Modeling Temperature as a Constraining Factor for Cocoa Yield in Ondo State

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Abstract

This research work has focused on the contribution of temperature on the yield of cocoa in Ondo state. A supervised classification was done to show the locations and the corresponding temperature. The interpretation charts show that months with high cocoa yield are relatively hot with temperature above 30^{o}C. Abrupt monthly mean temperature below 30^{o}C during the fruiting period—November to January correspond to low sunshine, thereby impeding ripening and quick drying of cocoa beans, hence low cocoa production. It has also shown the temperature range (27°C - 33°C) in the cocoa producing areas of Ondo state. This was achieved by the temperature model for cocoa production in the state.

Keywords: Temperature, cocoa production, sustain, location, constraining.

Introduction

Cocoa is a well-known crop around the world, the reason for its prominence could be attached to its importance as a commercial crop earning foreign exchange and/or its level of consumption. Cocoa bean, a dried and partially fermented fruit of the cocoa tree is a major constituent of chocolate and other beverages. Cocoa is believed to be produced principally in the developing country, having West Africa as its base particularly in areas along the equatorial region. Nigeria, a major cocoa bean exporter, has earned huge revenue of about half of the total export of major agricultural products from the cash crop (CBN, 1998). As a matter of fact, no agricultural product has ever earned foreign exchange for Nigeria as cocoa. The Nigerian economy has received tremendous boost from cocoa exportation, in terms of wealth and job creation for its citizenry, in the recent decades. A significant population of Nigeria earns their living from cocoa cultivation, thereby providing direct or indirect employment opportunities. Accounting for 70 per cent of Nigeria's annual cocoa production of 242,000 metric tonnes in 2008, the South Western states of Nigeria, which include: Ondo, Oyo, Osun, and Ekiti are regarded as the cocoa belt of Nigeria. Of the cocoa producing states in Nigeria, Ondo state—a south western state which lies in the rainforest zone of Nigeria has its annual cocoa production scaled over 50% of the total cocoa production in the country. Cocoa has been the source of revenue and economic sustenance to both people and government of Ondo state.

However, it is rather sad to know that cocoa production in Nigeria which was at its best decades ago has diminished in recent years. This falloff was attributed to 'poor soil quality' (Ajobo, 1980; Egbe, 1989) and most importantly irresistible climatic factors, especially rainfall and temperature. To salvage cocoa production from total collapse in Nigeria, the federal government has empowered some research institutes, such as the National Space Research and Development Agency (NASRDA), to use the newest technology to study the Ondo state cocoa producing areas for sustainable and optimum production.

This research work is, however, aimed at modeling temperature as an irresistible agro-meteorological constraining factor for cocoa yield in Ondo state.

Sampling, Materials and Methods

A total of 17 sampling locations (cocoa farmlands), which are located within the cocoa producing local governments of Ondo State were visited. Data were collected from each of these sampling locations, and a uniform sampling method was used in all. At each sampling location, the GPS reading of three randomly-chosen points around the farmland were taken and recorded. A soil point was strategically chosen within the farm where GPS reading and Elevation were taken and recorded. The soil type and vegetation were also mechanically determined and recorded for each of the farmlands visited. See table 1.1.

Garmin manufactured hand-held Global Positioning System GPS (Model - GPS76) receiver with a built-in Quad Helix antenna, and Wide Area Augmentation System (WAAS) capable, of a good accuracy was used for collection of co-ordinate data i.e. Longitude and Latitude in the farmlands. At every sampling point, the GPS receiver after it was powered on, initializes and starts acquiring satellites. The GPS receiver remains in this mode until it has acquired at least three satellite signals. But after acquiring at least four satellite signals, the receiver enters into the 3D GPS Location where the information is provided by the GPS on current position and altitude in the farmland. The sampling location was therefore recorded at this stage. This aided in GIS cocoa farmland map classification.

The temperature classification (Figure 1.2) was carried out using the Inverse Distance weighted (IDW) interpolation method. Surface interpolation is any formal technique that uses values at sampled locations to predict values at un-sampled locations. Inverse Distance Weighted (IDW) interpolation implements a basic law of geography—things that are close to one another are more alike than things that are far apart. To predict a value for any unmeasured location, IDW uses the measured values surrounding the prediction location. Those measured values closest to the prediction location have more influence on the predicted value than those that are farther away, hence the name 'inverse distance weighted'. IDW assumes that each measured point has some local influence that diminishes with distance. This method was used for interpolation in the analysis.

Results

Table 1.1 shows the results recorded from 17 strategically-chosen farmlands within the cocoa producing region of Ondo state. The record consists among others, the vegetation observed in each farmland, the location (longitude and latitude), and the elevation above the sea level. The monthly average temperature and the total yield from the Ondo state producing areas as gathered from the Ministry of Agriculture, Akure, Ondo state, Nigeria is shown in table 1.2(a). Table 1.2(b) is the summary of table 1.2(a).

Table 1.1: Meteorological factors as recorded from the sampled cocoa farmlands

S/N	Sampling Locations	Sampling Crop	Soil Type	Geographysical		Meteorological	
				Location		Vegetation	Elevation(m)
				Latitude	Longitude		
1	Ikpemen	Cocoa	Highly Laterized soil	7º 15′ 04.90″	5º 35′ 57.8″	Tropical rain forest	287.5
2	Ago-panu	Cocoa	Sandy soil	7º 17′ 19.60″	5º 36′ 59.6″	Savannah	260.3
3	Okeluse	Cocoa	Sandy soil	6°47' 49.00″	5°35'16.6″	Tropical rain forest	110.2
4	Ute	Cocoa	Dark loamy	6°52' 12.90″	5°36'20.7″	Tropical Rain forest	101.3
5	Arimogija	Cocoa	Dark loamy	6°49' 19.30″	5°41'40.2″	Tropical Rain forest	78.4
6	Ipele	Cocoa	Highly Laterized soil	7°03' 14.80″	5°40'53.5″	Savannah	178.5
7	Igbara-oke	Cocoa	Sandy soil	7°22' 47.30″	5°03'1.90″	Tropical rain forest	343.3
8	Ilara-mokin	Cocoa	Sandy soil	7°20' 41.50″	5°06'7.00″	Tropical rain forest	340
9	Ibule-soro	Cocoa	Sandy soil	7°19' 04.10″	5°06'49.4″	Tropical rain forest	383.9
10	Uso	Cocoa	Sandy soil	7°15' 28.50″	5°25'9.10″	Tropical rain forest	326.6
11	Ogbese	Cocoa	Sandy soil	7°14' 03.00″	5°22'57.7″	Tropical rain forest	304.5
12	Oba-Akoko	Cocoa	Highly Laterized soil	7°22' 02.20″	5°43'21.3″	Tropical rain forest	304.7
13	Ondo	Cocoa	Sandy soil	6° 58' 25.20″	4° 50' 54.1″	Tropical rain forest	227.2
14	Ile-oluji	Cocoa	Sandy/Laterized	7° 09' 45.70″	4° 51' 44.2″	Tropical rain forest	253.3
15	Idanre	Cocoa	Sandy soil	7° 10' 38.60″	5° 09' 00.1″	Tropical rain forest	297.6
16	Oda-Akure	Cocoa	Sandy/Laterized	7° 09' 48.80″	5° 14' 53″	Tropical rain forest	324.6
17	Ifon	Cocoa	Sandy soil	6°55' 00.70″	5°45'4.70″	Tropical rain forest	185.8

Table 1.2(a): Average Monthly Temperature and total yield for 2005 -2007 collected from ministry of Agriculture

	2005		2006		2007	
	Temp. (°C)	**Yield (MT)**	**Temp. (°C)**	**Yield (MT)**	**Temp. (°C)**	**Yield (MT)**
January	31.35	10,040.00	26.65	7,210.00	32.77	6,303.00
February	30.02	4,685.50	27.68	4,075.00	32.75	980.50
March	29.63	2,973.50	31.03	2,103.50	32.84	243.00
April	31.21	1,206.50	31.16	3,742.00	31.90	410.00
May	29.94	1,397.50	25.98	4,254.00	31.25	1,508.00
June	30.38	1,796.50	26.05	3,745.00	29.55	826.00
July	27.64	1,184.50	26.68	3,035.50	31.21	960.50
August	27.98	1,873.00	25.50	3,243.50	31.30	2,706.00
September	26.63	3,196.50	27.27	3,328.50	31.12	2,822.50
October	26.03	5,179.00	29.45	4,757.00	31.40	4,377.50
November	30.88	13,516.50	31.48	12,066.00	32.86	9,647.00
December	28.53	10,027.50	29.89	10,275.50	32.37	14,220.50
TOTAL		**57,076.50**		**61,835.50**		**45,004.50**

Table 1.2(b): Average Annual Temperature and total yield for 2005 -2007 collected from ministry of Agriculture

	2005	**2006**	**2007**
Temp. (°C)	29.19	28.24	31.78
Yield (MT)	57,076.50	61,835.50	45,004.50

Discussion of Results

Ondo state, the study area, is one of the Nigerian southwestern states (figure 1.1) positioned along the coast of West Africa. Ondo state has a coastline of about 73Km out of the 853Km Nigeria coastline. Figure 1.1 shows the even distribution of the sampling points which were located such that at least one sampling point belonged to each local government area within the producing area.

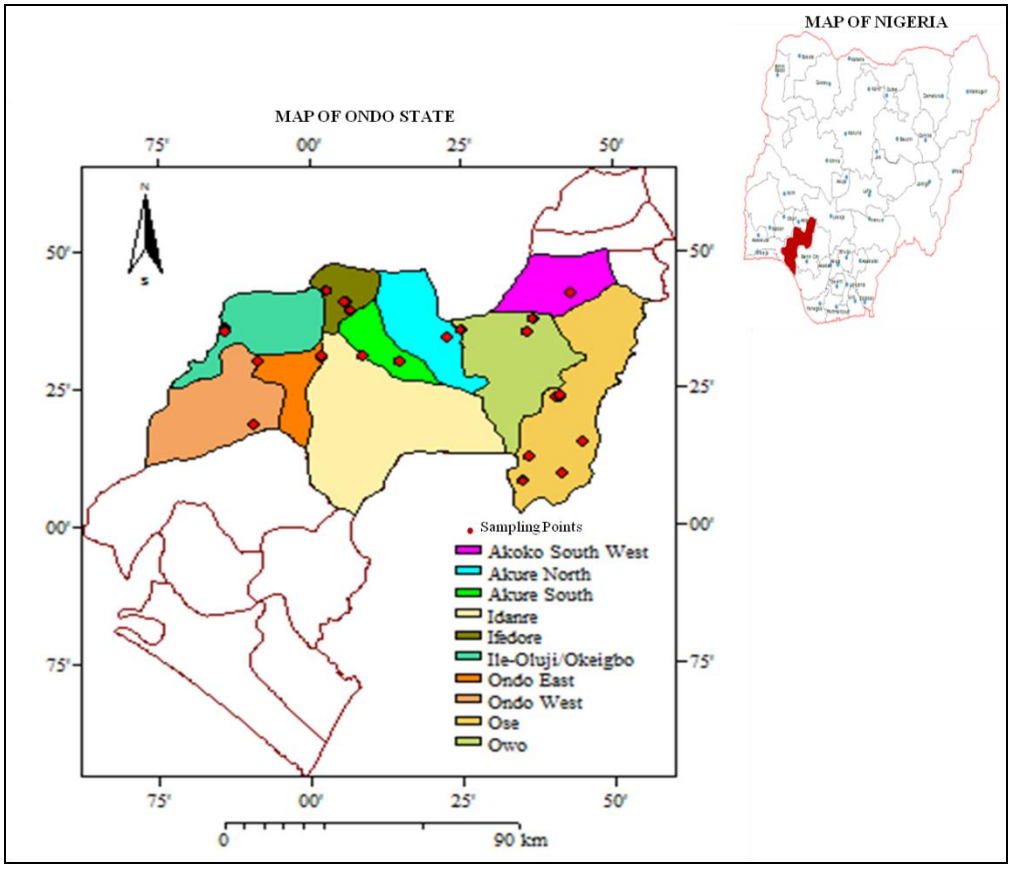

Figure 1.1: The study area

The temperature classification (figure 1.2) was achieved by the 'Geo-statistical' and 'Spatial analyst' accessories of the ArcGIS 9.3 application package. An Integrated Land and Water Information System (ILWIS 3.0) was also employed in the classification process. The figure (1.2) simply depicts the average distribution of temperature over three years within the sampling region. The classification reveals that the temperature range in the region is between 29.85°C and 34.08°C. Places like: Ifedore and Ilara-Mokin has high temperature range 33.23°C—34.08°C, and lowest temperature range of 29.85°C—30.696°C in places like: Ago-Panu, Ipele, Okeluse, Ifon, Ikpemen e.t.c

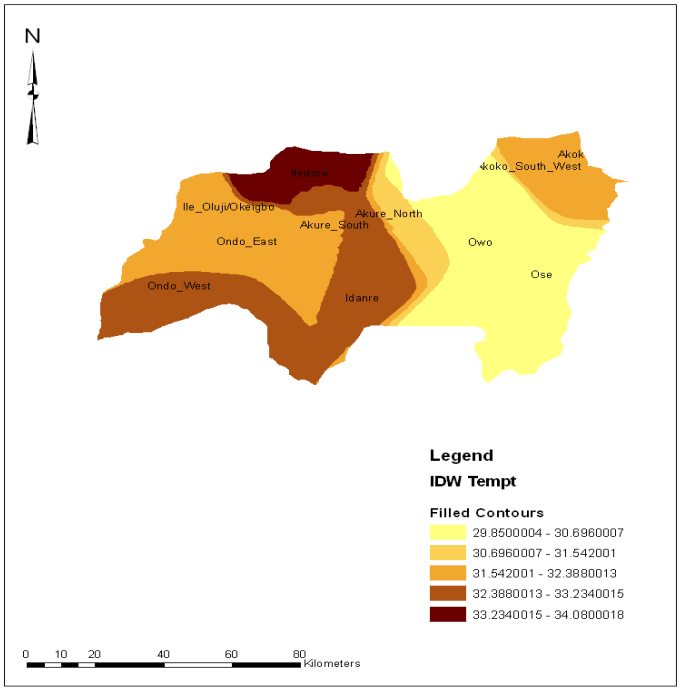

Figure 1.2: Temperature classification within the study area

Figures 1.3 – 1.5 show the monthly chart comparing yield and temperature for 2005 – 2007.

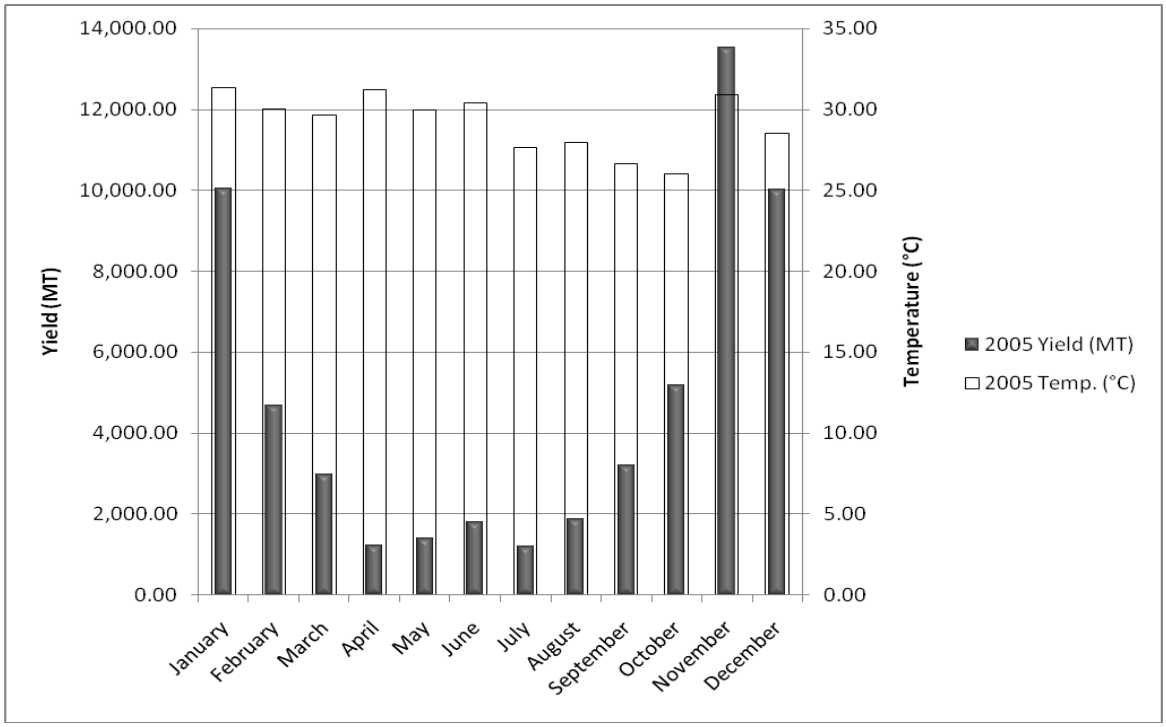

Figure 1.3: The monthly Temperature and Yield for year 2005

The highest yield (13,516.50MT) experienced in November, 2005 was when the average temperature was 30.88°C. Likewise, the lowest yield (1,184MT) in the same year 2005 (July) was experienced when the temperature was 27.64°C, the same temperature range when the yield was highest. The lowest average temperature—26.03°C was experienced in October that year when the yield was 5,179MT (figure 1.3). Figure 1.3 shows that between January to June, the temperature spread is within 30°C. The January temperature greater than 31°C led to very high yield close to 10,000 MT. When the temperature fell below 30°C from February, the yield reduced and there is no recovery in yield until November when the temperature rose above 30°C after an abrupt low temperature of less than 27°C in October. This shows that although the fruiting and ripening of cocoa is seasonal, low mean monthly temperature below 30°C can produce low yield of cocoa.

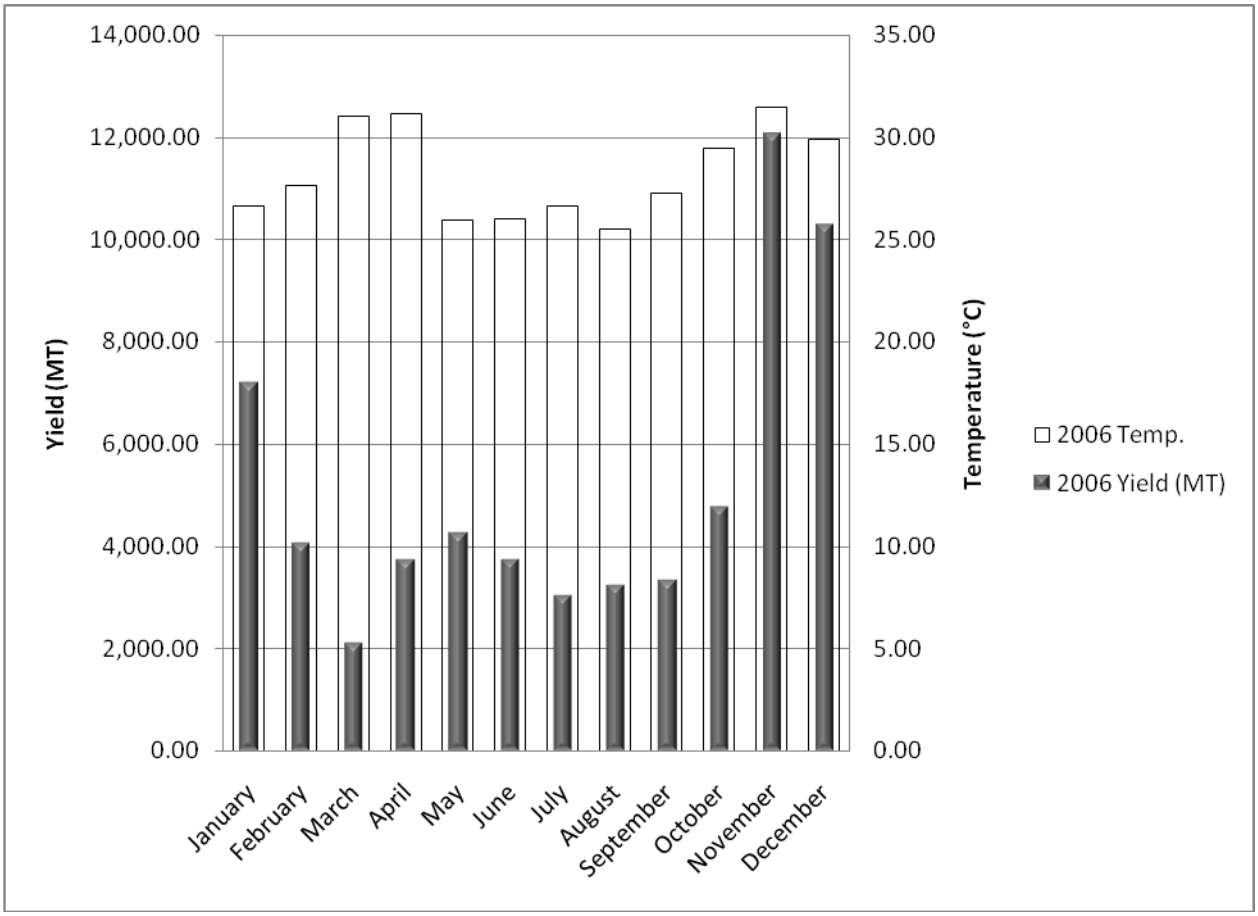

Figure 1.4: The monthly Temperature and Yield for year 2006

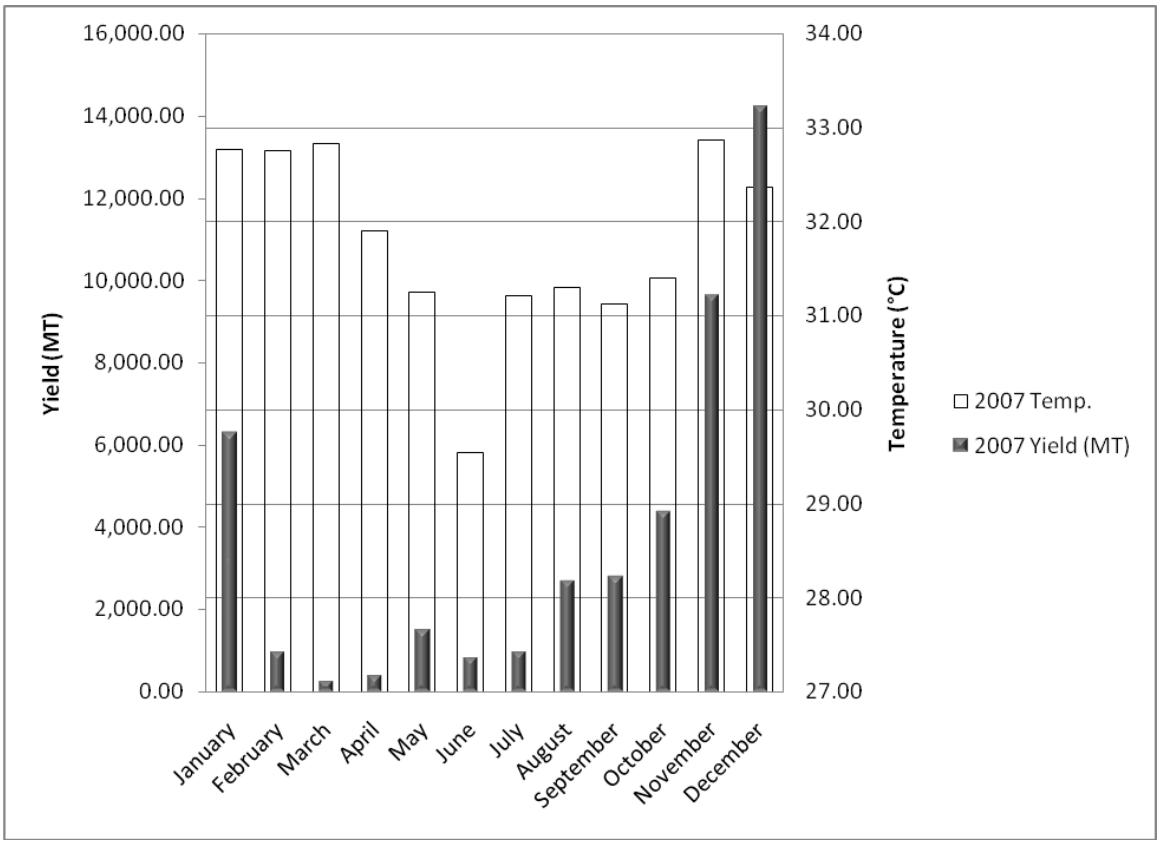

Figure 1.5: The monthly Temperature and Yield for year 2007

Conclusion

This study has revealed the areas within the state where temperature is highest as: Ifedore and Ilara-Mokin, and lowest—Ipele, Ikpemen, Ago-Panu e.t.c. in Ondo state cocoa producing region (figure 1.2).

It was observed that the months that usually experience high yield (November to January) are relatively hot with temperature around 30°C in year 2005 and 2006 (figure 1.3 & 1.4), and close to 33°C in 2007 (figure 1.5). Owing to this, the high sunshine resulting from high temperature is advantageous as it is needed for ripening of cocoa pods and also for drying of cocoa beans, hence a boost to overall cocoa yield.

On the contrary, however, low sunshine resulting from low temperature could impede the cocoa-ripening rate of cocoa pods and drying of its beans, and hence a retard in cocoa yield.

It was also observed from figures 1.3 – 1.5 that temperature has no 'direct' or 'sole' effect on the yield of cocoa, as temperature does not have a direct variation against yield in the study area towards the middle of the year (2005 – 2007).

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