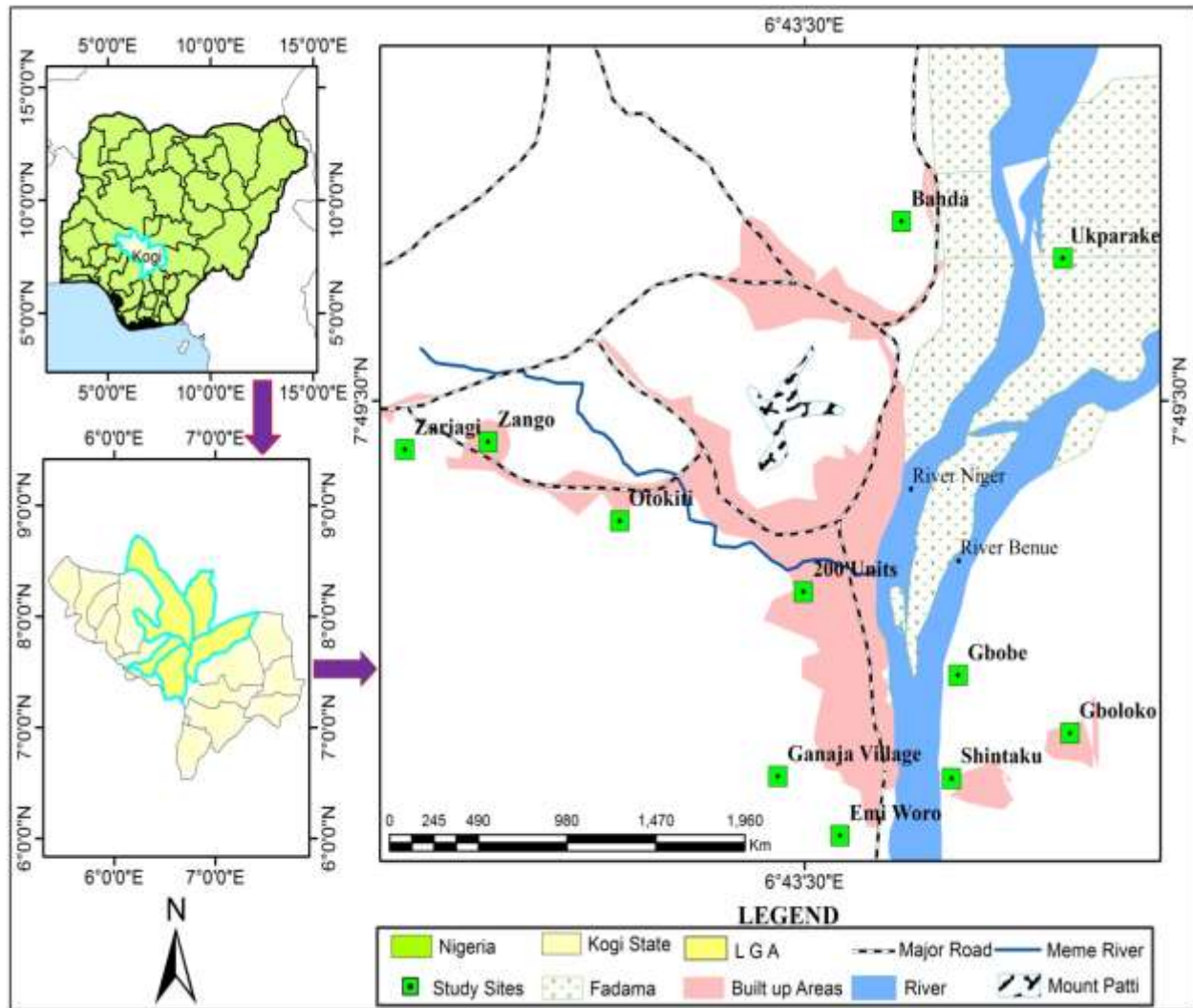


Fig. 1: Lokoja, the Study Area.  
Adapted from: Encarta Premium, 2015.

The terrain of Lokoja area is made up of dissected undulating plains, lofty hills and some mesas. The land rises from about 300 m along the Niger valley to about 1,500 m above sea level in the uplands. A number of intermittent valleys exist, with streams criss-crossing the breadth of the town. Two prominent relief features found in Lokoja are Mount Patti and Agbaja hills that are overlooking the town in the valley (Olatunde and Omachona, 2019). The major relief feature, Mount Patti in Lokoja area influence the local thunderstorm distribution in the region due to orographic effects.

The major rivers within the study area include Niger, Benue and their tributaries such as Memi, Osara, and Omeme (Olatunde and Omachona, 2019). These water bodies don't flow throughout the year that is it is seasonal except for rivers Niger and Benue. The presence of these water bodies facilitates the occurrence of local land and river breezes, with the breeze being stronger on the west bank because of less vegetation. The climate of the study area is the tropical continental type with

marked wet and dry seasons (Ogallo, 1977). The mean annual rainfall of the Lokoja area lies between 1016 and 1270 mm. For instance, it was 1213.877 mm in a study carried out by Olatunde and Adejoh (2018) while it was 1228.7 mm in the study done by Obot and Onyeukwu (2010). The distribution of rainfall in Lokoja area has a great effect on the annual thunderstorms amount since most thunderstorms are associated with rain. The mean annual temperature of Lokoja region is about 28.03° C and the relative humidity is about 30 % in the dry season and 70 % in the wet season (Audu, 2012). Average daily wind speed is about 89.9 km/hr while wind speed is usually at its peak in March and April. The average daily vapour pressure is 26 Hpa (Kogi State Statistical Year Book, 1997 cited in Audu, 2001). The study area is within the Guinea Savanna zone. However, the pattern of vegetation and land use can best be described as a mosaic of varying levels of cultivation, grassland and woodland (Adejuwon, 2004).

Lokoja town has a population of about 77,516 in 1991 which has increased to 196,643 in 2006, with 100,573 males and 94,688 female (NPC, 1991; 2006). The regional population is about 450,000 considering the Local Governments that make up the region with Bassa (139,687), Lokoja (196,643), Ajaokuta (122,432), Kogi (115,100), and Adavi (217,219) (Kogi State Government, 2019). The projected 2017 population for Bassa is 188,600, Lokoja (265,400), Ajaokuta (165,300), Kogi (155,400) and Adavi (293,200) (Kogi State Government, 2019). Lokoja is experiencing spatial growth along the major highways in the city. New development areas are concentrated along the Kabba-Okene road and towards the Ganaja – Ajaokuta road. The major settlement pattern is linear settlement along the major highways (Audu, 2015). Agriculture is the main occupation of the people. Wet season farming is a common practice in all the rural areas and patches of dry season farming takes place in Bassa and Kogi Local Government Areas. Fishing and trading are age long traditional occupations of the people of Lokoja region (Audu, 2012). Some of the residents in Lokoja region work in public institutions like Kogi State Polytechnic, Kogi State Specialist Hospital, Federal University Lokoja, Federal Medical Center and the few small to medium scale firms present.

**MATERIALS AND METHODS**

The data used for this study are both primary and secondary. The secondary data were sourced from the studies earlier carried out by Olatunde, 2013; Adejoh (2016); Olatunde and Adejoh (2017; 2018) and Yakubu (2018). They were the mean values for wind speed, directions and thunderstorms taken over the period of two decades from 1995 to 2014. These years were chosen because the data were continuous without any gap. In order to assess the perceived effects of local winds and thunderstorm on farming activities in Lokoja area, primary data were obtained from the administration of 150 open ended questionnaire. The questionnaire were administered to farmers in Gbobe and Shintaku, Bassa LGA, Banda in Lokoja LGA, Ganaja Village and Emi Woro in Ajaokuta LGA and Zango-Daji in Adavi LGA using simple random sampling methods because these areas have been identified as agriculturally active during the reconnaissance survey that was carried out.

**Test for Homogeneity**

For statistical analysis, wind and thunderstorm data should ideally possess the property of homogeneity that is, properties and characteristics of different portions do not vary significantly. Sometimes errors do creep in due to damage equipments, change of sites etc. as a result normality tests were carried out using Skewness and Kurtosis. The formula for Skewness being given as:

$$Z_1 = (\sum (x_1 - \bar{x}) / ((\sum (x_1 - \bar{x})^2/N)^{3/2}) (6/N)^{1/2} \dots\dots\dots 1$$

While that of the standard coefficient of Kurtosis was determined as:

$$Z_2 = \frac{(\sum (x_1 - \bar{x})^4/N) (\sum (x_1 - \bar{x})^2/N)^3}{(2x/N)^{1/2}} \dots\dots\dots 2$$

Where;

X = wind value

X<sub>1</sub> = long term mean

N = number of years sample

When the value of Z<sub>1</sub> or Z<sub>2</sub> exceeds ±1.95, a significant deviation from the normal curve is indicated at 0.95 confidence level. However the Z<sub>1</sub> and Z<sub>2</sub> were calculated using the computer software Microsoft Excel.

**Determining the Prevailing Local Winds in Lokoja Region**

The mean speed of local winds within the study period (1995-2014) was obtained using the formula;

$$\bar{X} = \frac{\sum x}{\sum f} \dots\dots\dots 3$$

Where;

$\bar{X}$  = Mean.

$\sum f$  = the sum of independent variables

$\sum f$  = the sum of dependent variables.....(Udofia, 2015)

The result was then used to determine the prevailing local winds using the Beaufort wind scale (Table 1)

**Table 1: The Beaufort Wind Scale**

Beaufort Scale	Wind Speed (KmPH)	Wind Speed (MPH)	Indicators	Terms Used in NiMet Predictions
0	0-2	0-1	Calm; Smoke rises vertically.	Calm
1	2-5	1-3	The direction can be noticed by the direction of the smoke, but not by the weather vanes.	Light air
2	6-12	4-7	Wind felt on exposed skin. Leaves rustle, vanes begin to move.	Light breeze
3	13-20	8-12	Leaves and small twigs constantly moving, light flags extended.	Gentle breeze
4	21-29	13-18	Dust and loose paper raised. Small branches begin to move.	Moderate breeze
5	30-39	19-24	Branches of a moderate size move. Small trees in leaf begin to sway.	Fresh breeze
6	40-50	25-31	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic garbage cans tip over.	Strong breeze
7	51-61	32-38	Whole trees in motion. Effort needed to walk against the wind.	High wind, Moderate gale,
8	62-74	39-46	Some twigs broken from trees. Cars veer on road. Progress on foot is seriously impeded.	Gale, Fresh gale
9	75-87	47-54	Some branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over.	Strong gale
10	88-101	55-63	Trees are broken off or uprooted, saplings bent and deformed. Poorly attached asphalt shingles and shingles in poor condition peel off roofs.	Storm, Whole gale
11	102-116	64-72	Widespread damage to vegetation. Many roofing surfaces are damaged; asphalt tiles that have curled up and/or fractured may break away.	Violent storm
12	117	73	Very widespread damage to vegetation. Some windows may break; poorly constructed sheds and barns are damaged. Debris may be hurled .	Hurricane-force

Source: NiMet Lokoja Office, (2018)

**Determining the Characteristics of Local Winds and Thunderstorms in Lokoja**

The Mean, Standard Deviation and Coefficient of Variations were used to determine whether the characteristics of winds and thunderstorms have changed from one year to another as well as from one decade to another.

**Wind characteristics**

Using data of wind directions, the vector averages were derived by decomposing the cardinal points into numerals in order to obtain the mean for each year and the general average for the study period. The mode wind average and its frequency are achieved by using the Vector addition formula to get the average direction for individual years. Furthermore, all the north-south components are added up. Also separately, all the east/west components are added up. The average direction therefore is the arctan of the east/west components divided by the north south components.

**Thunderstorm**

The arithmetic mean of the yearly data was obtained using the following formula;

$$\bar{X} = \frac{\sum fx}{\sum f} \dots\dots\dots 4$$

Where

$\bar{X}$  = Mean.

$\sum$  = summation

$x$  = independent variables

$f$  = dependent variables.....(Udofia, 2015)

The type of thunderstorm was determined through the use of thunderstorm spectrum as indicated in Table 2 below

**Table 2: Thunderstorm Spectrum**

		<b>length of 0-6 km shear vector (kt)</b>		
		<20	20-45	>40
<b>CAPE (J/kg)</b>	<1000	ORDINARY	ORDINARY OR MULTICELL	ORDINARY OR SUPERCCELL
	1000-2500	ORDINARY WITH SOME PULSE SEVERE	MULTICELL	SUPERCCELL
	>2500	ORDINARY WITH SOME PULSE SEVERE	MULTICELL	SUPERCCELL

Source: NiMet Lokoja, 2018.

For the frequency and intensities of thunderstorms, the formula below was used:

$$Frequency = \frac{1}{period} = \frac{(number\ of\ cycles)}{time} \dots\dots\dots 5$$

$$F = \frac{1}{T} = \frac{N}{t}$$

where

$f$  = frequency, the cycles in a unit of time

$T$  = period, the time required for one cycle

N = a number of cycles  
 t = an amount of  
 time.....Wiebull, 1939)

The thunderstorm depth was converted into intensity using the formula below;

$$i=d/t \dots\dots\dots 6$$

Where:  
 i= thunderstorm intensity,  
 d = the thunderstorm depth and,  
 t = thunderstorm duration..... Wiebull, 1939)

The values were then ranked in decreasing order with the highest having the value of 1 in the ranked order. The return periods T of the ranked values were then calculated using the Wiebull’s formula as seen in equation (7)

$$T = n+ \dots\dots\dots 7$$

Where;  
 T = the return period in years;  
 n = the total number of the values; and  
 m = the rank value of each thunderstorm intensity.....(Wiebull, 1939)

The probability was obtained using the following relationship:

$$P=1 T \dots\dots\dots 8$$

Where;  
 P = probability and  
 T = return period (recurrence interval).....(Wiebull, 1939)

After the thunderstorm intensity data mean ( $\bar{X}$ ) and standard deviation(S) were derived. The thunderstorm intensity was then regressed against duration for each year using Hydro CAD software to obtain the KT being the frequency factor for the return period. The KT was then computed for corresponding return periods using Gumbel’s distribution formula as shown below:

$$KT= \sqrt{6} \pi \{0.5772 + \ln[\ln( T T-1 )]\} \dots\dots\dots 9$$

Where;  
 T = return period  
 In = intensity.

Thunderstorm intensities were calculated for corresponding return periods.

$$XT = \bar{X}+ KT S \dots\dots\dots 10$$

Where:  
 KT = the thunderstorm intensities for each return period,  
 S = the standard deviation of thunderstorm intensities,  
 $\bar{X}$  = the mean thunderstorm intensities,  
 XT = the thunderstorm intensity for a given return period.....(Wiebull, 1939)

**Analysis of the Perceived Effects of Local Winds and Thunderstorms on Some Farming Activities in Lokoja Area.**

The effects of local winds and thunderstorm on farming activities in the study area were determined through the administration of questionnaire and analysis of the data derived. Also information and data about the effects of local winds and thunderstorms were sourced from literature and some newspapers. Descriptive statistics tools such as bar graphs and tables were used to analyse the views of the respondents on the effects of local winds and thunderstorms on some farming activities in Lokoja area.

**RESULTS AND DISCUSSION**  
**Frequency Distribution of the Thunderstorm Series in Lokoja Area**

The values of Z<sub>1</sub> and Z<sub>2</sub> at (1.22) and (1.26) were lesser than ±1.96. The values were positively skewed and the values for the standard coefficient of kurtosis were also positive (Table 3). These suggest that there have not been much variation in the thunderstorm series for Lokoja area and it shows that the data is normal.

**Table 3: Frequency Distribution of the Thunderstorm Series**

Z <sub>1</sub>	1.22
Z <sub>2</sub>	1.26

Source: Authors Data Analysis, 2018.

### Types and Characteristics of the Local Winds in Lokoja Area

The wind (speed and directions) that dominate the Lokoja region are the S/W and the N/E wind (directions) with mean average of 1.858 and 1.122 respectively. This indicates a dual season for the Lokoja region, with S/W wind, and N/E wind dominating alternatively. The average wind speed for Lokoja area during the study period was found to be 1.122 with a standard deviation of 0.184 (Table 4). Using the Beaufort wind scale in relation to the above findings, the average dominant local wind of Lokoja region can be described as *Calm*.

**Table 4: Values of Mean, Standard Deviation and Coefficient of Variation for Wind.**

WIND	SPEED	DIRECTION
Mean	1.858	1.122
SD	0.109	0.184
CV	0.006	0.006

Source: Authors Data Analysis, 2018.

Also, the direction of the winds in Lokoja region suggests an influence of the River Niger which lies at the center of the region running from North/West direction to South/East direction before finally heading directly South, therefore giving rise to local land and river breezes. These land and river breezes develop after the heating and cooling of the river bodies and land bodies that have different heating and cooling rates. Local air moves at night to replace the space created by the rising warm and lighter air above the river bodies from the surrounding lands. This causes an Eastward local wind on the East bank and Westward local wind on the West bank which can both be described as Land breeze and River breeze. These are characteristics that Lokoja area share with other areas with landmass close to large body of water (rivers, seas and oceans)

(Iwena, 2013). Results also indicated that the wind speed average during the study period varied between 1.7 and 2.1 (Table 5). Also the mean wind direction varied between 0.58 and 1.25 (Table 5).

Results showed that the year 2011 experienced the peak local wind speed. This corresponds roughly with the flooding in Lokoja area in 2011, with increase in the volume of water in Rivers Niger and Benue. This may likely have had influence on the local wind speed. The average wind speed was generally consistent during the years of the first decade of study but deviated more in the last years of the study period (Table 5 and Figure 2). However, the mean of wind directions fluctuated more widely between 2006 and 2012 and a little less before 2006 (Table 5 and Figure 2).

**Table 5: Average Wind Speed and Direction (1995-2014)**

S/NO	Years	Wind Speed Average In Knots (Kt)	Wind Direction In Letters	Wind Direction In Figures	Mean Of Wind Directions
1	1995	1.8	SW, S, NE	8, 2, 5	1.25
2	1996	1.9	SW, S	8, 2	0.83
3	1997	1.8	NE, SW	5, 8	1.08
4	1998	1.7	N, SW, S	1, 8, 2	0.92
5	1999	1.8	SW, NE	8, 5	1.08
6	2000	1.8	SW, NE, S	8, 5, 2	1.25
7	2001	1.7	SW, S, NE	8, 2, 5	1.25
8	2002	1.8	NE, SW	5, 8	1.08
9	2003	1.8	SW, S, NE	8, 2, 5	1.25
10	2004	1.8	SW, S, NE	8, 2, 5	1.25
11	2005	1.9	SW, NE, S	8, 5, 2	1.25
12	2006	1.9	SW, S, NE	8, 2, 5	1.25
13	2007	1.7	S, NE	2, 5	0.58
14	2008	1.9	SW, NE, S	8, 5, 2	0.95
15	2009	1.9	SW, N, S	8, 1, 2	1.2
16	2010	2.0	S, SW, NE	2, 8, 5	1.25
17	2011	2.1	NE, SW	5, 8	1.08
18	2012	2.0	SW, NE, S	8, 5, 2	1.25
19	2013	2.0	SW, S, NE	8, 2, 5	1.25
20	2014	1.8	SW, S, NE	8, 2, 5	1.25
<b>TOTAL</b>	20 years	37.1 Kt			22.57



Source: Nigerian Meteorological Agency, 2018.

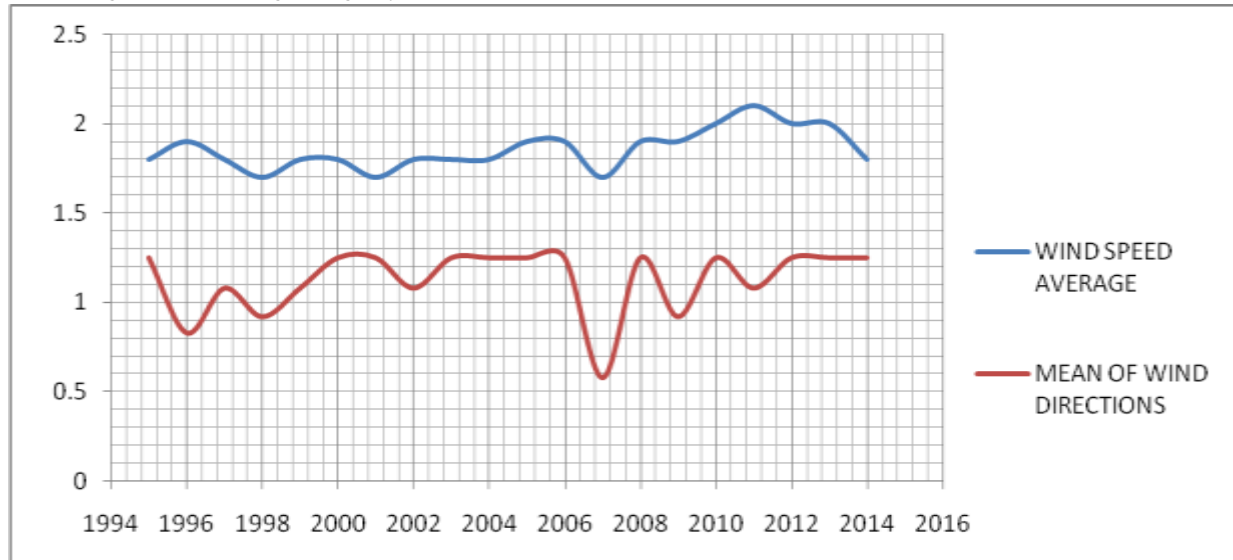


Fig 2: Graph Showing the Average Wind Speed and Directions for Lokoja Area 1995-2014.

Source: Authors Data Analysis, 2018.

**Characteristics of Thunderstorms during the Study Period**

The calculated mean thunderstorm for Lokoja area was 1221.4 during the study period. This value indicated the average thunderstorm expected in Lokoja area. The deviation from the mean (standard deviation) was 253.2622. The Co-efficient of Variation (CV) of the Lokoja area thunderstorm series which depicts the ratio of Standard Deviation (SD) to mean was found to be 0.12. It should be made clear that entire rainfall mean, CV and SD values for Lokoja tend to be different being either higher or lower (Olatunde and Adejoh,2018; Adejoh, 2016 and Obot et al., 2010). This is because not all rainfalls are considered as thunderstorms as well as the number of years considered by the study.

**Table 6: Values of Mean, Standard Deviation and Coefficient of Variation.**

Mean	1221.4
SD	253.2622
CV	20.5

Source: Authors’ Analysis, 2018.

Using the thunderstorm spectrum, results indicated that the thunderstorms in Lokoja area fall within the range of 1000-2500 J/kg with a mean of 1221.4 J/kg. This places the thunderstorms under the *ordinary* category with some *pulse severe*; however it cannot be totally dissociated with the *Multicell* being at the boundary between the two. This explains the reason for the severity of thunderstorms which sometimes occur in the area leading to damage to properties and lives.

Normal thunderstorm onset in Lokoja area is April, this also marks the beginning of the rainy season and cessation is in October every year with September as the peak period of thunderstorms with a mean thunderstorm amount of about 216 mm with a slight difference of 2.4 mm when compared to that of August which had a normal thunderstorm of about 208.2 mm (Figure 3).

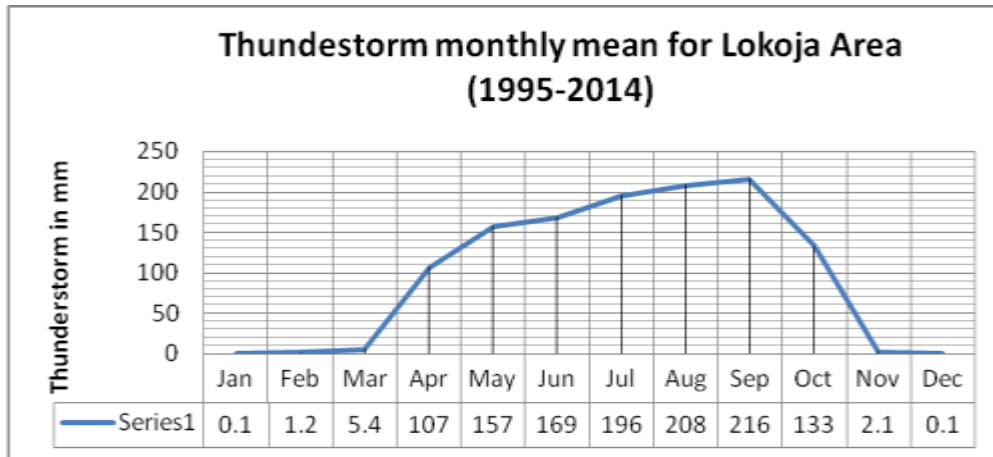


Fig 3: Thunderstorm Monthly Means for Lokoja Area (1995-2014)

Source: Authors Data Analysis, 2018.

The total thunderstorms for two decades (1995-2004, and 2005-2014) as well as the annual total thunderstorms experienced positive increase during the study period. The total thunderstorms in the second decade (2005-2014) were found to have exceeded the previous decade (1995-2004) with a value of 4851 (Table 7 and Figure 4). This increase of about 4.9% may not be a sign of climate change but that of climate variability as it affects the Lokoja area. This result agrees with that of Adejoh (2016), in which the trend in the occurrence of thunderstorms in Lokoja area was that of increase.

**Table 7: Amount of Thunderstorms during Two Decades of Study.**

Decade	1995-2004 (1 <sup>st</sup> Decade)	2005-2014 (2 <sup>nd</sup> Decade)
Amount of Rainfall (mm)	12214.0	12699.1
Percentage (%)	-	4.851
Change		

Source: Authors' Analysis, 2018.

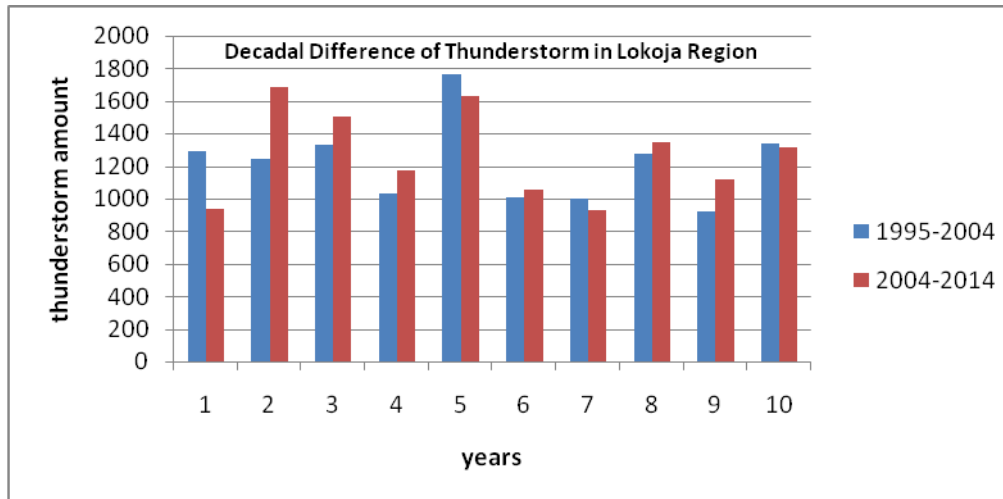


Fig 4: Total Decadal Annual Thunderstorm Differences of Lokoja Region.

Source: Authors Data Analysis, 2018.

**Perceived Effects of Local Winds and Thunderstorms on Some Farming Operations in Lokoja Area**

**Effects of Local Winds and Thunderstorms on Pre-planting Operations**

Out of the 150 farmers that questionnaire were administered to in Lokoja area, 96 (64 %) attached advantages to the effects of thunderstorms on pre-planting operations. The remaining 54 (36 %) farmers perceived local winds and thunderstorms as major disadvantage to pre-planting operations in Lokoja area.

**Advantages**

Of the 96 farmers (about 64 % of respondents) that attached advantages to local winds and thunderstorms on pre-planting

operations, 50 (52 %) perceived that the advantage of early thunderstorms during pre-planting season is the wetting of soil and making it ready for tillage, while 20 % perceived that thunderstorms make the soil damp and aids seeds germination. On the other hand, 17 % of the respondents mostly those educated beyond secondary school level opinionated that early thunderstorm has the advantage of providing moisture needed for chemical reactions to take place, for example humification of dead leaves within the soil. The remaining 11 % were indifferent and not sure about the advantages of thunderstorm on pre-planting operations rather they see it as an indication of the stability of rainy season (Table 8).

Table 8: Advantages of Early Thunderstorms on Pre-planting Operations.

Responses	Frequency	%
Early thunderstorms wet the soil and make it ready for tillage.	50	52%
Early thunderstorm makes the soil damp for seeds germination	19	20%
Thunderstorm allow moisture needed for chemical reactions e.g. humification	16	17%
Thunderstorm is an indication of the stability of rainy season	11	11%

Source: Authors Data Analysis, 2018.

**Disadvantages**

Of the remaining 54(36 %) respondents that said the occurrence of local winds and thunderstorms is a major disadvantage to pre-planting operations in Lokoja area, 26 % indicated that local winds blow off seeds dried out for the purpose of planting, while 34 % mentioned dumping of dried leaves on the cleared farm sites as another effect. Surface run off that reduces soil nutrients

and cause flash flooding was identified by 36 % of the respondents as a disadvantage. Dampness of seeds intended for planting was also identified by 2 % of the respondents as a disadvantage, while the remaining 2 % mentioned that the occurrence of thunderstorms and local winds make pre-planting farm activities uncomfortable (Figure 5).

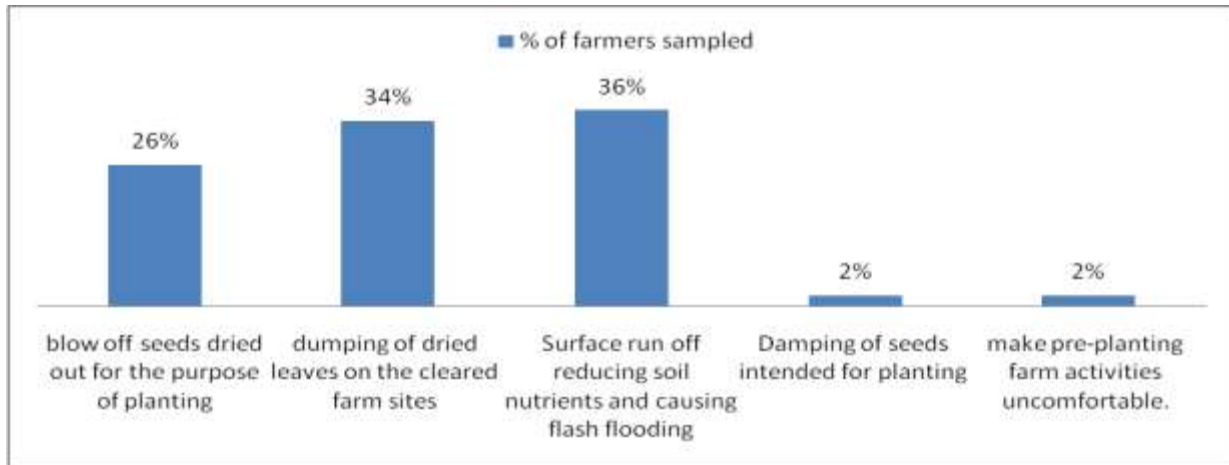


Fig 5: Disadvantages of Early Thunderstorms on Pre-planting Operations.

Source: Authors' Analysis, 2018.

**Effects of Local Winds on Planting Operations**

The 150 respondents sampled in Lokoja area identified the effects of local winds on planting activities as follows; 33 % identified damages to plant stalks resulting to breakage of young plants, droppings of unripe fruits from stems and weakening of plant branches while 15 % stated that local winds encourage the dispersal of weed seeds from uncultivated lands to the farms of the respondents. 2 % of the respondents mentioned that local winds cause cross pollination of pollen grains from unhealthy plants to healthy plants (Figure 6).

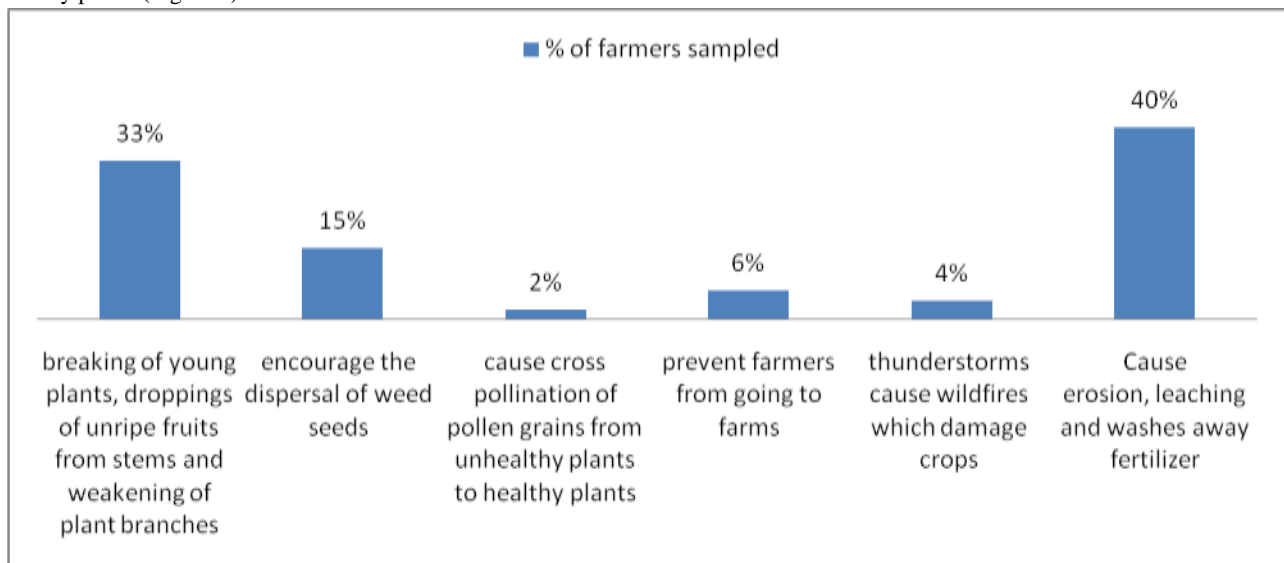


Fig 6: Advantages of Early Thunderstorms on Planting Operations.

Source: Authors' Analysis, 2018.

**Effects of Thunderstorm on Post-Planting Operations**

Results indicated that 67 % of the 150 respondents sampled were of the opinion that thunderstorms cause decay of ripe fruits while 24% said it breaks off ripe (especially dry) fruits from stalks while 3 % said it exposes cubs for insects to destroy. The remaining 6 % that were mostly root crops farmers were not sure of its effects on post planting operations (Figure 7).

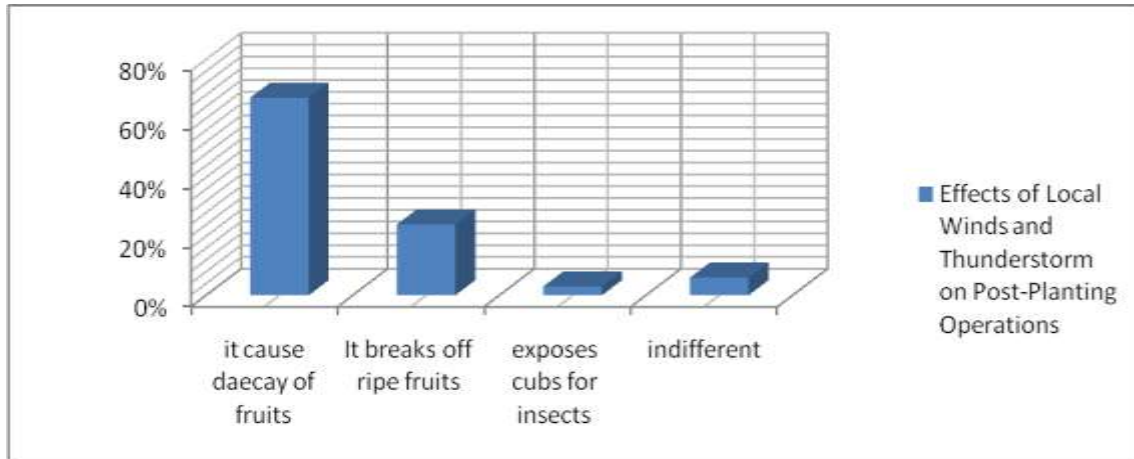


Fig 7: Effects of Thunderstorms on Post-Planting Operations.

Source: Authors' Analysis, 2018.

Also, results and findings indicated that 38 % of the respondents perceived that thunderstorms disrupt agro-marketing activities, 43 % opinionated that they make farmland inaccessible to vehicles, while 19 % said they make storage on farmlands difficult and almost impracticable (Figure 8)

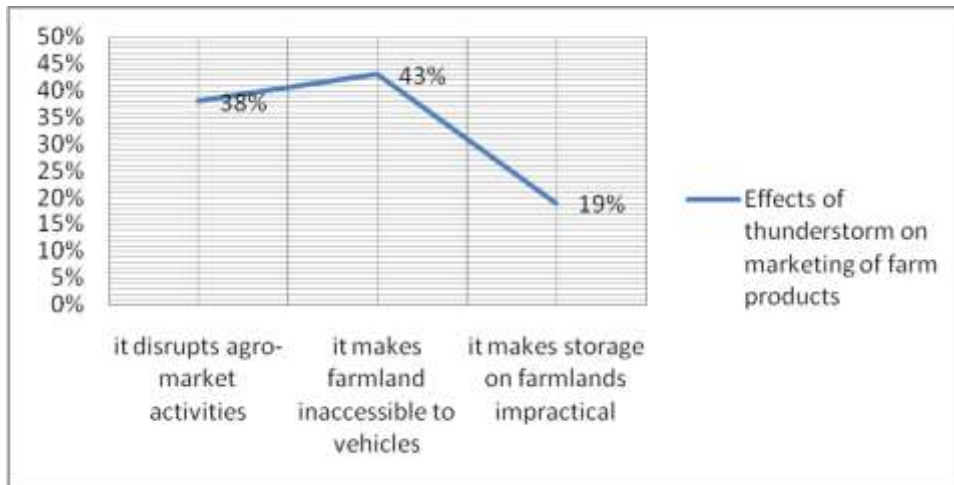


Fig 8: Effects of Thunderstorm on Marketing of Farm Produce

Source: Authors' Analysis, 2018.

Findings indicated that 47 % of respondents said thunderstorms make open storages like yam barns difficult to operate. Also, 30 % said it negatively affects the drying of farm produce, while 5 % said they damage crops on farm land if stored before haulage while 18 % said they damage storage huts and silos which are mostly thatch roofed (Figure 9).

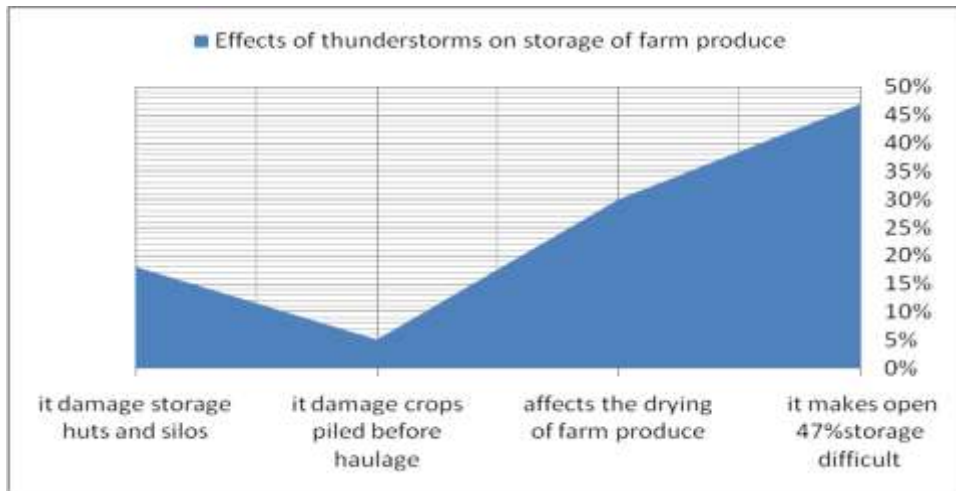


Fig 9: Effects of Thunderstorm on Storage of Farm Produce.  
Source: Authors' Analysis, 2018.

**Coping Strategies against Damaging Effects of Local Winds and Thunderstorm on Farming activities**

On coping methods used against the damaging effects of winds and thunderstorms on farms, about 79 % of the respondents mentioned the use of local methods such as perimeter fencing of farmlands with trees, filling eroded parts of farmlands with sand and planting cover crops. The remaining 21 % of the respondents said they allow nature to take its course believing that damage is an act of divine power and that man should not intervene with nature.

**Assistance Received to Reduce the Effects of Local Winds and Thunderstorm on Farming Activities**

6 % of the respondents admitted having received government assistance in form of grants and soft loans to compensate for their losses. On the other hand only 2 % admitted having received any kind of assistance from their various village heads or traditional rulers. However, 68 % said they got assistance from their peer groups or friends based cooperative societies. Furthermore 3 % of the respondents said they received assistance from people as a result of free will donations while 15 % said they got assistance from family members and friends. The remaining 6 % of respondents said they did not receive any form of assistance (Figure 10).

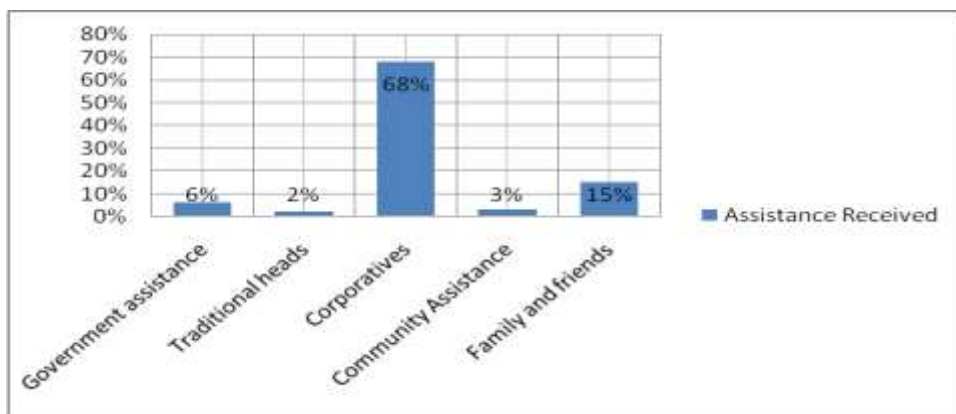


Fig 10: Sources of Assistance Received by Farmers in Lokoja Area  
Source: Authors' Analysis, 2018.

**CONCLUSION**

The study looked at the occurrence and characteristics of local winds, thunderstorms and their perceived effects on some farming activities in Lokoja area. The study identified a *South West Calm* wind on the west bank of Niger River at night and a *North East Calm* wind on the east bank of River Niger

associated with land and river breezes in Lokoja area. Also, Mountain and valley winds were identified to occur along the slopes of Mounts Patti and Agbaja. The thunderstorms in Lokoja area have been characterised to be within the *Single Cell* (1000-2500 J/kg) that tends towards the multicell category. This is

likely the reason for the damages to farmlands caused by thunderstorms in the area.

### RECOMMENDATIONS

In order to make the results of this research relevant to the people and the community of the study area, the following recommendations are suggested. It is recommended that careful attention should be paid by the inhabitants especially farmers of the study area to forecasts as this will assist them to prepare better against the damaging effects of local winds and thunderstorms. Also, the damages resulting from thunderstorms on storage facilities can be reduced if not avoided when metal roofs are used on storage facilities rather than thatch roofs. The damages can also be reduced or avoided if the buildings are made with cement blocks and concrete instead of mud. Farmers in the study area should endeavour to make use of species of crops that can tolerate and possibly withstand the damaging effects of local winds and thunderstorms.

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