

Mathematical Modelling For Food Security in Nigeria (A Case Study of Taraba State)

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Abstract: Prices of agricultural commodities have been increasing considerably year after year. This upward trend in agricultural prices captured the world's attention as a new food crisis was emerging. The aim of this paper is to use time series equations to forecast the prices of agricultural commodities, since price is one of the factors that can determine food security in any country. Data were collected on monthly basis for the prices of five agricultural commodities for the period of nine years (2008-2016). The commodities include local rice, cassava flour, Red maize, White beans and Red guinea corn (measured in a bowl used for measuring things in the northern part of Nigeria called mudu). The models formulated for the selected commodities were used to forecast the prices for these commodities in the future from 2017 to 2030. The results showed that the prices of the commodities will keep increasing if proper agricultural policies are not put in place which will help to increase the yield of these commodities which will in turn reduce its prices. It is only when such is achieved that Nigeria as a nation can boast of food security.

Keywords: Price, Food Security, Commodities, Forecast, Agriculture.

I. INTRODUCTION

Food can simply be defined as anything that we take when we are hungry to quench hunger. Jenkins and Scanlan (2001), stated that food is the most basic of human needs and it is the centre to the discussion of human rights and social development [12]. Hunger is usually understood as an uncomfortable or painful sensation caused by insufficient food energy consumption. Scientifically, hunger is referred to as food deprivation. Hunger is both a violation of human dignity and an obstacle to social, political and economic progress. International law recognizes that everyone has the fundamental right to be free from hunger, and 22 countries have enshrined food rights in their constitutions. National governments must do everything possible to ensure that people have the physical and economic access to enough safe, nutritious food to lead healthy and active lives. Food security and hunger are by no means tightly-defined concepts and different definitions arise depending on the number of factors involved (Masset E.2010) [13]. Food security is a difficult concept to measure since it deals in very broad terms with the production, distribution and consumption of food. Food insecurity on the other hand lends itself more readily to measurement and analysis. It should be stressed that food security and famine

and hunger are not to be confused: food security refers to the availability of food whereas famine and hunger are the consequence of the non-availability of food, in other words the results of food insecurity. Despite considerable efforts of national governments and the international community to reduce hunger and improve nutrition in the context of the Millennium Development Goals (MDGs) and other initiatives, the proportion of undernourished people in developing countries has been largely constant since the mid-1990s (FAO, 2010) [8]. A rights-based approach to food security holds that people have a fundamental right to be free from hunger. It considers the beneficiaries of development not merely as passive recipients, but as active stakeholders. It also puts the primary responsibility on the State, requiring it to do everything possible to ensure people have physical and economic access at all times to enough nutritious, safe food to lead healthy and active lives (FAO, 1996)[7]. Food security is defined as the ability of people to meet their required level of food consumption at all times. This means that for any country to boast of food security, food must be available at all times, it must be accessible; there must be quality nutritious food and stability of food for the entire populations. Food security describes a country's access to food of sufficient quantity and quality at all times either from domestic production or world food markets. Accordingly, a country is considered food secure at the macro level if domestic food production is sufficient to meet the domestic food demand, if the country's external balance and currency reserves allow for importing sufficient food (also in times of global food price spikes), or both (Diaz-Bonilla, Thomas, and Robinson 2002[5]; Pinstrup-Andersen 2009)[16]. Food is a fundamental human right. And yet one in nine people around the world (805 million) go hungry every day (FAO, IFAD and WFP 2014).

The World Food Programme defines availability as "The amount of food that is present in a country or area through all forms of domestic production, imports, food stocks and food aid". (WFP, 2009, p.170) [19].

This paper is organized as follows; section I, contains the introduction, section II contains the related work, section III contains methodology, section IV contains results and discussion, section V contains conclusion while section VI contains recommendations.

II. RELATED WORK

Food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (Stamoulis K and Zeeza A2003)[17].

Amaka G. Metu et al (2016), stated that Sustainable food security is an access by all people at all times to enough food for an active healthy life at present plus the ability to provide enough for future generation[1].

Food security in Vietnam should be seen as a key element of development and adaptation to climate change (Hoang Xuan Thanh et al, 2013)[11].

USAID (2005); defines food security as the state when, “when all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life[18].

Food security is defined as the ability of people to meet their required level of food consumption at all times (Wole Ogundare 2015) [20].

Food production will have to grow substantially by the middle of the century in order to feed a more populous and richer world (Fouré et al., 2013) [9].

The World Bank Committee on World Food Security defines food security as the “physical and economic access to adequate food by all household members without undue risk of losing the access.

FAO report (2004) emphasised that agriculture is a key to food security in many parts of the world. The report indicates further that agriculture contributes to poverty alleviation by reducing food prices, creating employment, improving farm income and increasing wages [7].

The issue of food security really came to the fore in the 1970s and at the 1974 World Food Conference in Rome the first explicit acknowledgement was made that this issue concerned the whole of mankind. Violations of the right to food include blocking access on the grounds of race, sex, language, age, religion or political belief. In addition, food should not be used to exact political or economic pressure, for instance, through food embargoes or blocking humanitarian convoys. Paying attention to human rights is not just a lofty ideal; it is also an effective development approach. Research shows a link between civil and political freedom and economic growth. And protecting human rights can also prevent one of the most damaging obstacles to the right to food: famine. Ensuring the right to food involves many factors, from access to land to sufficient opportunities for earning income. The International Covenant on Economic, Social and Cultural Rights, which came into force in 1976, gave national governments the primary responsibility. States’ human rights obligations operate on three levels: Obligations to respect put limits on the exercise of State power. The State must not interfere with individuals’ livelihoods. If national legislation

is found to have such an effect, then immediate action must be taken to correct it. Obligations to protect require regulations against poor conduct by non-State actors that would hinder people from acquiring adequate, safe food. These regulations cover food hygiene, quality and labelling standards, labour conditions and land tenure. Regulations must also protect against unfair market practices, such as withholding price information or creating monopolies. Obligations to fulfil require action by the State to identify vulnerable groups and to design policies that improve their access to food-producing resources or income. As a last resort, direct assistance may be needed, to ensure that, at a minimum, people do not starve [19].

FAO report (2004) emphasised that agriculture is a key to food security in many parts of the world. The report indicates further that agriculture contributes to poverty alleviation by reducing food prices, creating employment, improving farm income and increasing wages. The Food and Agriculture Organization of the United Nations (FAO) State of Food Insecurity for 2010 assesses that nearly 1 billion people are estimated to be undernourished, representing almost 16 percent of the population of developing countries [7].

It is generally recognized that food security, and therefore food insecurity, is a multi-dimensional phenomenon. Several indices measuring hunger and the progress in achieving hunger eradication helped understanding the issue and monitoring the progress in eliminating hunger as well as providing targets for national and international political action (Clay Ed., 2002) [3].

However, none of these indexes reach to capture all aspects of food insecurity, as stated by the Scientific Symposium on Measurement and Assessment of Food Deprivation and under-nutrition in 2002. The lack of a commonly accepted, comprehensive measure for food security on an international scale has been identified as one of the roadblocks on the way to the eradication of hunger and malnutrition (Heidhues and von Braun 2004). A suite of indicators is therefore needed to cover the different dimensions of food security: availability, access, utilization and stability[10].

Ojo and Adebayo (2012), stated that Nigeria needs to come up with food policy which is lacking in order to alleviate crisis is food security [14].

Massive food import, particularly by developing countries, usually has negative effect on foreign reserves and causes budgetary haemorrhage (Davies, 2009). Countries that are food-secure do not have this dreadful situation to contend with (Davies, 2009). In essence, a country should be considered as food-secure when food is not only available in the quantity needed by the population consistent with decent living, but also when the consumption of the food should not pose any health hazard to the citizens (Davies, 2009) [4].

Oliver Ecker and Clemen Breisinger (2012); In their study, observed that Macro- level food security is considered a necessary but not sufficient condition of micro-level food

security, whereas an individual’s nutritional status is a direct outcome of various micro-level factors and an indirect outcome of a set of macro-level factors [15].

III. METHODOLOGY

In this research, our main objective was to determine the state of food security in Nigeria in the nearest future with respect to the prices of the selected agricultural commodities. We consider prices because it is one of the factors that can affect food security.

Estimating Trends by Regressions:

The methods of moving averages that has been described is effective in eliminating the erratic and short- run components in a series and thereby revealing any long run trend in the series. However, when theory or experiences indicates that the trend should poses a simple structure, it is usually preferable to determine the trend directly and treat the erratic components as random variables For example, some series, it is to be expected that the terms will increase by a constant amount each year in which case the series will possess a linear trend. The standard method for determining a linear trend is the method of least square that was used for linear regression. This is accomplished by replacing the variable x by the variable t in

$$Y = \alpha + \beta x \quad \text{to} \quad Y_t = \alpha + \beta t \quad (1)$$

Which is $\bar{Y}t = \alpha + \beta t$

The estimates for α and β i. e a and b are then

$$b = \frac{\sum t_i y_i - n \bar{t} \bar{y}}{\sum t_i^2 - n \bar{t}^2} \quad (2)$$

Where $\bar{t} = \frac{\sum t}{n}$ and $a = \bar{y} - b \bar{t}$

In this work, we assign the values of x to the years so that $\sum x = 0$. The equation of the least square is written as

$$Y = \bar{Y} + \left(\frac{\sum xy}{\sum x^2} \right) x = \bar{Y} + bt \quad (3)$$

With the equations above, we obtain the following models for the five common food commodities in Taraba State;

Local Rice; $Y = 317 + 14.2t$ (4)

Cassava flour; $Y = 122 + 3.7t$ (5)

Red Maize; $Y = 177 + 16.5t$ (6)

White beans; $Y = 252 + 15.7t$ (7)

Red Guinea Corn; $Y = 179 + 20.1t$ (8)

Table 1: Data on averaged prices of some selected common food commodities per mudu in Taraba State

ITEMS	YEARS									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	
LOCAL RICE	278	278	278	300	300	320	345	350	400	
CASSAVA FLOUR	112	112	112	120	120	120	120	130	150	
RED MAIZE	142	142	142	150	150	150	150	250	300	
WHITE BEANS	205	208	208	250	250	250	250	300	350	
RED GUINEA CORN	138	138	138	150	150	150	150	250	350	

SOURCE: Taraba State Statistical Year Book

Formulated Models and Explanations

Graphs of the data for the five common food commodities in Taraba state



Figure 1: Graph of price of Local Rice

From this graph above, we discover that the price was stable from 2008 to 2010 and between 2011 and 2012, there was stable increment. From 2013, there was upward increment which gets to the pick in 2016.

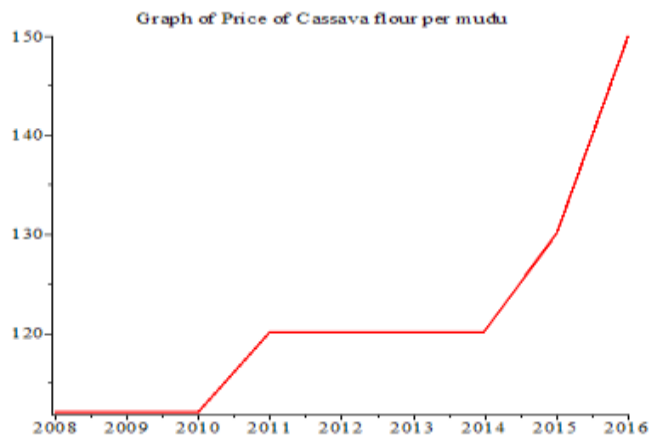


Figure 2: Graph of Price of Cassava

In the graph of price of cassava flour, we observed that there was a steady price from 2008 to 2010. In 2011, there was a slight increment which became stable till 2014 and then increases from 2015 till 2016.

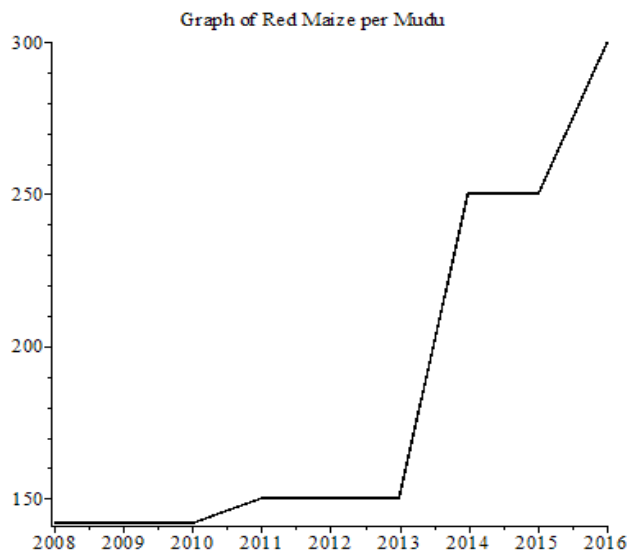


Figure 3: Graph of Price of Red Maize

From the graph of the price of Red Maize, we observed that between 2008 to 2010, there was stability in price and after that the price started fluctuating until 2015 when we observed upward increment in price.

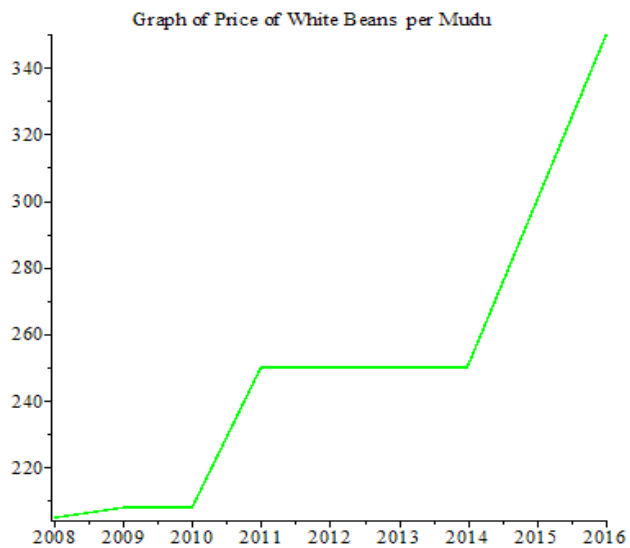


Figure 4: Graph of Price of White Beans

In the graph of White Beans above, we observed that from 2008, there was gradual increase in the price which became pronounced from 2010 and keeps fluctuating until 2014. From 2015 to 2016, there was upward increment in the price.

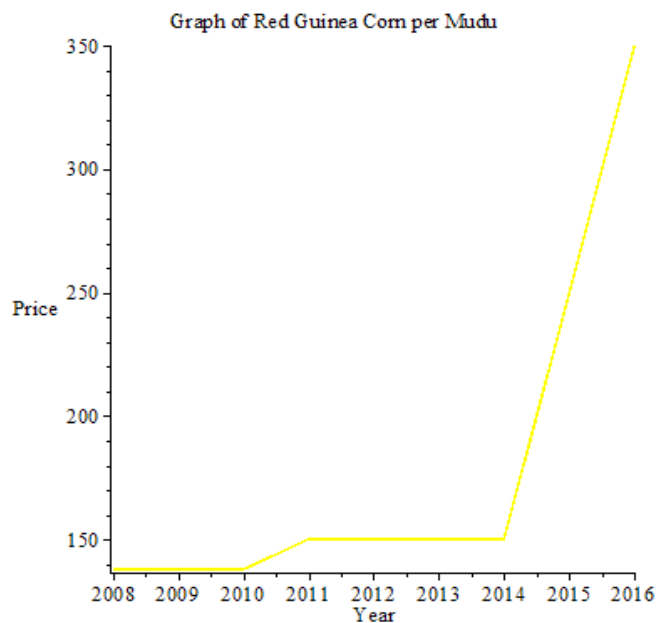


Figure 5: Graph of Red Guinea Corn

The graph of the price of Red Guinea Corn shows a stable price from 2008 to 2010 and gradual increment in 2011 which also remains stable until 2014. 2015 and 2016 shows an upward increment in price.

IV. RESULTS AND DISCUSION

Table 2: Forecasting the future prices of the selected food commodity from 2017 to 2030

Year	Local Rice	Cassava flour	Red Maize	White Beans	Red Guinea Corn
2017	385	140	260	330	120
2018	400	140	275	345	140
2019	415	145	290	360	160
2020	430	150	300	375	180
2021	440	155	325	390	200
2022	455	155	340	400	220
2023	470	160	360	420	240
2024	485	165	375	440	260
2025	500	170	390	450	280
2026	515	170	400	470	300
2027	530	175	420	485	320
2028	540	180	440	500	340
2029	555	180	455	518	360
2030	590	185	470	530	380

4.1: Graphs of the Projected Prices for the Five Selected Agricultural Products

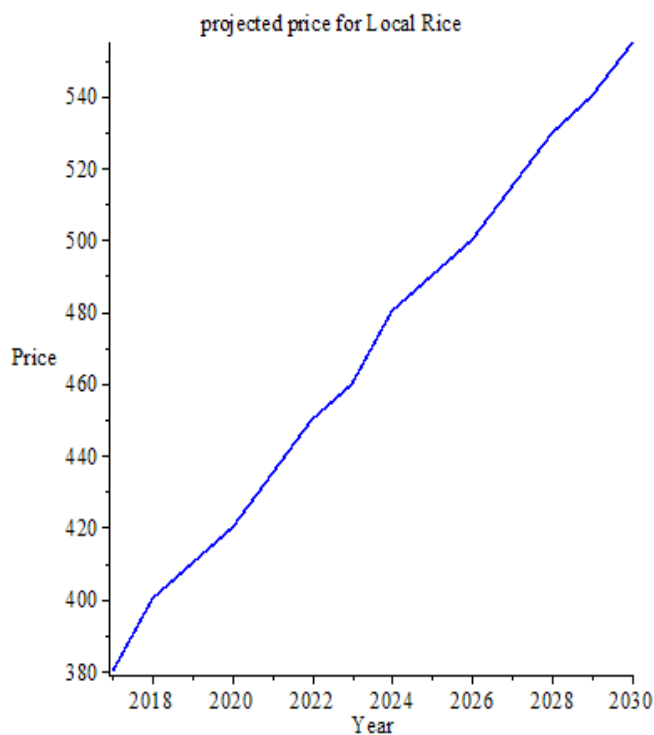


Figure 6: Graph of the projected Price for Local Rice

The graph of projected price of Local Rice shows that the price is not stable rather it keeps increasing from year to year.

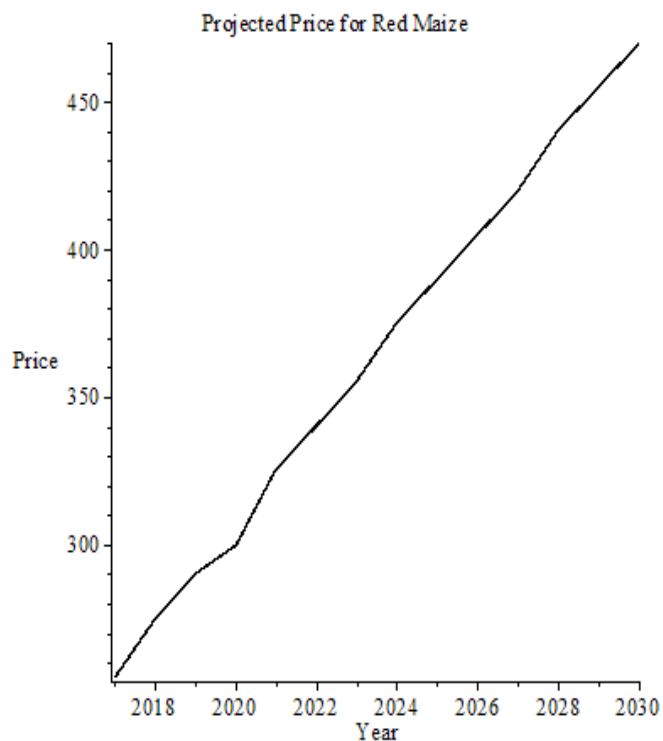


Figure 8: Graph of the projected Price for Red Maize

Price of Red Maize is not stable from this graph but keeps increasing.

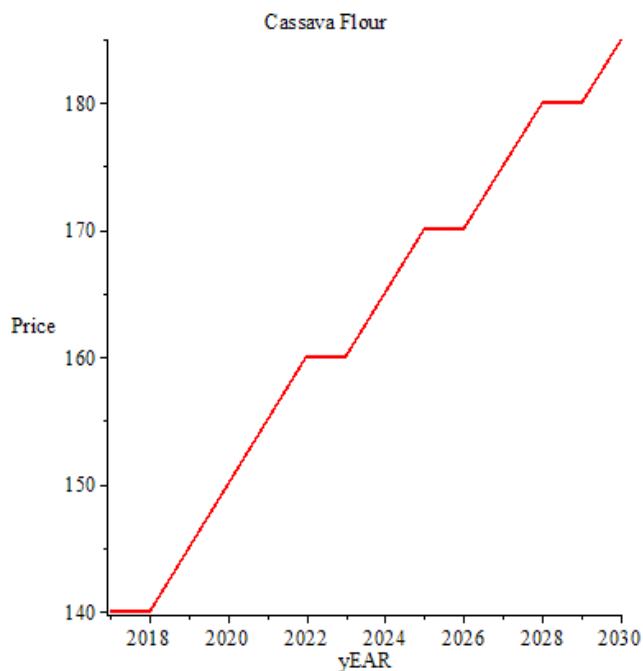


Figure 7: Graph of the projected Price for Cassava flour

From this graph of Cassava flour, we observed that the prices keep fluctuating from year to year.

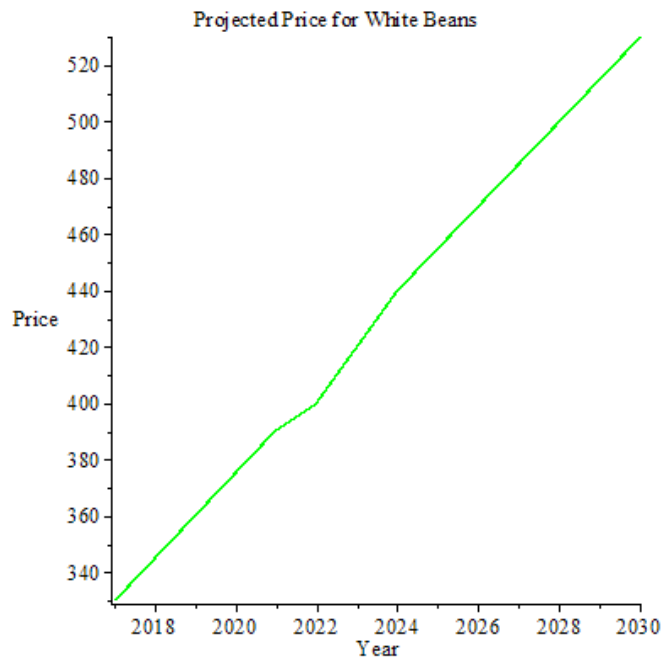


Figure 9: Graph of the projected Price for White Beans

The graph shows that the price of White keeps increasing from year to year.

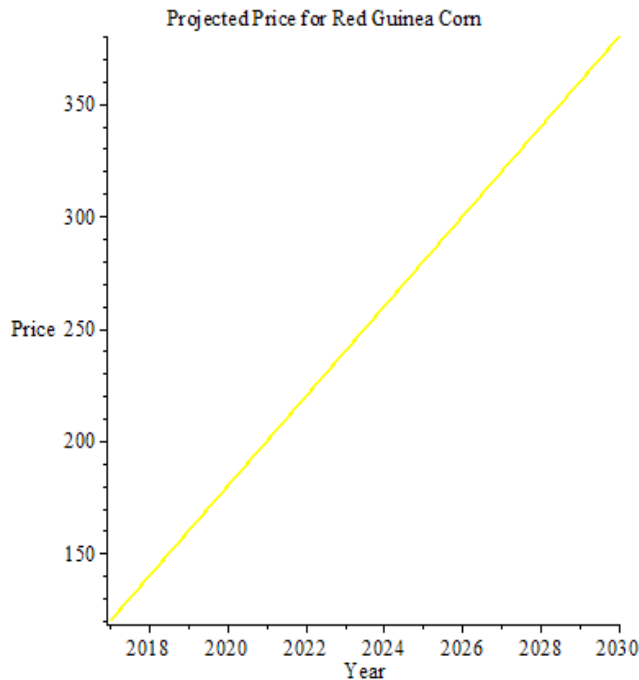


Figure 10: Graph of the projected Price for Red Guinea Corn

The graph of the projected price of Guinea Corn shows that the price is not stable but keeps increasing exponentially.

V. CONCLUSION

It is a known fact that we all need food to stay alive. Since we all eat food, there is need for the food to be available and affordable for all. From our results, we discovered that the prices of these selected agricultural commodities keep increasing from time to time. Considering the way the prices of these agricultural commodities are increasing, hunger and malnutrition are bound to be the order of the day in Nigeria. This is because as the prices keep increasing, the low income earners will find it difficult to provide enough food for the households. In order to avoid hunger and malnutrition in Nigeria, urgent attention is to be paid to food security.

VI. RECOMMEDATIONS

Youths should be encouraged to go into farming. Government should assist the farmers in the area of funding and acquisition of improved varieties of crops that will bring increase in yields. Government should establish agricultural policies that will govern everything concerning agriculture such as the prices of agricultural produce

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