ASSESSING RAINFALL VARIABILITY IMPACTS USING AGRICULTURAL RAINFALL INDEX (ARI) ON CASSAVA GROWTH IN ILORIN AREA OF KWARA STATE, NIGERIA

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ABSTRACT

The scientific evidence on rainfall variability and its very important impact on crop growth are now stronger than ever. It is even more so on tubers (cassava) that serve as staple food in most parts of the world. Hence, the objectives of this study are to assess rainfall variability impacts using agricultural rainfall index (ARI) on cassava growth. Major areas where cassava is highly produced in parts of Ilorin were selected and rainfall data for the period of (2009 and 2010) and the potential evapotranspiration were estimated for the analysis of agricultural rainfall index (ARI). Arc-View GIS were also used to show mean monthly (ARI) deviation for some selected months in the study area. The result of the analysis show that agricultural rainfall index (ARI) varies from place to place and from month to month. The findings also reveals that effective rain fed agriculture can easily be carry out for both short variety and other types of crops most especially cassava between April & October whose ARI were greater than 100%, thereby improve the existing cassava industry in the country.

Keywords: ***Rainfall variability, agricultural rainfall index (ARI), Growth, Cassava crops, Impacts, Ilorin area and Nigeria.***

INTRODUCTION

Rainfall variability impact analysis is a way of looking at the range of consequences of a given rainfall or change (Adejuwon, 2004). The performance of any crop around the globe depends largely on the availability and distribution of rainfall during the cropping season. Too much rainfall can result in flooding of cultivated land on the other hand shortage of rainfall during rainy season can lead to draught which results to wilting and in a more serious situation leads to the death of crop plants. Therefore, both excess and shortage of rainfall can lead to poor harvest or total loss of crops to farmer (Yahaya, 2006,) The scientific evidence on rainfall variability with its significant impacts on cassava production are now stronger than ever Baguma, (2002).

One undisputable cause of ‘famine’ in Kwara State and particularly Guinean Savanna in Nigeria is the failure of crops resulting from insufficient or untimely rainfall IPCC (2004a) has studied the inter-annual variability in climate of West Africa Countries, and particularly the magnitude of rainfall variability impact on human activities, including crop production.

Previous studies on the impact of rainfall variability on crops yield have formerly examined the impacts on some specific crops only statistical modeling (Yahaya, 2012). Among these are the work by Tim, (2000), FAO (2001), Adejuwon,(2004), Adebayo, (1999) observed that over the period of 1971 to 2000 the North East Arid zone of Nigeria experienced a decline in rice based farming systems.

The farming-grazing transitional zone, located in the Semi arid area of northern part of Ilorin, has an array of the ecological problems. This problem is caused by natural environment, especially the rainfall variation and man-land relationship. Olaniran,(2002).Because of this fluctuation the land was suitable to crop plantation in one period, while suitable to stock breeding in another period. For adapting to the fluctuation, the farmers have to select suitable land use pattern to resolve the contraction between the ecological fragility of land use and the rigid demand of farmer's living necessity. The study examines the rainfall variability on cassava production using agricultural rainfall index (ARI) in part of Ilorin Kwara state, Nigeria.

THE STUDY AREA

Location

Ilorin Area is the capital of Kwara state. It is located on latitude 8° 31N and 4° 35E and longitude 4° 57N and 8° 52W with an area of about 100 km^2 square (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, 1993). Fig.1

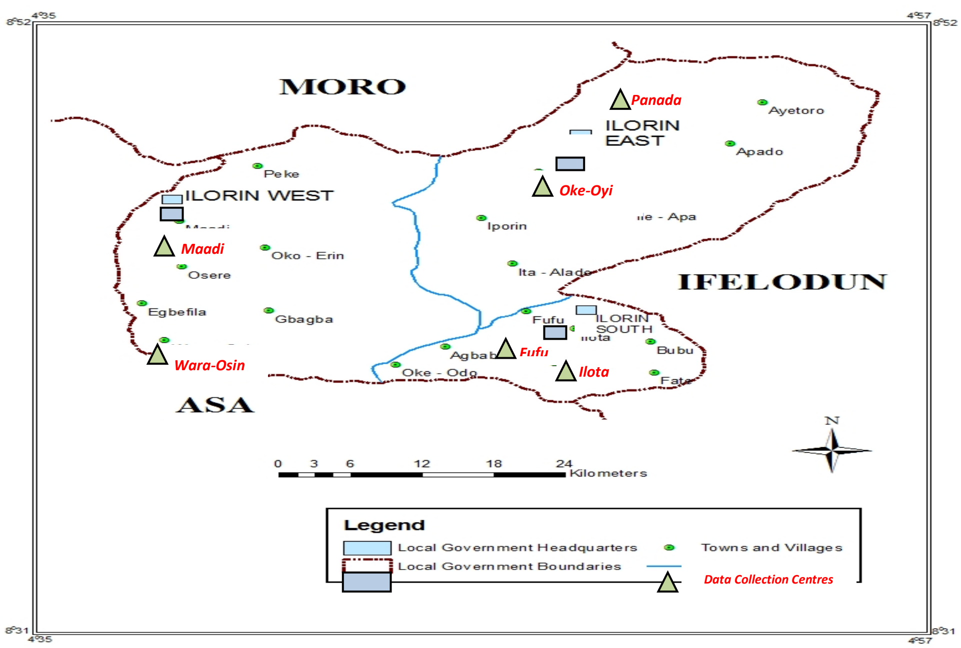


Fig.1: The Study Area Showing Data Collection Centers
Source: Field Survey, (2011)

Climate

The climate is humid tropical type and is characterized by wet and dry seasons (Ilorin Atlas, 1981). The wet season begins towards the end of March and ends in October. A dry season in the town begins with the onset of tropical continental air mass commonly referred to as harmattan. The wind is usually predominant between the months of November and February (Olaniran, 2002). The temperature is uniformly high throughout the year. The mean monthly temperature of the town varies between 25^{o}C and 29.5^{o}C with the month of March having about 30^{o}C. Ilorin falls into the Southern guinea savanna zone. This zone is a transition between the high forest in the southern part of the country and the far north with woodland properties (Yahaya, 2006)..

MATERIALS AND METHOD

Data on mean rainfall for six stations, Panada, Oke-Oyi, Wara-Osin, Maadi, Fufu and Ilota for period of 2 years (2009 and 2010) were obtained from Nigeria Meteorological Section, Ilorin International Airport. The data was augmented with the data collected from the Agricultural Development Centres (ADP) located in each of the local government areas of the six stations. A hand-held GPS was used to pick various points of the various areas of the study area. The coordinates acquired during the field truthing were entered into the system using the Microsoft Excel Worksheet, overlaid on the extracted study area from administrative map of Kwara State for proper feature identification of six stations.

The potential evapotranspiration was estimated from fan evaporation E_p and total annual rainfall was used to calculate the agricultural rainfall index value for the six stations in the study area. The potential evaporation was estimated from E_p in accordance with the procedure by Yahaya,(2012).

. The potential evapotranspiration is expressed as:-

$$ET_0 = K_p \times E_p$$

Where: $ET_0 = \ Potential\ evaporation\ \left(\frac{mm}{day}\right)$

$Ep = \ \ Potential\ evaporation\ \left(\frac{mm}{day}\right)$

$Kp = Pan\ coeffcient$

Agricultural Rainfall Index (ARI) expresses rainfall at a certain probability level as a percentage of the crop water needs, represented by the potential evapotranspiration (PET) or any other available indicator of the evaporation power of the climate. The Agricultural Rainfall Index can be expressed statistically as:

$$\text{ARI} = \frac{\text{Total annual rainfall}}{\text{PET}}\ \text{x}\ \frac{100}{1}$$

Where:

ARI = Agricultural Rainfall Index

PET = Potential Evapotranspiration

RESULTS AND DISCUSSION

Applied Parameters of Rainfall Amounts in Ilorin Area, Kwara State

The Agricultural Rainfall Index (ARI) defines the length of the growing season on the consecutive number of months when A.R.I is over 100%. The A.R.I index is used to compute the growing season for six selected stations of the study areas as shown in (Table 1).

It can be seen that A.R.I. value varies from place to place and from month to month. For instance, Panada and Oke-Oyi had a very low value in January while the other study points recorded no value of A.R.I. By February, the value of A.R.I at Panada had increased to about 80%. This value is still lower than 100% and thus considered as dry period. Oke-Oyi, Wara Osin and Maadi had an increase from 0 to 40.56%, 33.79% and 22.30% respectively.

Table 1: A.R.I Values in (%) for Six Stations of the Study Area

Months	Panada	Oke-Oyi	Wara-Osin	Maadi	Fufu	Ilota
Jan	4.60	3.40	0	0	0	0
Feb	80	33.79	40.56	22.30	0	0
March	117.66	67.35	30.25	107.76	94.69	60.21
April	138.45	99.09	41.97	116.96	130.14	72.30
May	278.97	50.42	160.61	70.31	100.1	64.34
June	120.63	222.98	175.91	251.62	228.51	128.34
July	503.03	118.82	340.72	596.17	288.75	207.31
Aug	145.26	410.73	30.09	185.31	469.95	278.21
Sept	8.84	318.26	390.39	185.31	469.95	278.21
Oct	2.42	126.76	446.31	119.71	165.21	178.42
Nov	0	105.01	19.50	5.13	0.27	0.12
Dec	0	0	0	0	8.47	3.02

Source: Field Survey, 2011

The value of A.R.I exceeded 100% at Panada and Maadi in the month of March whereas in Oke-Oyi, Wara-Osin, Fufu and Ilota, the values of A.R.I in March were below 100% (Table 1). The Month of April witnessed an improvement in the distribution of A.R.I. Panada, Maadi and Fufu, had A.R.I value about 100%. Other settlements had a slight increase in the value of A.R.I value below 100% but it increased in June, July, August, September and October. Other areas such as Oke- Oyi and Fufu continued to enjoy high ARI value from August to October.

Effective Rain fed agriculture can easily be carried out for both short variety and other types of crops between April and October. This is because A.R.I values were greater than 100%. The month of November marks the period when the water need of cassava is no longer adequate.

The months when A.R.I is below 40% in the study area indicated that rainfall supplied less than half of the necessary moisture. This situation represents a serious deficit.

The value of A.R.I enables the growing season for each month to be well pronounced for each station. The period when A.R.I < 40 conforms to the dry season, while the period when A.R.I > 100 conforms to the length of rainy season (LRS). The use of A.R.I values therefore is in agreement with the length of rainy season as was used by (Adefolalu, *et al.* 1995). This implies that the period when the available moisture is favourable to plant cultivation is within the range of the length of rainy season.

The mean monthly A.R.I deviation can be seen (Table 2). The table reveals that both positive and negative deviations were exhibited in the study area, and this varies from place to place

Table 2: Mean Monthly A.R.I Deviation

Months	Panada	Oke- Oyi	Wara-Osin	Maadi	Fufu	Ilota
Jan	3.05	-1.55	-1.55	1.59	-1.55	-1.55
Feb	47.01	-2.21	4.87	-13.69	-35.99	-35.99
March	34.12	-16.19	-53.28	24.22	11.15	6.28
April	33.13	-6.23	-63.35	11.64	24.82	18.24
May	146.87	-81.68	29.5	-61.81	-32.0	-12.32
June	-76.27	23.08	-24.0	51.71	28.69	14.42
July	145.53	-238.68	-16.78	238.67	-68.75	-28.71
Aug	-104.61	160.87	110.23	-64.56	220.09	87.34
Sept	-265.7	43.72	85.85	-99.24	195.41	79.11
Oct	-169.68	-45.34	274.21	-52.40	-6.89	-14.04
Nov	-25.98	79.03	-6.48	-20.85	-25.71	-17.34
Dec	-1.7	-1.7	-1.7	-1.7	-6.77	-1.7

Source: Field Survey, 2011

Table 3: Mean Annual Rainfall for Selected Station in the Study area

Year	Panada	Oke- Oyi	Wara-Osin	Maadi	Fufu	Ilota
2009	981.9	1000.6	875.4	865.8	961.2	1014.6
2010	1468.8	1599.4	1239.4	1225.8	1411.2	1489.6
	*1225.35	*1300	*1057.4	*1045.8	*1186.2	*1252.1

Key: * = mean

Mean Monthly ARI Deviation in June in Ilorin Area, Kwara State

The mean monthly A.R.I deviations in June in Ilorin indicate that the northern part of the study area had values which were below the mean. This exhibits a stronger variation in the North Eastern part of the study area. The Southern parts have values above the mean monthly value, with high positive deviation to the eastern part (Fig 2).

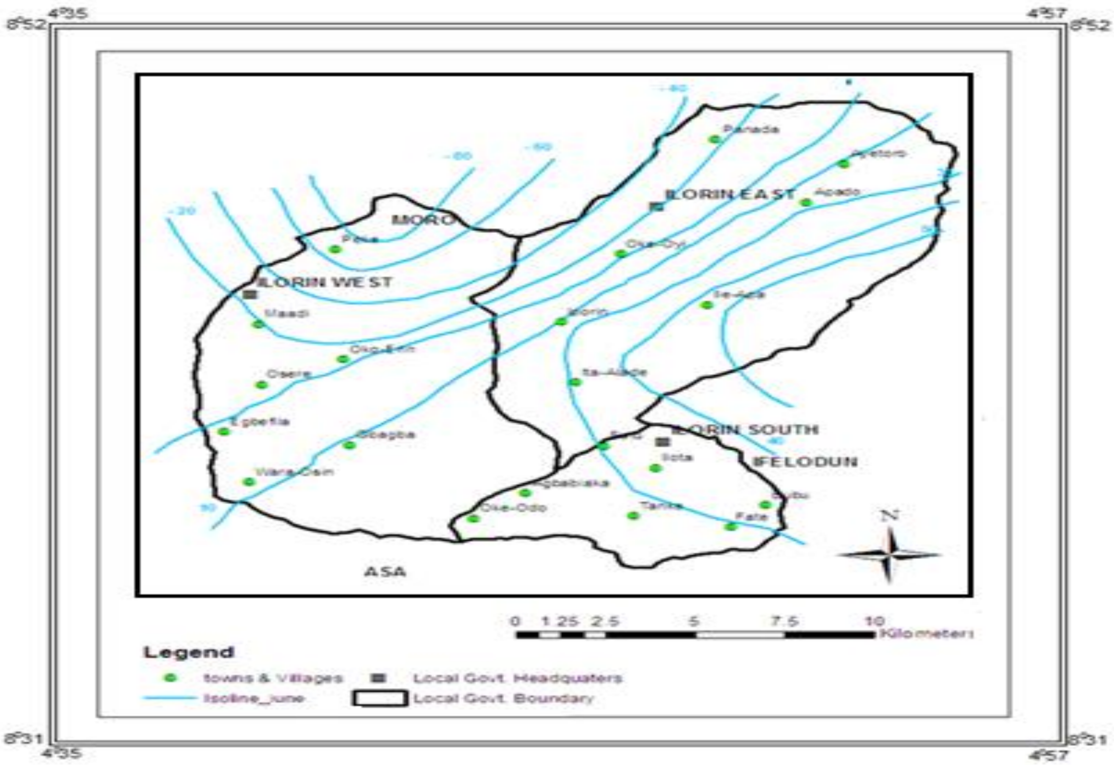


Fig. 2: Mean Monthly ARI Deviation in June in Ilorin Area, Kwara State
Source: Field Survey, (2011)

In general, the northern part of the study area has negative mean variations while the Southern part has positive deviation for the month of June. This implies that the month of June favors the growth of cassava more in the Southern part of the study area while the Northern part of the study area is less supportive for cassava growth.

Mean Monthly ARI Deviation in July in Ilorin Area, Kwara State

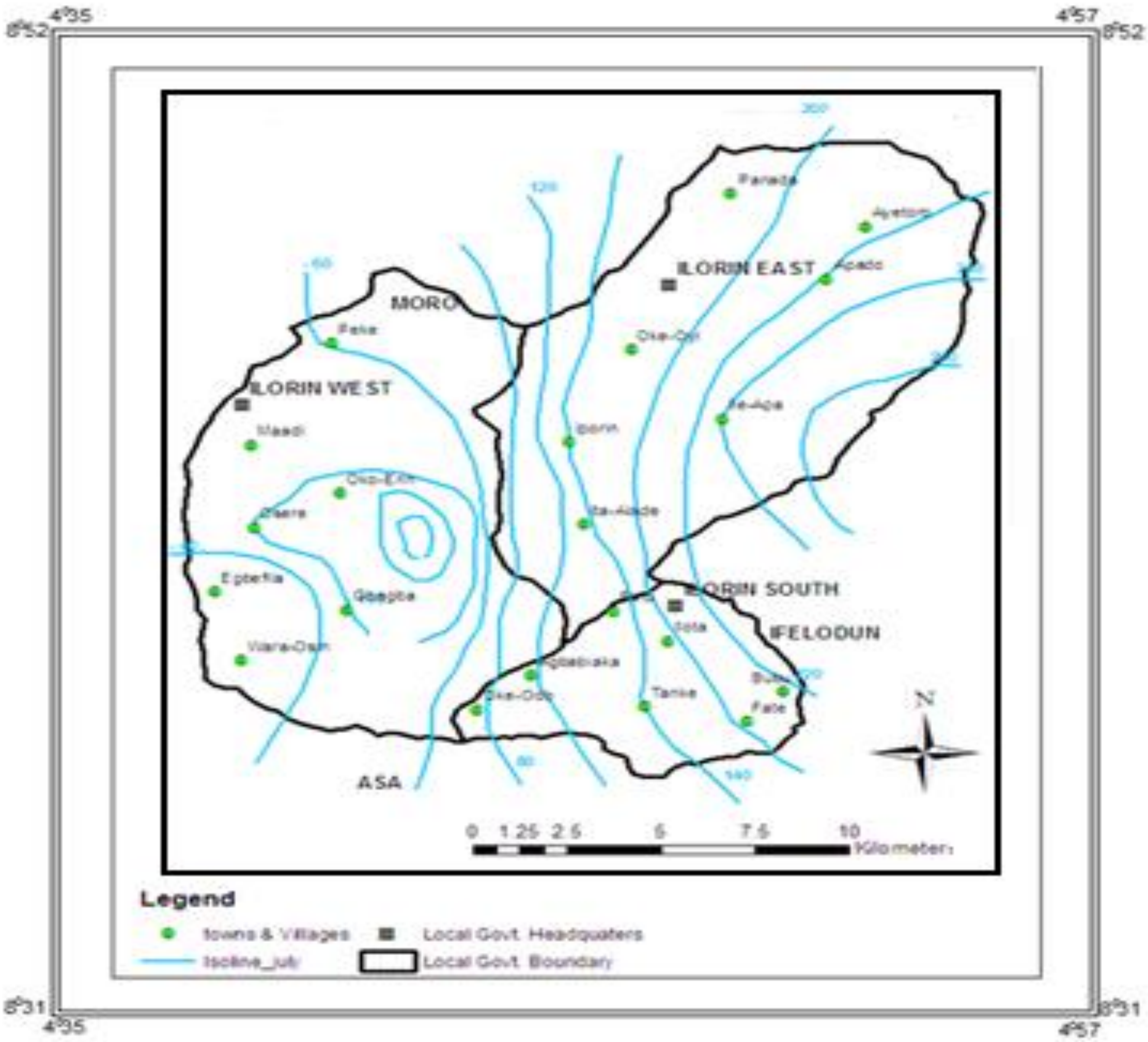


Fig 3: Mean Monthly ARI Deviation in July in Ilorin Area, Kwara State
Source: Field Survey, (2011)

For the month of July, the spatial A.R.I deviations from the mean indicate that the south western part of Ilorin had A.R.I values below the mean. The eastern part shows a positive deviation with maximum values obtained around the South eastern part of the study area. In general, the eastern part of the study area had positive mean deviation while the Western part had negative mean (Fig 3)

Mean Monthly ARI Deviation in August in Ilorin Area, Kwara State

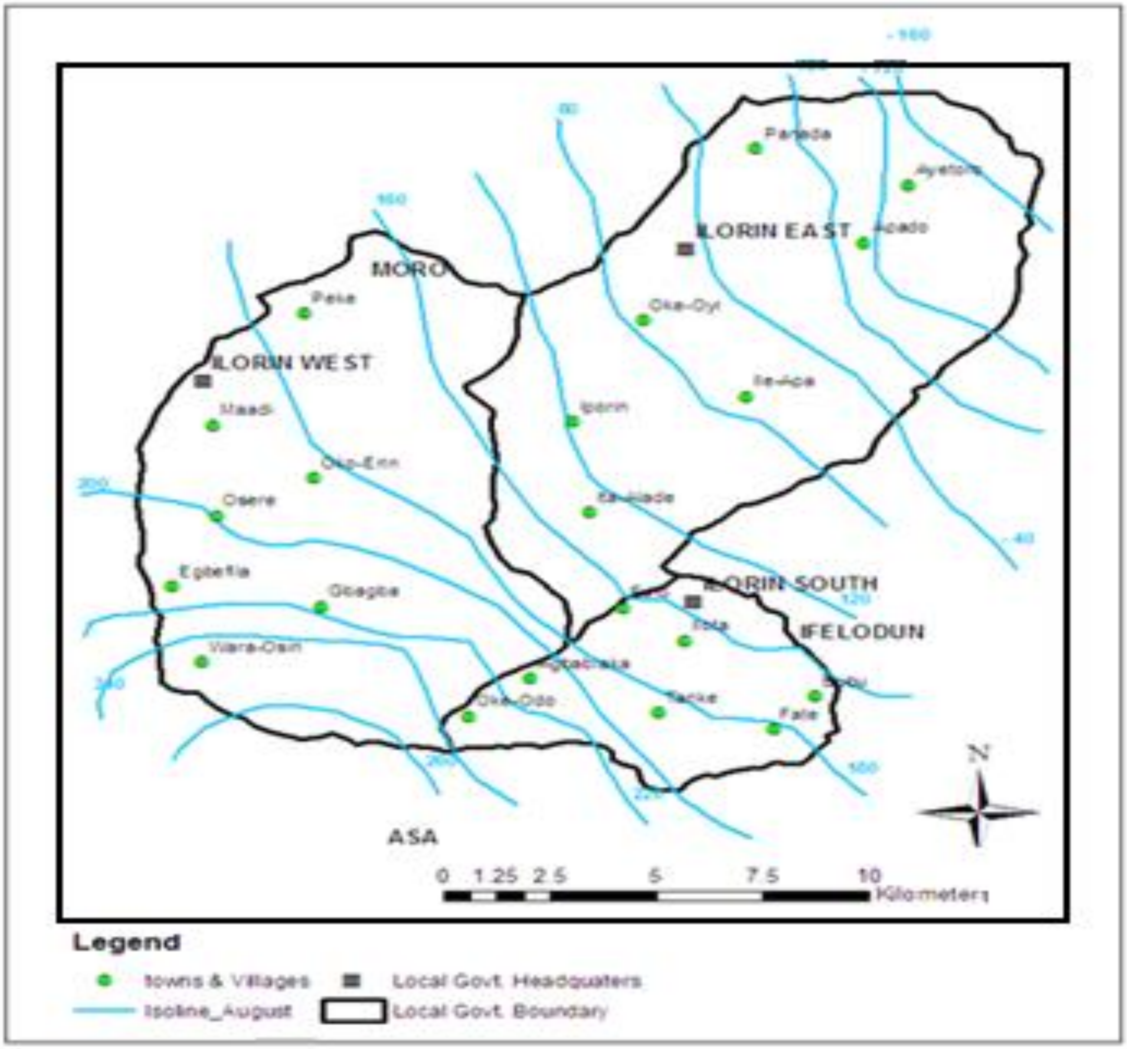
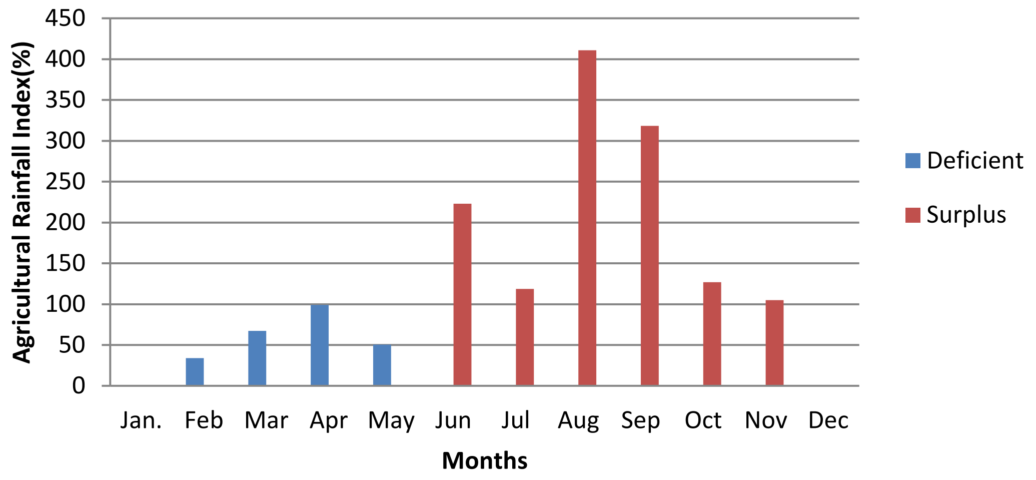
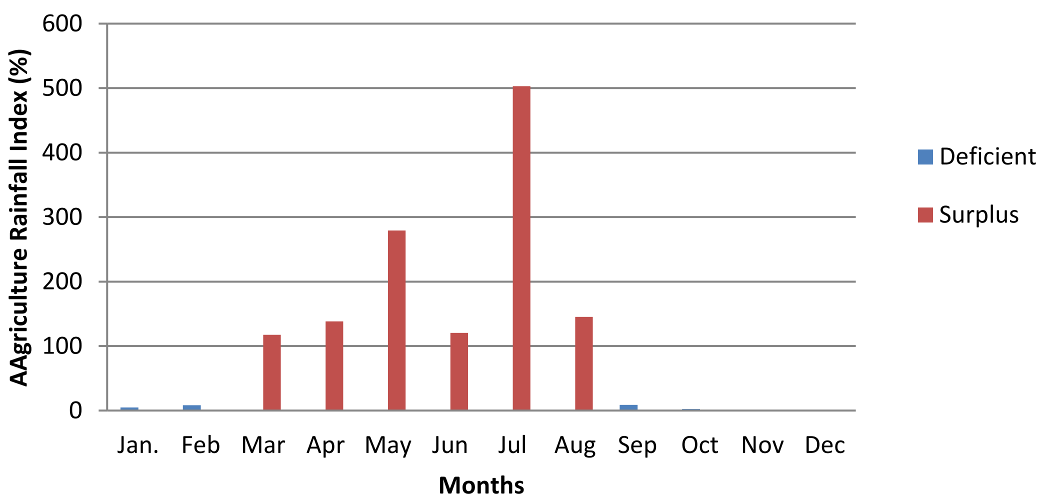


Fig. 4: Mean Monthly ARI Deviation in August in Ilorin Area, Kwara State
Source: Field Survey, (2011)

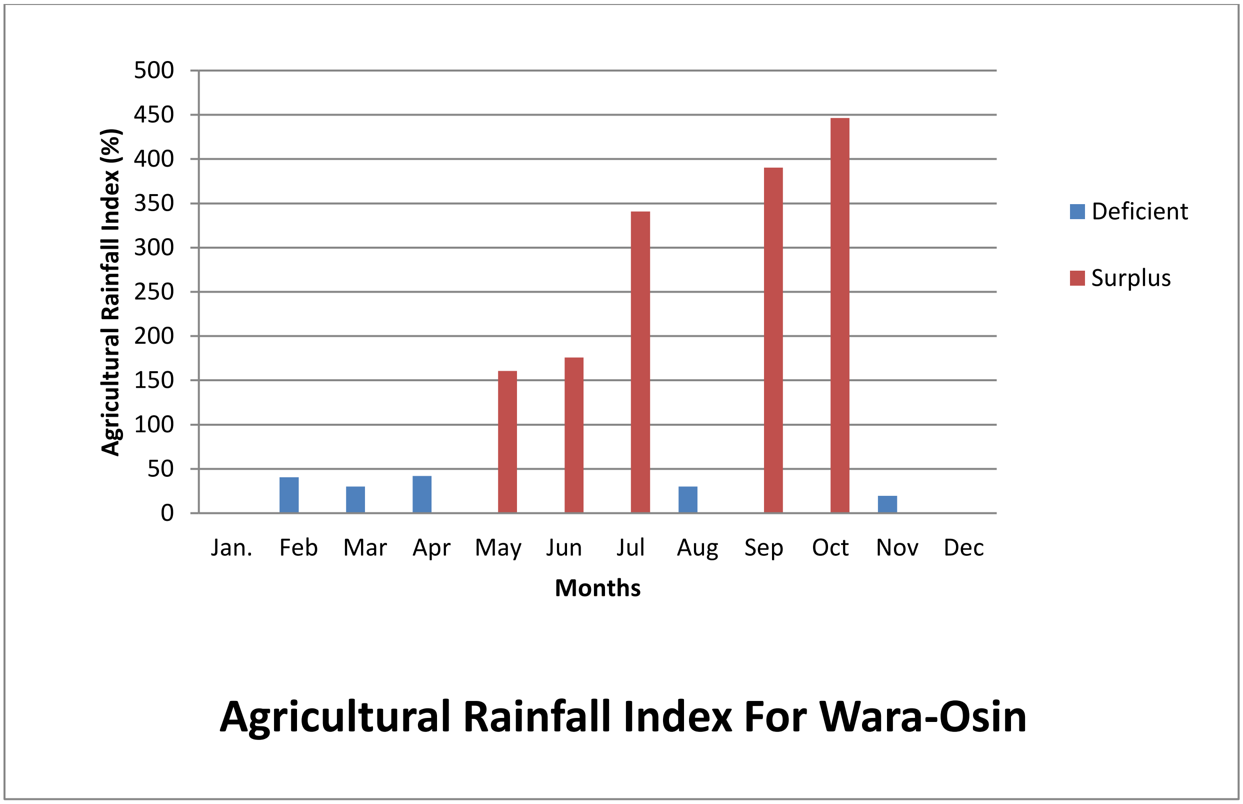
The month of August showed that A.R.I deviation varied from place to place. Fig. 4 revealed that the north eastern part of the study area had negative fluctuations while the north western and southern parts of the study area have positive values of mean A.R.I. Other variations in A.R.I mean deviations values can be seen in Table 2 and Figure 5

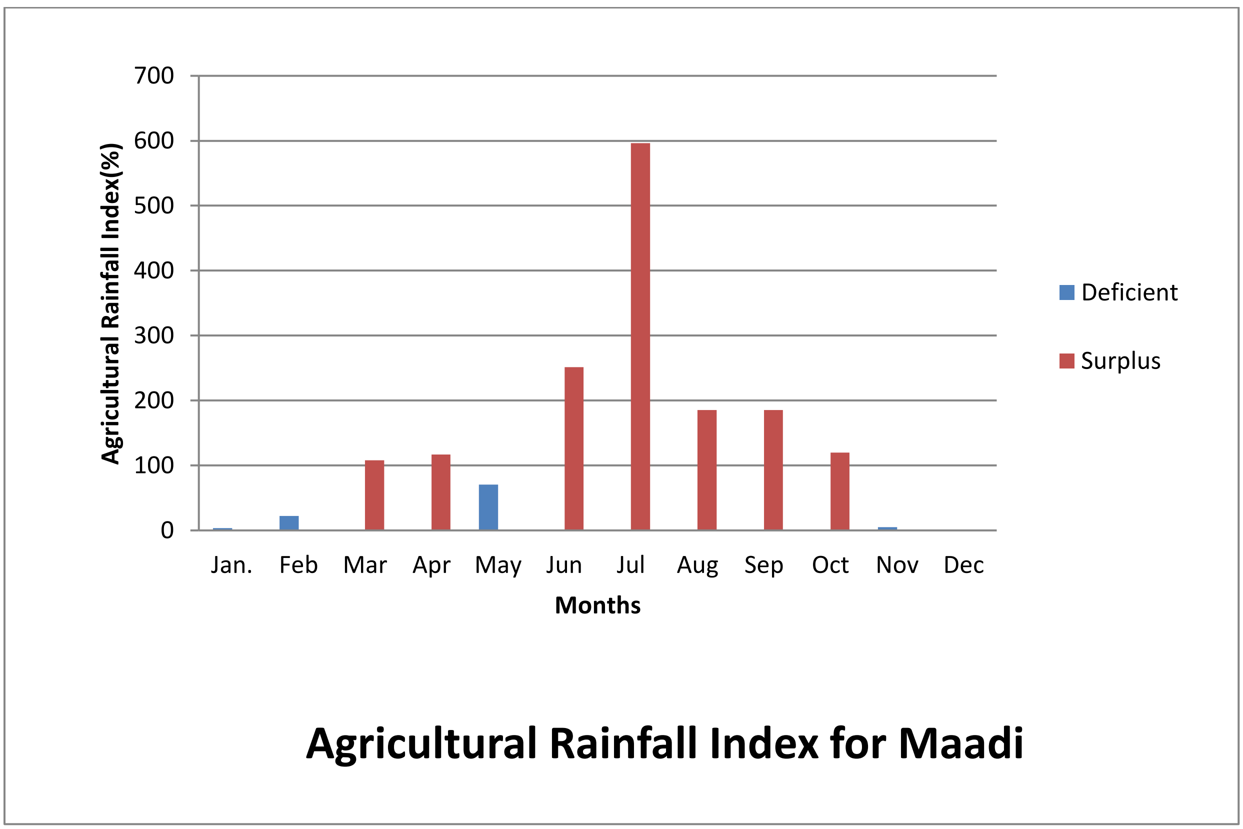


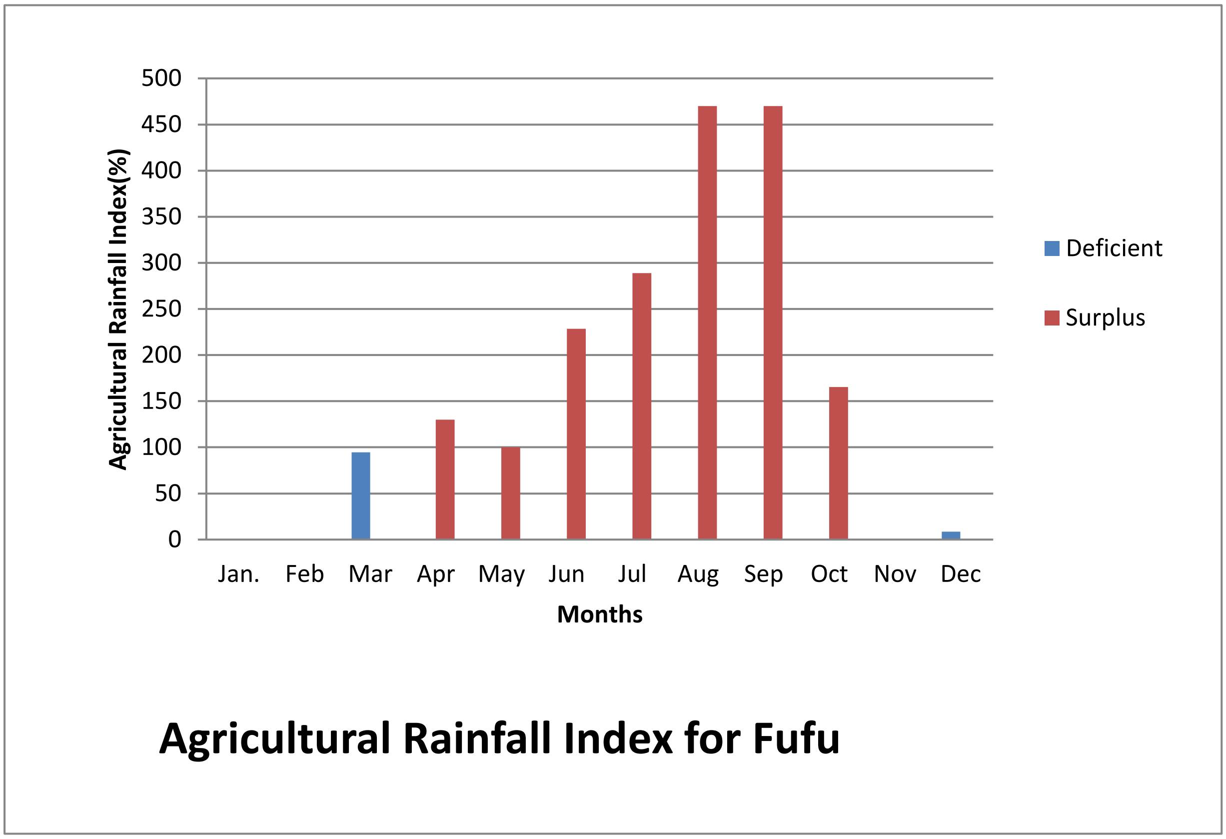
Agricultural Rainfall Index for Oke-Oyi



Agricultural Rainfall Index for Panada


500
450
400
350
300
250
200
150
100
50
0
Agricultural Rainfall Index (%)
Jan.
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Months
Deficient
Surplus
Agricultural Rainfall Index For Wara-Osin


700
600
500
400
300
200
100
0
Agricultural Rainfall Index(%)
Jan.
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Months
Deficient
Surplus
Agricultural Rainfall Index for Maadi


Agricultural Rainfall Index(%)
500
450
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350
300
250
200
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100
50
0
Jan.
Feb
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Aug
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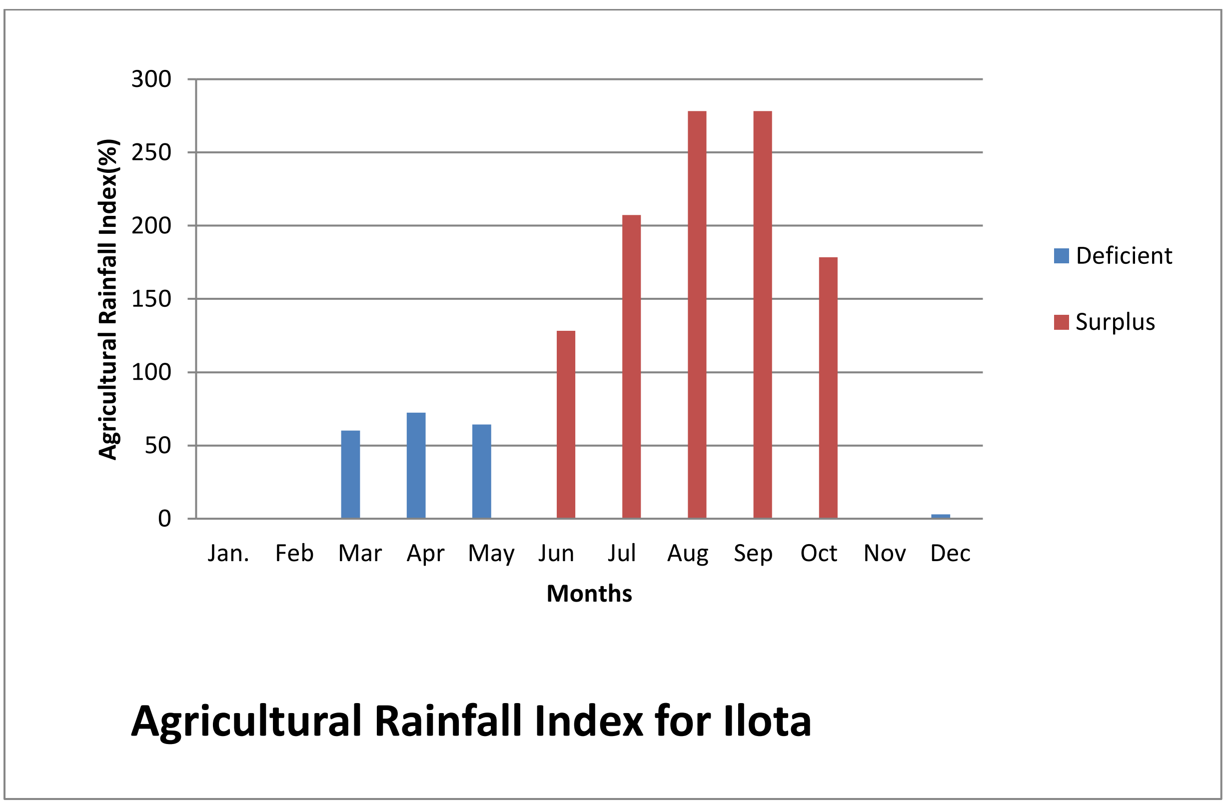
Oct
Nov
Dec
Months
Deficient
Surplus
Agricultural Rainfall Index for Fufu


Agricultural Rainfall Index(%)
300
250
200
150
100
50
0
Jan.
Feb
Mar
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Jun
Jul
Aug
Sep
Oct
Nov
Dec
Months
Deficient
Surplus
Agricultural Rainfall Index for Ilota

Figure 5

CONCLUSION AND RECOMMENDATION

In Conclusion, the A.R.I deviations shows that places around the eastern and south eastern parts of the study area tended to favour cassava growth and yield more. This is because the positive mean A.R.I deviations were more pronounced in these regions. The northern and north western parts however, were less supportive to cassava growth, yield and development. It is therefore recommended that attention should be given to crop-weather studies to understand the mechanism of growth in cassava, the attainment of this recommendation will ensure maximum yield in cassava production and thereby improve the existing cassava industry in the country.

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