DETERMINATION OF SEASONAL RAINFALL VARIABILITY AND THEIR AGRO-CLIMATIC IMPLICATION IN ILORIN, KWARA STATE, NIGERIA

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ABSTRACT

The study investigated determination of seasonal rainfall variability and its Agro-climatic implication in Ilorin, Kwara State, Nigeria. Rainfall data on daily basis were collected from three agro-ecological zones in the study area from 1979 to 2008. These data were used to determine the monthly and annual rainfall mean, rainfall trends, and distribution pattern as well as rainfall characteristics. The difference in the onset and cessation was also employed in the estimation of the effective length of rainy season. The result of the study ascertained that weak zonal pattern in amount of rainfall from the South Western part of the North-East was noticed. Also there was a positive correlation with most of the years in Ilorin East with 1.5% R value, 4.4% R value at 95% level of significance in the South and 20% R value in the West, the highest in the agro-ecological zones in the study area. The study also indicated that the onset, cessation and length of rainy season vary from one ecological zone to another. Based on the findings, it was concluded that variation in rainfall distribution across the study area would assist the farmers in their farming activities leading to high yield in crops production.

Keywords: Agro-climatic, Seasonal Rainfall Variability, Determination

INTRODUCTION

Agro-climatology is the study of the relationship between climate and agriculture. This includes the effects of climate on crop growth yield as well as on the livestock production.

In the tropics and Kwara State in particular, of all the climatic elements, rainfall is probably the most important as far as crop production is concerned, and availability of water is one of the major climatic factors that affects plant growth, development and yield (Yahaya, 2011).

The drastic changes in the seasonal rainfall variability particularly in sudano-sahelian region part of the world since later part of the 1960s is well documented in the literature (Lamb, 1982, Nicholson, 1979, Donnet, et al, 1985, Adefolalu, 1986, Hoss, et al, 1995, Nicholson, et al, 2000, Bello, N.J. 2009). This phenomenon has been attributed to the complex interplay of sea surface temperature anomalies (SSTA) over the tropical Atlantic Ocean and attendant shift of circulation system during dry years. These drastic changes in the (SRV) were also compounded by human action in allowing both human and livestock population to increase beyond critical level in many parts of West Africa during wet years (Olasantan, F.O. et al, 2004, Hastenrath, 1990). It has also been noted by Ayoade, (2003) among others that when fluctuations in climate constitute significant departure from the normal climate state then there are problems of adjustment and the environment, man and his socio-economic activities most especially farming become very vulnerable. This paper therefore examines seasonal rainfall variability and its agro-climatic implication in Ilorin, Kwara State in order to assist the farmers in proper understanding of onset, cessation dates and length of raining season for high improvement in crops production.

THE STUDY AREA

Ilorin is the capital of Kwara state. It is located on latitude 8^0 31N and 4^0 35E and longitude 4^0 57N and 8^0 52W with an area of about 100km^2 squares (Kwara state Diary, 2007). For administrative purposes, it is divided into Ilorin town council (West), Ilorin East and Ilorin South. Being situated in the transitional zone, between the forest and the savanna region of Nigeria i.e. the North and the West coastal region; it therefore serves as a "melting point between the Northern and Southern cultures" Oyebanji, J.O. (1993) .fig 1.
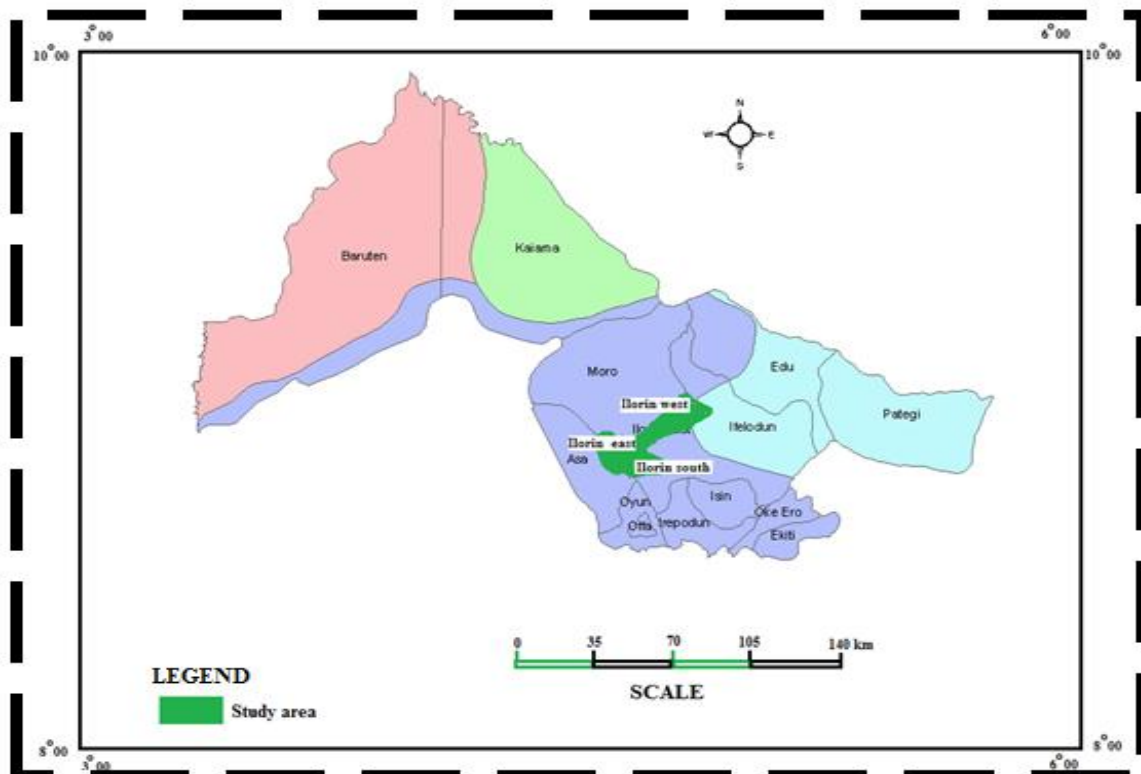

Figure 1: Map of Kwara State Showing Local Government and the Study Area
Source: Geography Department FUT Minna

MATERIALS AND METHODS

Daily rainfall records from three agro ecological zones in the study area from 1979 to 2008 were collected. The stations include: Apado, Oke-Oyi, Panada, Osere, Egbejila, Maadi, Fufu, Tanke, Fate, etc.These data was obtained from the Nigerian Meteorological Services (NIMET), Oshodi, Lagos, Department of Geography, University of Ilorin and Meteorological section, Ilorin International Airport. The data was augmented with data collected from numerous agencies in Kwara state, most especially the ADP centers located in each of the local government areas. These data were used to derive the rainfall characteristics such as the onset, cessation, length of rainy season (LRS), which are very crucial in plant growth and development. The rainfall data was also used to ascertain the rainfall trends and distributional patterns of rainfall amounts in the study area.

The administrative map of Kwara State was acquired and scanned with an A0 scanner to allow further processing, that is, vectorizing/digitizing; the study area was then extracted. A hand-held GPS device was used to pick various points of the various areas of the study area and also the related attributes entered with the point. (Fig 2)

The mean was employed to analyze the rainfall distribution pattern and rainfall trends in the study area.

$$X \quad = \quad 1/n \sum n \; \; xi \; (i = 1.2\text{--------}n) - \text{equation 1}$$

Where:

xi	=	rainfall amount for the 1st term
$\sum$	=	summation of the terms from i to n
n	=	number of cases

The difference in onset and cessation dates of the rain was employed in the estimation of the effective length of the rainy season (LRS) as discussed by Ndagi et al (1989) and Adefolalu, D.O. (1990) expressed in the form:

$$LRS \quad = \quad ¢ - ó \qquad - \qquad \text{equation 2}$$

Where: LRS represents the length of rainy season
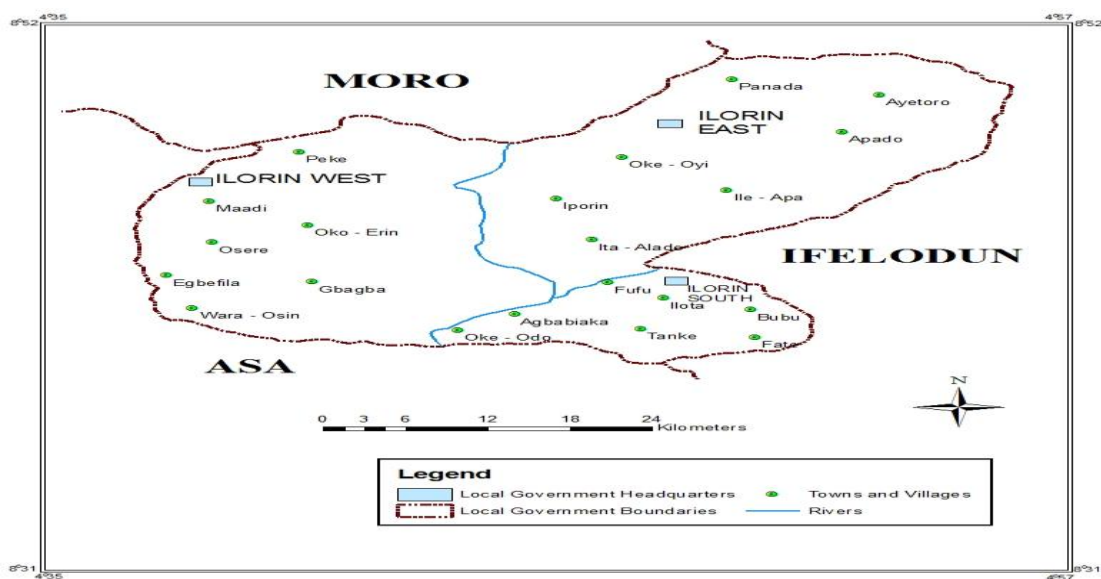¢ represents cessation date
ó represents the onset date of the rain

Figure 2: **The Study Area Showing Data Collection Centers**

RESULT AND DISCUSSION

Distribution Pattern of Mean Annual Rainfall Amount

Fig. 3 shows the distribution of mean annual rainfall in Ilorin of Kwara state. The figure shows a weak zonal pattern in nature and the amount of rainfall varies from the South Western part to the North East. For instance, the mean annual of rainfall received in settlements such as Iporin, Apado Panada oke-oyi and its environs all in Ilorin East ranges from 1056mm to 1150mm.
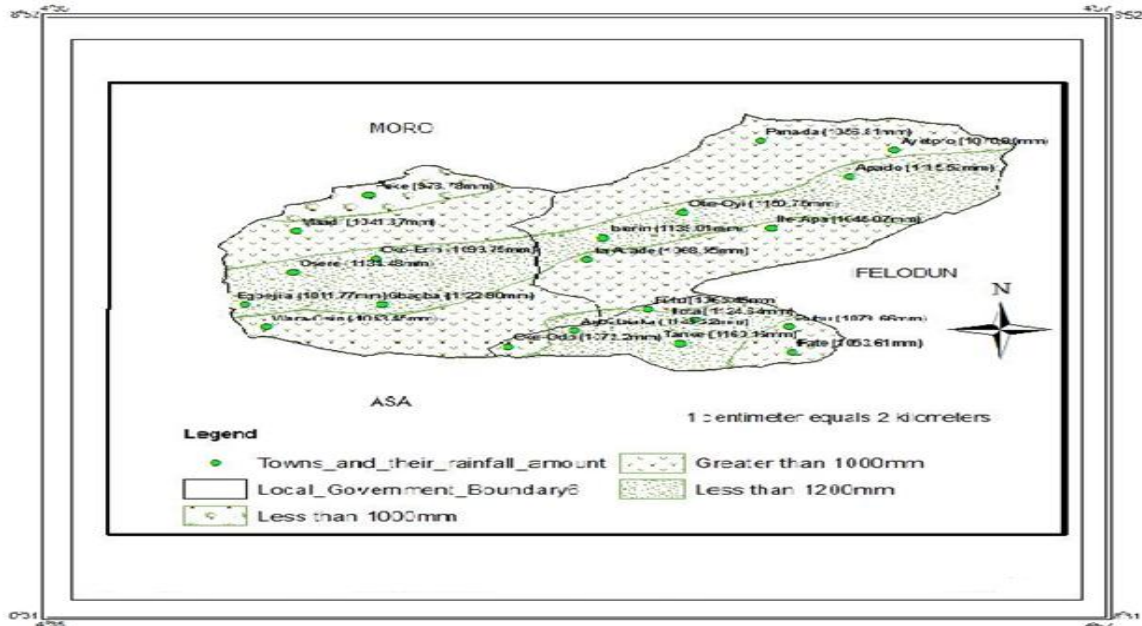

Figure 3:   **Mean Annual Rainfall (mm) in Ilorin, Kwara State (1979 – 2008)**

In Ilorin, for instance, the mean annual rainfall was above 1130mm. the areas to the extreme west of the study area such as Maadi, Oko- Erin, Osere, Gbagba, Egbejila, Peke and Wara- Osin are also characterized with fluctuation with mean annual rainfall ranging from 978mm to 1122mm. Settlements such as Gbagba recorded a fairly amount of rainfall as compared with areas like Peeke and Wara Osin. The settlement in the Southern part of the study area such as Fufu, Ilota, Tanke, Agbabiaka, Fate, Oke- and Odu and Bubu also recorded different variation in the annual mean rainfall. Settlements such as Agbabiaka and Ilota had high rainfall.
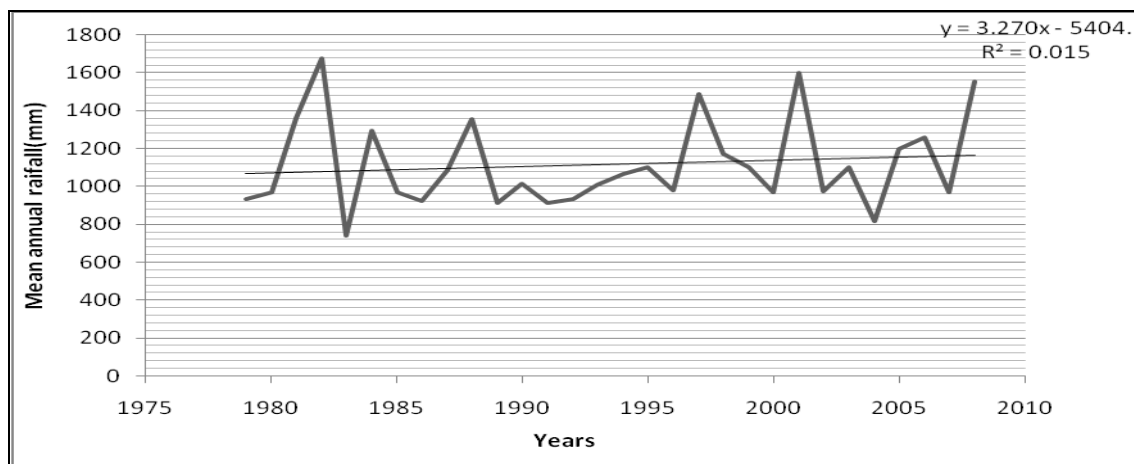

Figure 4:   **Mean Annual Rainfall for Ilorin East (1979 – 2008)**

Figure 4 above and Table 3 show the mean annual rainfall for Ilorin East from (1979-2008). The figure shows that there is an upward trend in the rainfall with an indication that there is about 1.5% R value which shows a positive correlation with most of the years.
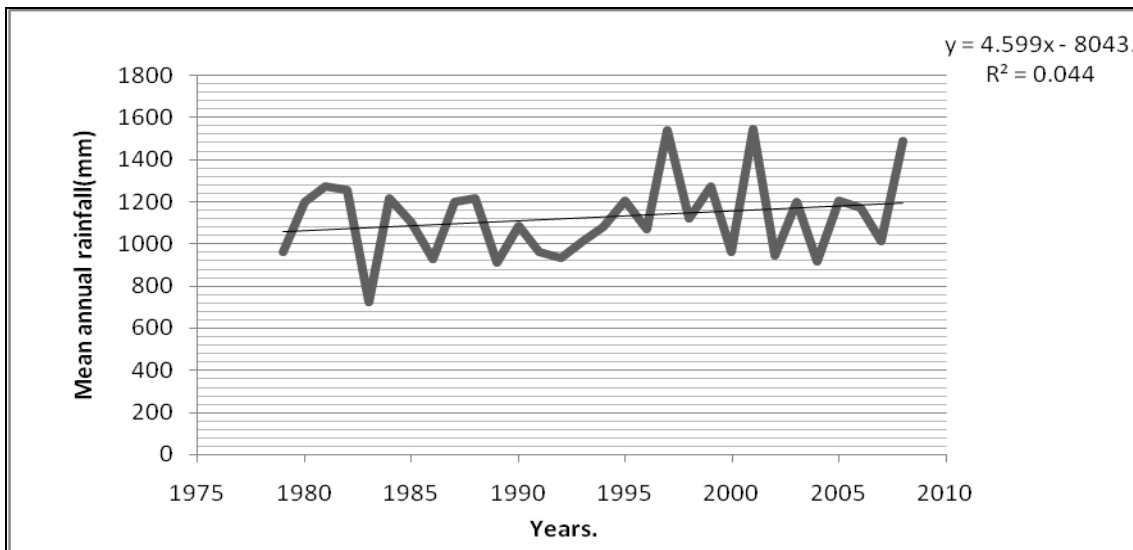

Figure 5: **Mean Annual Rainfall for Ilorin South (1979 – 2008)**

The mean annual rainfall trend for Ilorin- South from (1979- 2008) was as shown in figure 5.and Table 1. The graph shows an upward trend with about 4.4% R value at 95% level of significance.
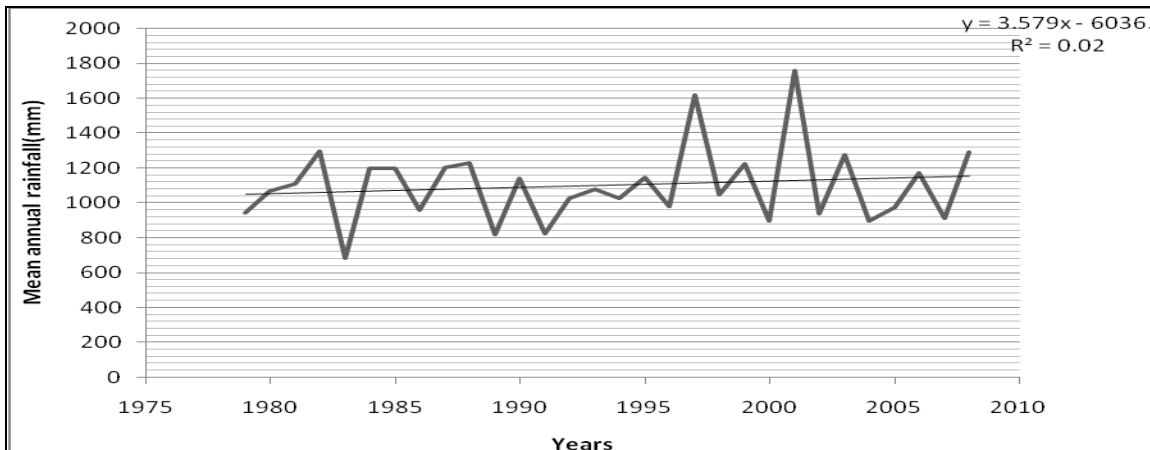
Figure 6: **Mean Annual Rainfall for Ilorin-West (1979 – 2008)**

The figure 6 and Table 2 show the mean annual rainfall trend for Ilorin-West (1979- 2008), the graph shows a positive trend which showed an R value of 20%, the highest so far in the three Local Government Areas under study. The trend showed an increasing trend for most part of the 1990s, 2000 up to the end of the 21st century.

In Agriculture, two of the most important phonological aspect of rainfall which are useful in decision making are the onset (ø) and cessation (¢) of the rains. The combination of these two determines the length of the rainy season (LRS). (Fig. 6 − 8) shows onset, cessation and length of the rainy season for the study area. The earliest onset dates of rain in Panada, Oke- Oyi, Iporin, Osere, Gbagba, Wara-Osin, Maadi, Gbagba and Egbejila is before 31st March. This implies that between 25th and 30th

February the above settlements would have expected the first rainfall in the year. In places such as Oke- Odo, Agbabiaka, Tanke, Fate, Fufu and Ilota, the onset date of the rain starts from 31st of March and extends to after 30th of April (Fig. 7).
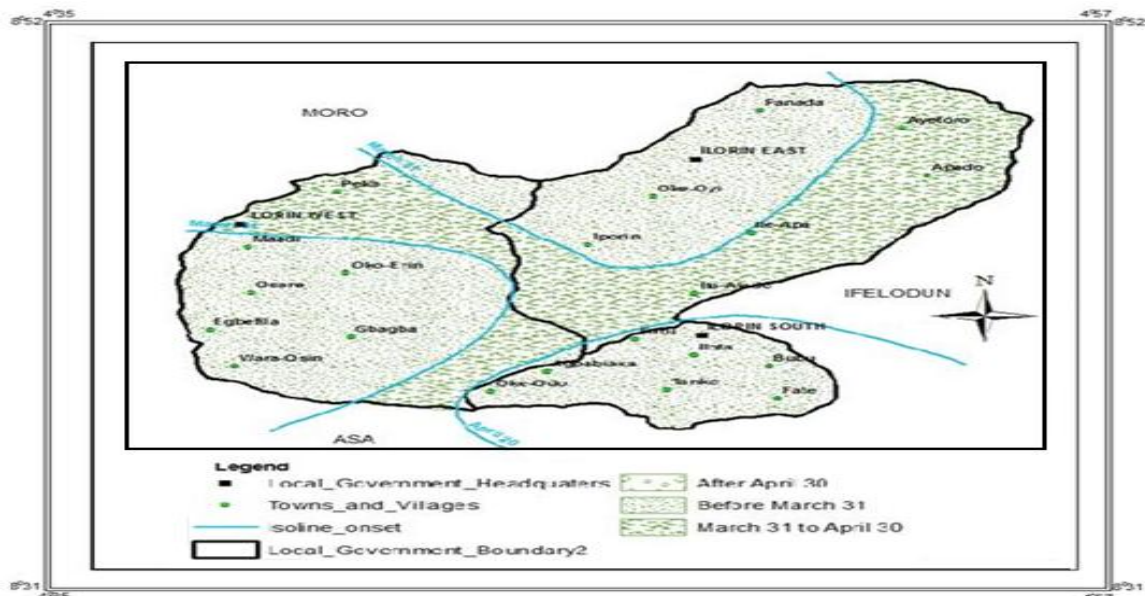
Figure 7:   Onset Dates of Rains in Ilorin, Kwara State

This implies that land preparation for planting can be done between 25th and 30th of February. Actual planting of crops however can be carried out as from 31st March. This is because rain may not be steady until 1st of April or 15th April, for the purpose of crop production.

The dates of cessation for the study area are shown in (Fig. 8). The cessation dates in places like Panada, Ayetoro, Apado, Oke- Oyi and Ile- Apa occur before 7th October. The cessation dates of rains in Iporin, Ita Alade, Agbabiaka, Tanke, Fate, Oke Odo and Ilota is between 7th October and 27th October, while places like Peke, Oko Erin, Osere, Gbagba, Wara- Osin, Maadi and Egbejila had its cessation dates of rains between 27th October and 5th November (Fig. 8). There are periods when rain terminates either early or late. These are periods of anomalies. An early cessation will affect agriculture, these periods are critical to crop production/ maturity, and this may also lead to crop failure.

Figure 8:   Cessation Dates of Rains in Ilorin, Kwara State

Length of Rainy Season

Figure 9 illustrates the length of rainy season. The length of rainy season in Gbagba, Ita Alade, Egbejila and Wara Osin ranges between (210 to 220 days) while the shortest LRS of less than 210-220mm was recorded in Oke – Ode, Tanke, Fate, Ilota, Bubu and Agbabiaka.
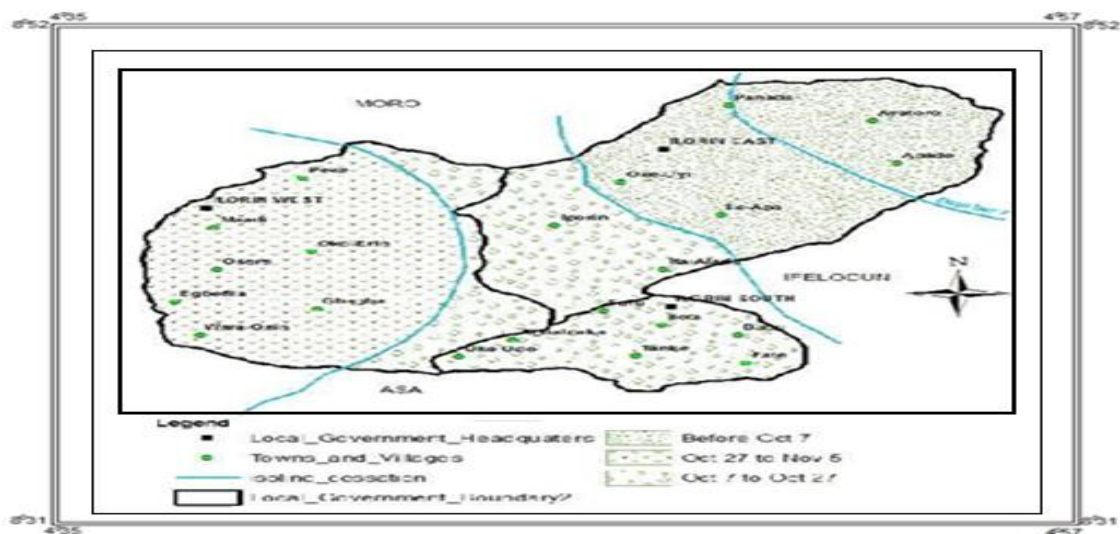
The LRS in Iporin, Ile- Apa, Apado, Oko- Erin, Maadi and Osere ranges from 220- 230 days and longest LRS of more than (230 days) was recorded in Peke, Panada and Ayetoro.
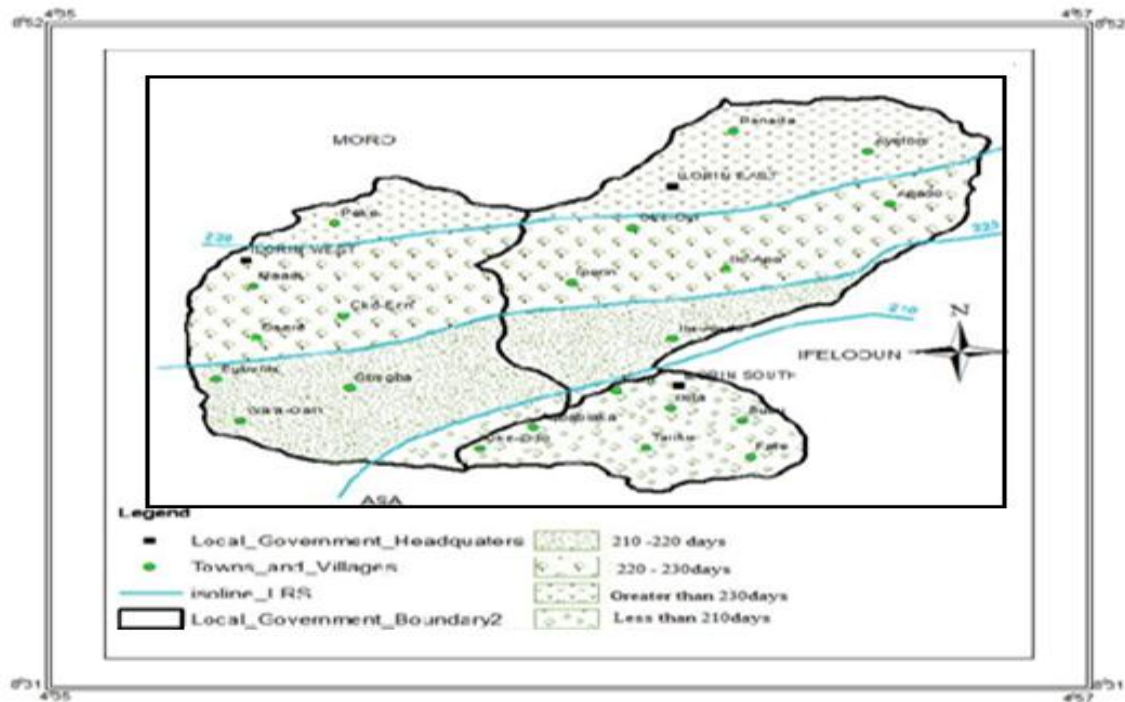
Figure 9:   Length of Rainy Season (L.R.S.) in Ilorin, Kwara State

Generally speaking, LRS decreases from settlements such as Maadi, Oko Erin, Ile- Apa and Iporin both in the Western and Eastern parts of the study area to places like Oke-Odo, Tanke, Fate, Agbabiaka and Ilota in the Southern part of the study areas (Fig. 9). The implication of the above is that both cereal and root crops can be cultivated in the study area.

CONCLUSION AND RECOMMENDATION

The analysis epitomized general information on the importance of seasonal rainfall variability with regards to onset, cessation, length of raining season and its agro-climatic implication. The study shows that rainfall distribution in Ilorin, Kwara State fluctuates from place to place from East to West and South respectively.

Investigation also revealed that the onset, cessation and length of rainy season varies from the three ecological zones, although the analysis showed that there was no significant difference in the amount of rainfall distribution across the zones in the study areas.

It is therefore recommended that land preparation and planting of crops can be embarked upon after 30th April and since the average length of LRS is about 220 days, this means that reliable rainfall period is adequate for most crops in the study area.

Table 1: Mean Annual Rainfall for Selected Stations in Ilorin-South

APPENDIX 4: - Mean Annual Rainfall for Selected Stations in Ilorin-South							
YEARS	Fufu	Ilota	Tanke	Agbabiaka	Fate	Oke-Odo	Bubu	
1979	910.8	961.4	991.76	981.64	900.68	920.92	922.944	961.4
1980	1137.6	1200.8	1238.72	1226.08	1124.96	1150.24	1152.768	1200.8
1981	1206.9	1273.95	1314.18	1300.77	1193.49	1220.31	1222.992	1273.95
1982	1191.6	1257.8	1297.52	1284.28	1178.36	1204.84	1207.488	1257.8
1983	685.8	723.9	746.76	739.14	678.18	693.42	694.944	723.9
1984	1155.6	1219.8	1258.32	1245.48	1142.76	1168.44	1171.008	1219.8
1985	1045.8	1103.9	1138.76	1127.14	1034.18	1057.42	1059.744	1103.9
1986	880.2	929.1	958.44	948.66	870.42	889.98	891.936	929.1
1987	1137.6	1200.8	1238.72	1226.08	1124.96	1150.24	1152.768	1200.8
1988	1155.6	1219.8	1258.32	1245.48	1142.76	1168.44	1171.008	1219.8
1989	865.8	913.9	942.76	933.14	856.18	875.42	877.344	913.9
1990	1031.4	1088.7	1123.08	1111.62	1019.94	1042.86	1045.152	1088.7
1991	910.8	961.4	991.76	981.64	900.68	920.92	922.944	961.4
1992	885.6	934.8	964.32	954.48	875.76	895.44	897.408	934.8
1993	957.6	1010.8	1042.72	1032.08	946.96	968.24	970.368	1010.8
1994	1022.4	1079.2	1113.28	1101.92	1011.04	1033.76	1036.032	1079.2
1995	1141.2	1204.6	1242.64	1229.96	1128.52	1153.88	1156.416	1204.6
1996	1011.6	1067.8	1101.52	1090.28	1000.36	1022.84	1025.088	1067.8
1997	1461.6	1542.8	1591.52	1575.28	1445.36	1477.84	1481.088	1542.8
1998	1060.2	1119.1	1154.44	1142.66	1048.42	1071.98	1074.336	1119.1
1999	1207.8	1274.9	1315.16	1301.74	1194.38	1221.22	1223.904	1274.9
2000	910.8	961.4	991.76	981.64	900.68	920.92	922.944	961.4
2001	1465.2	1546.6	1595.44	1579.16	1448.92	1481.48	1484.736	1546.6
2002	894.6	944.3	974.12	964.18	884.66	904.54	906.528	944.3
2003	1137.6	1200.8	1238.72	1226.08	1124.96	1150.24	1152.768	1200.8
2004	867.6	915.8	944.72	935.08	857.96	877.24	879.168	915.8
2005	1141.2	1204.6	1242.64	1229.96	1128.52	1153.88	1156.416	1204.6
2006	1110.6	1172.3	1209.32	1196.98	1098.26	1122.94	1125.408	1172.3
2007	961.2	1014.6	1046.64	1035.96	950.52	971.88	974.016	1014.6
2008	1411.2	1489.6	1536.64	1520.96	1395.52	1426.88	1430.016	1489.6
Mean	1065.45	1124.64	1160.16	1148.32	1053.61	1077.29	1079.66	

Table 2: Mean Annual Rainfall for Selected Stations in Ilorin-West

YEARS	Maadi	Oko-Erin	Osere	Gbagba	Egbejila	Peeke	Wara-Osin	
APPENDIX 5: - Mean Annual Rainfall for Selected Stations in Ilorin-West								
1979	894.6	944.3	974.12	964.18	868.756	840.427	904.54	**944.3**
1980	1013.4	1069.7	1103.48	1092.22	984.124	952.033	1024.66	**1069.7**
1981	1051.2	1109.6	1144.64	1132.96	1020.832	987.544	1062.88	**1109.6**
1982	1230.3	1298.65	1339.66	1325.99	1194.758	1155.799	1243.97	**1298.7**
1983	649.8	685.9	707.56	700.34	631.028	610.451	657.02	**685.9**
1984	1135.8	1198.9	1236.76	1224.14	1102.988	1067.021	1148.42	**1198.9**
1985	1135.8	1198.9	1236.76	1224.14	1102.988	1067.021	1148.42	**1198.9**
1986	912.6	963.3	993.72	983.58	886.236	857.337	922.74	**963.3**
1987	1141.2	1204.6	1242.64	1229.96	1108.232	1072.094	1153.88	**1204.6**
1988	1166.4	1231.2	1270.08	1257.12	1132.704	1095.768	1179.36	**1231.2**
1989	775.8	818.9	844.76	836.14	753.388	728.821	784.42	**818.9**
1990	1081.8	1141.9	1177.96	1165.94	1050.548	1016.291	1093.82	**1141.9**
1991	782.1	825.55	851.62	842.93	759.506	734.7395	790.79	**825.55**
1992	976.5	1030.75	1063.3	1052.45	948.29	917.3675	987.35	**1030.8**
1993	1024.2	1081.1	1115.24	1103.86	994.612	962.179	1035.58	**1081.1**
1994	976.5	1030.75	1063.3	1052.45	948.29	917.3675	987.35	**1030.8**
1995	1089.9	1150.45	1186.78	1174.67	1058.414	1023.901	1102.01	**1150.5**
1996	930.6	982.3	1013.32	1002.98	903.716	874.247	940.94	**982.3**
1997	1533.6	1618.8	1669.92	1652.88	1489.296	1440.732	1550.64	**1618.8**
1998	992.7	1047.85	1080.94	1069.91	964.022	932.5865	1003.73	**1047.9**
1999	1162.8	1227.4	1266.16	1253.24	1129.208	1092.386	1175.72	**1227.4**
2000	851.4	898.7	927.08	917.62	826.804	799.843	860.86	**898.7**
2001	1667.7	1760.35	1815.94	1797.41	1619.522	1566.712	1686.23	**1760.4**
2002	888.3	937.65	967.26	957.39	862.638	834.5085	898.17	**937.65**
2003	1211.4	1278.7	1319.08	1305.62	1176.404	1138.043	1224.86	**1278.7**
2004	851.4	898.7	927.08	917.62	826.804	799.843	860.86	**898.7**
2005	924.3	975.65	1006.46	996.19	897.598	868.3285	934.57	**975.65**
2006	1112.4	1174.2	1211.28	1198.92	1080.264	1045.038	1124.76	**1174.2**
2007	865.8	913.9	942.76	933.14	840.788	813.371	875.42	**913.9**
2008	1225.8	1293.9	1334.76	1321.14	1190.388	1151.571	1239.42	**1293.9**
Mean	**1041.87**	**1099.75**	**1134.48**	**1122.90**	**1011.77**	**978.78**	**1053.45**	

Table 3: Mean Annual Rainfall for   Selected Stations in Ilorin-East

YEARS	Panada	Apado	Oke-oyi	Iporin	Ile-Apa	Ita-Alade	Ayetoro	Mean
APPENDIX 6: - Mean Annual Rainfall for Selected Stations in Ilorin-East								
1979	887.4	936.7	966.28	956.42	877.54	897.26	899.232	936.7
1980	918.9	969.95	1000.58	990.37	908.69	929.11	931.152	969.95
1981	1288.8	1360.4	1403.36	1389	1274.5	1303.12	1305.984	1360.4
1982	1585.8	1673.9	1726.76	1709.1	1568.2	1603.42	1606.944	1673.9
1983	703.8	742.9	766.36	758.54	695.98	711.62	713.184	742.9
1984	1225.8	1293.9	1334.76	1321.1	1212.2	1239.42	1242.144	1293.9
1985	921.6	972.8	1003.52	993.28	911.36	931.84	933.888	972.8
1986	878.4	927.2	956.48	946.72	868.64	888.16	890.112	927.2
1987	1027.8	1084.9	1119.16	1107.7	1016.4	1039.22	1041.504	1084.9
1988	1283.4	1354.7	1397.48	1383.2	1269.1	1297.66	1300.512	1354.7
1989	865.8	913.9	942.76	933.14	856.18	875.42	877.344	913.9
1990	961.2	1014.6	1046.64	1036	950.52	971.88	974.016	1014.6
1991	865.8	913.9	942.76	933.14	856.18	875.42	877.344	913.9
1992	888.3	937.65	967.26	957.39	878.43	898.17	900.144	937.65
1993	955.8	1008.9	1040.76	1030.1	945.18	966.42	968.544	1008.9
1994	1011.6	1067.8	1101.52	1090.3	1000.4	1022.84	1025.088	1067.8
1995	1045.8	1103.9	1138.76	1127.1	1034.2	1057.42	1059.744	1103.9
1996	928.8	980.4	1011.36	1001	918.48	939.12	941.184	980.4
1997	1407.6	1485.8	1532.72	1517.1	1392	1423.24	1426.368	1485.8
1998	1110.6	1172.3	1209.32	1197	1098.3	1122.94	1125.408	1172.3
1999	1045.8	1103.9	1138.76	1127.1	1034.2	1057.42	1059.744	1103.9
2000	918.9	969.95	1000.58	990.37	908.69	929.11	931.152	969.95
2001	1515.6	1599.8	1650.32	1633.5	1498.8	1532.44	1535.808	1599.8
2002	923.4	974.7	1005.48	995.22	913.14	933.66	935.712	974.7
2003	1045.8	1103.9	1138.76	1127.1	1034.2	1057.42	1059.744	1103.9
2004	775.8	818.9	844.76	836.14	767.18	784.42	786.144	818.9
2005	1134.9	1198	1235.78	1223.2	1122.3	1147.51	1150.032	1197.95
2006	1193.4	1259.7	1299.48	1286.2	1180.1	1206.66	1209.312	1259.7
2007	918.9	969.95	1000.58	990.37	908.69	929.11	931.152	969.95
2008	1468.8	1550.4	1599.36	1583	1452.5	1485.12	1488.384	1550.4
	176.44	186.24	192.124	190.16	174.48	178.40044	178.7925	186.242
Mean	**1056.81**	**1115.52**	**1150.75**	**1139.01**	**1045.07**	**1068.55**	**1070.90**	

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